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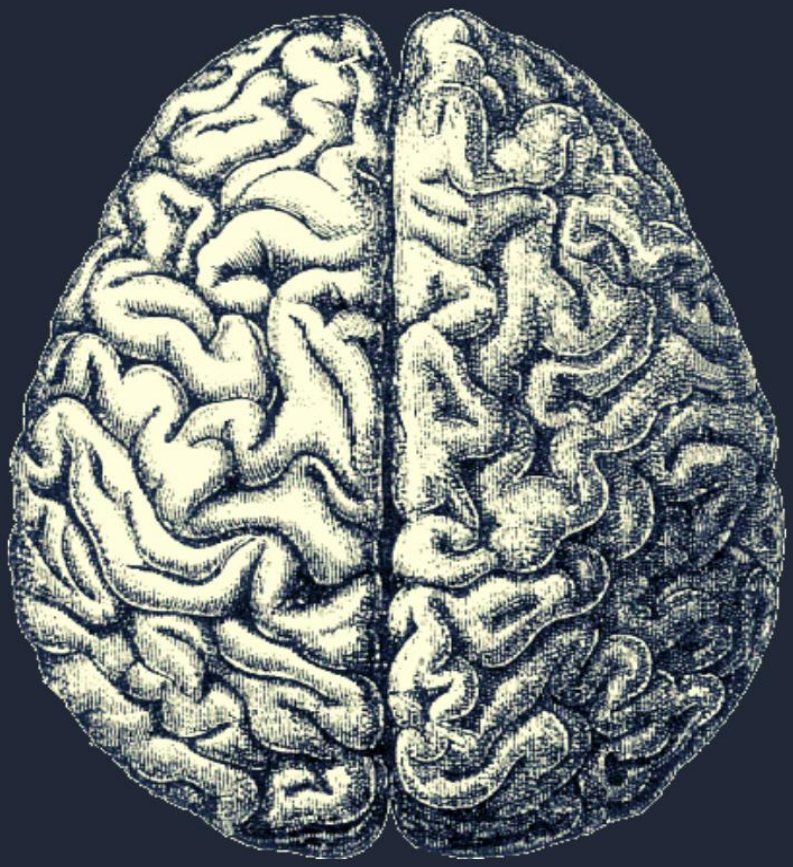

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Physiological alteration and anaesthetic drugs effects on intraoperative neurophysiological monitoring procedures

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Keywords
intraoperative neurophysiological monitoring, motor evoke potentials, eloquent areas, propofol, volatile agents, intravenous anaesthesia

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ABSTRACT

Intraoperative neurophysiological monitoring (IOM) and especially motor evoked potentials represents an important tool in the evaluation of the nervous system integrity and particularly of the motor tracts. A real and correct registration of the potentials with a proper interpretation of the modification is mandatory for an optimal outcome in eloquent areas, tumours, brainstem and medullary lesions. For all this to happen a suitable anaesthetic protocol must be used. Even though there is a large spectrum of anaesthetic agents at our disposal it is imperative to know their effect on the IOM signals recordings and the fact that some of them are dose-dependent. Drugs effects and physiological changes produced intraoperatively must be corrected before a shift in the direction of the surgical lesion resection it is taken. We present an overview of the action of the anaesthetic agents, most used protocols and the physiological alteration encountered in the operative theatre.

INTRODUCTION

Nowadays tumors located in functional areas of the brain, brainstem and medullary lesions still represents a challenge for many neurosurgeons because of the high risk of postoperatively permanent neurological deficits, but the technological development comes in our aid and the golden standard of maximal resection with minimal neurological disfunction can be reached more often using functional technique perioperatively [12,34,35,41,46].

Considering those date, intraoperative neurophysiological monitoring (IOM) represents a suitable modality for the assessment of the integrity of the nervous system with a real time feedback [32,45,52].

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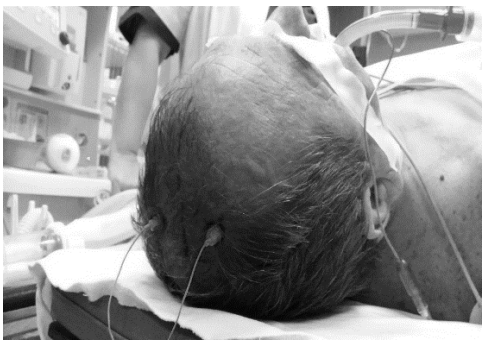
This technique includes various evaluation possibilities e.g., direct cortical / subcortical stimulation and monitoring modalities like motor evoked potentials (MEPs), somatosensory evoked potentials (SSEPs), brainstem auditory evoked potentials (BAEPs), electromyography / free running EMG. For proper recording of the motor /sensitive response special anesthetic drugs are used with differences between the induction step and the stage of maintaining of the sedation [4,9,24]. In order to record the motor response, the drugs used during surgery have a major role in data accuracy [11].

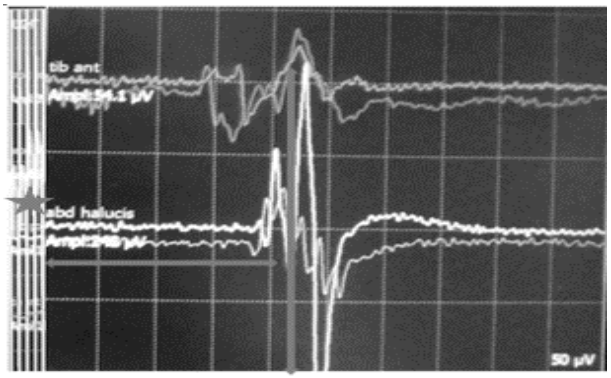
The vast majority of anesthetic drugs decrease the synaptic activity, this effect being dose dependent. They have a direct action on synaptic pathways or indirect effect by altering the influence of inhibitory or excitatory mediators: some anesthetic agents may bind to gamma-aminobutyric acid-a receptors, others may block the excitatory effect of glutamic acid and another group act at the neuromuscular junction level at the" n-type" acetylcholine receptors [43].

Anesthetic agents' effects on intraoperative evoked potentials.

Volatile anesthetics agents (Sevoflurane, Desflurane, Halothane, Nitrous Oxide), dose dependently suppress the MEPs by inhibiting the pyramidal activation of spinal motor neurons, they increase the latency and decrease the amplitude (**Figure 1**). MEPs are more sensitive to their action in comparison with SEPs [43]. Some studies say that a concentration under 0,5-1 at the alveolar level (MAC) it is safe for IOM recording. Nevertheless, for patients with preoperative neurologic disfunction, motor/sensitive alteration or neuropathy, lower doses may impede or even abolish the potentials [55].

a.





b.

Figure I. a) cork-screw electrodes placement for transcranial MEPs recordings; **b)** morphology of MEPs from tibialis anterior muscle and abductor hallucis muscle: red star – time of the stimulus application, yellow arrow – latency (unit: seconds), red arrow – amplitude (unit: volts) (images form dr. Coșman M. personal collection).

Between sevoflurane and desflurane the former has a bigger impact on decreasing the amplitude of MEPs. The recordings from the lower limbs seem to be more sensitive to anesthetics than the upper limbs [8]. The action mechanisms of desflurane are on different levels: on pre-postsynaptic receptors, on cellular ionic channels and on serotonin type 3 receptors [33,47] hence its capacity of maintaining proper anesthesia and amnesia at 0,5 MAC [16].

Sevoflurane, halothane, isoflurane are considerate "potent" agents and nitrous oxide is less "potent" being used at higher concentration. The latter is used for IOM in combination with other drugs e.g. nitrous-narcotic technique and the effect depends on the agent already present [43]. His action determines a decrease in amplitude and no effect on cortical potentials latency, without changing the wave morphology [5,42].

Intravenous agents such as Propofol interact with SEPs and MEPs recordings, dose dependent, but in a smaller extent compared with volatile agents [44]. By comparison with the baseline the latency of the evoked potentials is prolonged and the amplitude is decreased after both isoflurane or propofol is administrated, but the former has a bigger inhibitory effect on IOM than the latter [7].

Propofol is been used commonly in TIVA technique (Calanci et al. 2001, Deletis 2002, Langeloo et al. 2003, Chen et al. 2004, MacDonald et al. 2006, Sala et al. 2006, Szeleny et al. 2007, Lieberman et al

2017, Marafona et al.2018, Toossi et al. 2019) [6,7,10,18, 20,24,27,39,49,51] or with inhalant anesthetic agents to decrease their dosage [14,17,25,44]. Although is the preferred drug in IOM procedures, in a study from 2017 it was concluded that hemorrhage may alter the pharmacokinetic properties, the reduction of the cardiac output was associated with increase of the serum concentration which had the capacity to generate false positive results [20].

Etomidate influence only the cortical SEPs (increases the amplitude) and ketamine enhance the response of both potentials, making those agents a good choice for patients with preoperatively functional deficit. Nowadays the former is not used so frequently because of the risk of increasing the intracerebral pressure. Etomidate produces the less depression over potentials amplitude but utilized in continuous infusion may induces adrenocortical suppression [30,42].

Barbiturates (Thiopental) influence significatively the MEPs, but they do not affect the SEPs registration so strongly. Benzodiazepines – Midazolam decreases the potential recordings, especially of MEPs but has an advantage by inducing amnesia [30].

Dexmedetomidine ensure analgesia and sedation acting on α2 agonist receptors with minimal respiratory depression. In a study from 2015 published by Rozet it is shown that this agent does not have a significant effect on the potential's latency and amplitude [36].

As an adjuvant, when propofol is utilized for IOM anesthesia, dexmedetomidine determine smaller changes on MEPs recordings in comparison with midazolam but alters in a bigger way the hemodynamical parameters [1]. Also in a randomized double blinded study the use of dexmedetomidine before induction (1 μg/kg over 10 minutes) and at the maintenance stage (0,2μg/kg/hr) was associated with a need of lower doses of propofol and stable hemodynamical parameters [48].

From opioids, fentanyl may even improve the myogenic reaction when utilized for IOM by reducing the spontaneous muscular contraction from the background [43]. Another intravenous agent, remifentanil can be used in infusion, being an ultra-short action narcotic, but he has the disadvantage of opioid-induced hyperalgesia [14].

Muscular relaxants have little effect on SEPs recordings but interact with MEPs registration. Partial muscular blockade has the advantage of reducing the patient movements and facilitate the tissue retraction. To determine the degree of blockage we can use two methods: we measure the amplitude produced by supramaximal stimulation of the peripheral motor nerve – T1 (M wave) and compare with the baseline value obtained after the drugs where administrated. Another technique requires to evaluate the motor response after 4 stimuli are delivered at 2 Hz rate [43].

Various anesthetic techniques were used and some combination have been tested with the aim of minimum effect on IOM recordings. It was observed that at the same MAC concentration volatile drugs have a greater suppression effect. However, the best protocol is still controversial [9,54]. However, it is important to know that: the most resistant type of potential at anesthetic drugs are BAEPs, visual evoked potentials are the most sensitive, MEPs can be totally blocked by skeletal muscle relaxants and the recordings of SEPs depends on type of the anesthetic drugs [15]. Sometimes to assess the depth of the anesthesia can be a challenge for the anesthesiologist because the placement of the electrodes may coincide with the skin incision and so the type of the anesthesia must be chosen keeping in mind the site of the operation and the general status of the patient [17].

A summary of medications interactions with neurophysiological monitoring, especially with the MEPs recordings is presented in **Table 1.**

Table 1. Aesthetic drugs influence on Motor Evocated Potentials [15,22,30].

Anesthetic drug	MEP - Latency	MEP-amplitude	Observation
Sevoflurane	Increase	Decrease	Use: MAC – 0.5
Nitrous oxide	Increase	Decrease	Strong effect, should be avoided
Fentanyl	Preserved	Slight depression	Dose dependent
Remifentanyl	Preserved	Decrease	Rapid metabolism – rapid titration
Propofol	Increase	Decrease	Dose dependent;

			Rapid metabolism – rapid titration
Thiopentone	High increase	High decrease	Marked suppression
Etomidate	Decrease	Increase	Enhances the potentials
Ketamine	Increase	Increase	Enhances the potentials
Midazolam	High increase	High decrease	Marked suppression; indicated only in premedication administration
Dexmedeto-midine	Increase	Decrease	Use to lower other TIVA agents dose

A combination of those drugs may be used as well with proper sedation and without impairing the IOM measuring's. Gunter presented in 2016 a protocol which includes inhalant agent at a MAC= 0,5 associated with remifentanil and dexmedetomidine. This technique has the advantage of a quick emergency from the general anesthesia due to the latter drug, which produces the sedation effect by acting in locus ceruleus [14].

Another study presented by Isik et al. in 2017, where optimal potentials recordings were obtained by using desflurane (0,5 MAC) with remifentanil (0,05-0,3μg/kg/min at 50% O2) considers this association safe and an alternative for more used TIVA technique [16].

In a randomized survey published by Martin et al. in 2014 a comparison has been made between the two classes of drugs: the total intravenous technique (Propofol – Remifentanil) with volatile agents (Desflurane – Remifentanil). The results showed the necessity of a higher voltage to elicit response in volatile agent anesthesia [14,28]. Similar results have been found by Velayutham et al. in a study on spinal cord tumors from 2019 where the stimulation applied was 205 ± 55 Volts for propofol anesthesia (6-8mg/kg/hr) and 274 ± 60 Volts for isoflurane [53].

Sloan et al. presents in 2015 a combination of inhalant and intravenous anesthesia (0,5 MAC Desflurane with Propofol) with good results regarding electrophysiological monitoring and this technique may be an advantage for patients with opioid tolerance [3,44].

In a retrospective cohort study published in 2020 by Oh et al. it was evaluated the postoperatively liver function in patients with preoperative transaminase alteration comparing the group cases operated using total intravenous anesthesia (Propofol) with those operated using inhalator agents (Sevoflurane). The halogenated inhalational drugs are frequently used but they are associated with hepatotoxicity which is less encountered in latest anesthetic agents like sevoflurane or desflurane. The study concluded that the changes in liver enzyme levels were obviously lower for patients from the TIVA group and this type of anesthesia is indicated in neurosurgical intervention especially because of the longer time of the operation [2,31,37].

Other study from 2020 presented by Grau et al. discusses de impact of the anesthesia type on tumors recurrence and how the surgical stress can affect the mechanisms of the immune response inducing a vulnerable perioperative period. The idea started from the results obtain in vitro, where anesthetic drugs acted over tumor cells culture. Propofol induced apoptosis in contrast with isoflurane which increased proliferation of glioblastoma stem cells, however the results have not been consistent because of the differences induced by the cell line [29,38]. The conclusion that Grau et al. have reached shows no difference between volatile agents and TIVA regarding glioblastoma recurrence (volatiles 8 vs. propofol 8,4 months) or overall survival (volatiles 16,9 vs. propofol 17,4 months) [13].

Another thing to keep in mind when there is a oscillation between TIVA and inhalational anesthesia is the fact that in a study from 2014 published by Tamkus et al. volatile drugs were associated with obviously higher false positive responses (15% vs. 3,2%) compared with intravenous agents, when recording transcranial MEPs [50].

Modification in potentials amplitude and the need of a higher voltage to elicit the same result was observed as independent of anesthetic drugs concentration during the intervention, phenomenon named "anesthetic fade". This situation is produced by a long exposure of the nervous system to the drugs action [23]. In contrast with this decrease effect, it was observed and an increase impact called "anesthetic fade-in". This may happen if the baseline measurements of the MEPs were recorded before the surgical procedure started and before the effect

of the myorelaxants drugs used at induction disappeared [19].

Therefore, the mainstay in anesthesia protocols are synthetic opioid (fentanyl, sufentanyl) and propofol which under continuous administration have the capacity to maintain a constant serum concentration. Due to their pharmacokinetic properties the influence on amplitude, latency of MEPs and direct cortical stimulation is negligible [30]. This makes TIVA (Lo et al.2006, Martin et al. 2014, Tamkus et al. 2014, Sloan et al.2015, Malcharek et al. 2015, Velayutham et al. 2019, Oh et al.2020) more suitable for MEPs recording than inhalant anesthesia [21,26,28, 31,44,50,53].

Physiological changes on intraoperative evoked potentials.

Temperature. Cortical SEPs are the most vulnerable to temperature changes. Brain irrigation with cold serum affects the potential recordings [15]. Hyperthermia decrease the latency of MEPs where the hypothermia increases the latency. The effect of temperature on the conduction velocity of both MEPs and SEPs is raised in case of hyperthermy and reduced in case of hypothermia [27,40].

Ventilation. On the one hand the most visible alteration induced by hypoxemia is on SEPs, on the other hand hypocapnia has a smaller effect on SEPs and MEPs [15]. Hypercapnia has inhibitory effect on anterior horn cell and on cortical level, but the registration of the potential is altered only when extreme level of CO2 is reached [22].

Blood rheology. The blood viscosity and oxygenation depend on hematocrit values. Studies have shown that mild anemia is associated with increase in SEPs amplitude, but no results are cited about MEPs [22,43].

Intracranial pressure. Intracranial hypertension decreases the amplitude of SEPs and prologs the latency. When the uncal herniation occurs the brainstem response is lost and MEP signal can no longer be recorded [22,43].

Blood pressure. Of all the above, hypotension may induce severe potential alteration. At first when the perfusion pressure is raised again the changes restore to baseline. If the perfusion pressure is decreased under 15 ml/ min/100g tissue there are important changes, severe alteration and even the evoked potentials may be abolished [40]. Usually mild to moderate changes do not affect MEPs values [22]. Sometimes systemic blood pressure values may not predict regional ischemia induced by local factors like: prolong tissue retraction, vasospasm, positioning, head extension which can be discovered by potentials alterations [15,40,43].

Conclusion

A good neurological outcome for lesion located in eloquent area or for those with medullary development depends on the correct interpretation of the IOM signals and surgical maneuvers. But all of those are interconnected with proper anesthesia management and a teamwork. So far, a standard anesthetic protocol is missing, but general recommendations have been made. Even though the intravenous agents are more appropriate, the use of volatile anesthetic agents or a combination of them it is up to the anesthesiologist and the particularity of the case.

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Complications after sciatic nerve defect repair in rats

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ABSTRACT

Experimental microsurgery is a provocative field with great rewards. Nerve microsurgery is particularly challenging because the results of the operation can only be tardily observed. During this time frame, multiple complications can appear to the laboratory rats, which can influence the final results.

For this reason, when experimenting with Wistar rats, one must be familiarized with the possible complications in order to know the suitable solutions for all the issues. Lack of information and henceforth lack of action might result in compromising the final data.

Keywords
sciatic nerve,
rats,
microsurgery

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INTRODUCTION

On a simple internet search with the phrase "sciatic rat nerve", there are a total of over 3,2 million results. [1] This goes to prove that there is a great interest in experimental surgery on the sciatic nerve conducted on laboratory rats.

The rat, particularly the Wistar rat, represents the most suitable candidate for experimental nerve surgery, as it is affordable, easy to manipulate and has a suitable anatomy for different types of experiments. Furthermore, the faster nerve regeneration period (compared to that of humans) represents a major advantage in working with these laboratory animals.

The anatomy of the sciatic nerve in rats is similar to that in humans: the main nerve divides into 3 branches - common peroneal nerve, tibial nerve and sural nerve. [2] The anesthesia is another positive aspect for choosing Wistar rats – it can be performed by the operator by direct intraperitoneal injection. There are more solutions which can be used, depending on the type and length of the operation. [3]

In all experimental surgery performed on animals, a good collaboration with a veterinary is crucial, as he/she provides important expertise regarding anesthesia, post-operative evolution, solutions to problems; it is also stated in the law that in all animal projects, the

presence of a veterinary in the team is compulsory. Furthermore, all types of animal experimentation require approvals from the Ethics Committee and the Sanitary Veterinary Department. [4]

MATERIAL AND METHOD.

The complications presented in the article were mostly observed and handled during an experimental project for a PhD thesis, where 4 methods of defect nerve reconstruction were compared:

- nerve graft,
- nerve conduit made from a rat aorta (simple aortic conduit),
- platelet-rich plasma (PRP) inside an aortic conduit,
- stem cells inside the aortic conduit.

Each batch consisted of 10 lab rats and 2 extra lab rats were sacrificed to obtain PRP and aortic conduits.

The anesthesia used was a mixture of xylazine 10mg/kg and ketamine 75mg/kg. After injecting the anesthesia and preparing the operation site (shaving the dorsal gluteal-thigh region), the Wistar rat was placed in prone position and the incision was performed along the femur, 0,5cm inferior to it. A breach was created through the biceps femuri muscle and the sciatic nerve was exposed for a length of 4 cm to be able to observe the emerging branches. 2 separate incisions at a distance of 0,5cm were performed on the sciatic nerve, proximal to the emergence of its branches and the resulting defect was repaired using one of the above-mentioned methods. After nerve reconstruction, the muscle was close using absorbable suture and the skin was close using non-absorbable sutures.

Postoperatory, the rats were placed 2 in a cage, between the 2 existing a separating transparent plastic support. This was to prevent cannibalism between the rats.

The post-operative treatment consisted of enroxil 0,003mg/kg and meloxicam 1mg/kg both injected subcutaneously for 3 days. The wounds were treated locally with betadine solution alternating with baneocin powder.

The rats were monitored for 3 months and afterwards they were euthanized using an overdose of the anesthetic mixture and KCl injected intracardiac.[5] During this period, some rats experienced several complications which were treated accordingly.

RESULTS

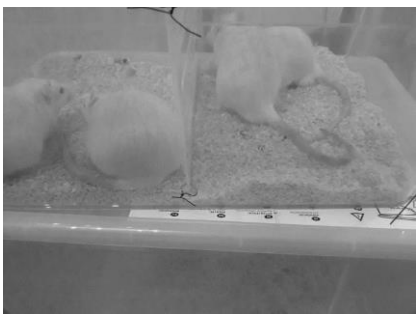
Out of the 40 rats included initially in the study, 2 rats were excluded due to major complications which could influence the final results – one due to postoperative death, the other one due to sciatic nerve rupture.

The one death recorded was due to an anesthetic overdose – because the rat would not sleep under anesthesia, multiple doses were administered. This resulted in a profound anesthesia once the drugs took effect, and a prolonged anesthesia time (even after the surgery was over). The rat died the day after the operation.

The first postoperative complication observed was wound dehiscence. This occurred in all batches 1-5 days after surgery due to chewing on the surgical knots. Some dehiscence were partial, others were total. 2 different measures were taken, unfortunately without the desired effect.

The first solution was to redo the suture under local anesthesia with the help of an assistant who would firmly restrain the rat not to bite during the procedure. This proved ineffective and dangerous as the rat would bite through the second knots as well.

The second solution was to try to perform a dressing so that the operated rat could no longer reach the wound. This also proved ineffective, as the rat could easily slip out of the dressing and attempt to nibble on the knots.



Special designed plastic cages with a plastic support to create 2 separate compartments

Sutured wound with different types of dressings

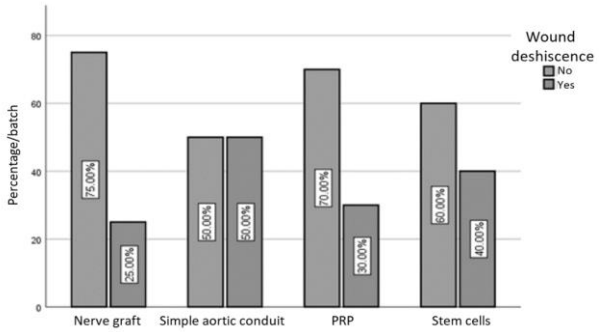
The wounds were treated with different antiseptic solutions and they closed per secundam in maximum one week.

A statistical analysis performed to see which batch presented more wound dehiscence revealed that there was a higher prevalence in the second batch (simple aortic conduit), followed by the stem cells batch. However, this analysis didn't have statistical power (X2 =1.479 (3); p=0.687).

Presence/absence of dehiscence wound in the 4 batches

Batch		Dehiscence		Total rats / batch
		No	Yes	
Nerve graft	No.	6	2	8
	Pct.	75%	25%	100%
Simple aortic conduit	No.	5	5	10
	Pct	50%	50%	100%
PRP	No.	7	3	10
	Pct	70%	30%	100%
Stem cells	No.	6	4	10
	Pct	60%	40%	100%
Total per wound	No.	24	14	38
	Pct	63.2%	36.8%	100%

Graphic of the wound dehiscence distribution in the 4 batches



Another complication encountered was that of self-mutilation of the affected limb. Luckily, the mutilation was limited at the fingernails and like the wound dehiscence it was self-limiting.

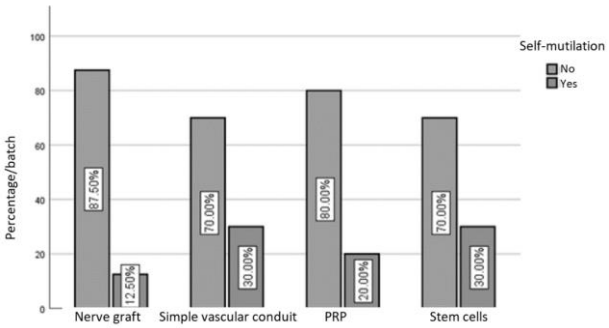
Limb autophagy after sciatic nerve transection – erythema and swelling of the foot and mutilated fingernails (footprint covered with ink due to footprint test).

Presence/absence of self-mutilation in the 4 batches

Batch		Self-mutilation		Total rats/batch
		No	Yes	
Nerve graft	No.	7	1	8
	Pct.	87.5%	12.5%	100%
Simple aortic conduit	No.	7	3	10
	Pct.	70%	30%	100%
PRP	No.	8	2	10
	Pct.	80%	20%	100%
Stem cells	No.	7	3	10
	Pct.	70%	30%	100%
Total self-mutilations	No.	29	9	38
	Pct.	76.3%	23.7%	100%

Similar to the wound dehiscence percentage, the self-mutilation of the denervated limb was predominent in the prevalence in the second batch (simple aortic conduit) and the stem cells batch, without statistical difference.

Graphic of self-mutilation distribution in the 4 batches

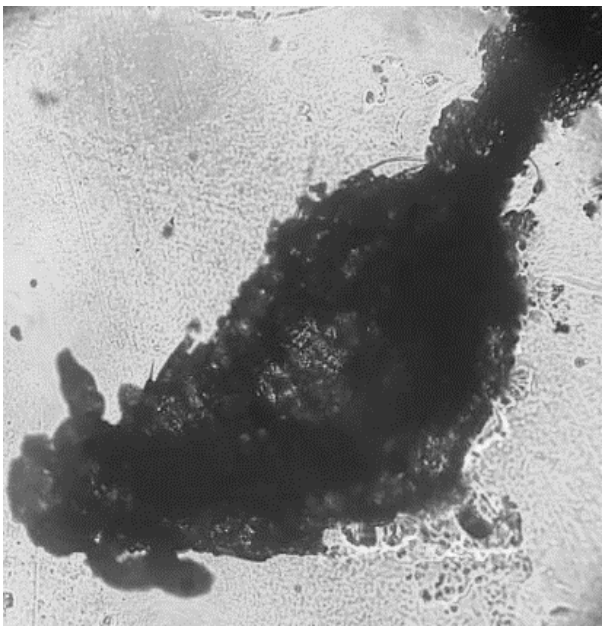


One month after the beginning of the project, all rats presented severe pruritus. As differential diagnoses, alergic dermititis and parasitologic contamination were taken into consideration. Due to scratching, some rats presented crusts and erosions, especially around the neck and back.

Weight loss occured to all rats experiencing these symptoms. Due to severe scratching, there was an important hair loss in the area with the pruritus. Until the diagnosis was established, the wounds were treated locally with methylene blue, to prevent infection.

Scratching lesions with hair loss and methylene blue application.

After a dermatologic consult, tape was applied on the skin and the sample was then examined under the microscope. The diagnosis of pediculosis with Polyplax spp. was put and all rats underwent treatment with Stronghold 15mg (Selamectin). This treatment was repeated after 2 weeks. Thorough mechanic sanitation of all cages was performed, as well as of the rooms where the cages laid. Furthermore, the rooms were sterilized for 24 hours using a UV lamp.



Microscopic aspect of the parasite Polyplax spp.

After the first application of Selamectin, there was a complete relief of the pruritus and a significant improvement of the scratching lesions. All rats recovered both locally (regaining the lost hair) as well as in terms of general state (in the following weeks there was a progressive weight gain).

3rd week after Selamectin treatment

Discussions

Proper anesthesia is the key to a successful surgery with optimal results. While it would help to sedate the animals using inhaling substances such as isoflurane before injecting them, direct intraperitoneal injection with ketamine, xylazine or acepromazine (or a mixture of these solutions) can be performed even without sedation but with proper contention. [6,7,8]

Correct calculation of the proper dose is crucial for the outcome. If a rat doesn't fall asleep in 5 minutes after the normal dose is administrated, this doesn't mean it has drug resistance, but rather that it takes the anesthetic a longer time to come into effect. Therefore, if a rat doesn't respond in the 5-minute time frame, it should be left aside and another rat should be prepared for surgery. Otherwise, administrating a new dose of anesthetic might result in a prolonged anesthesia or even death.

After the rat is under anesthesia, another important aspect is the handling or moving of the rat. Taking into consideration the muscle relation induced by the anesthesia, the rat is susceptible to aspiration if it is grabbed by the tail, with the head down. If this occurs, one should try freeing the airways using a small cannula attached to a vacuum. The typical symptoms a rat experiences in such cases are hiccup-like movement, with desaturation; if no prompt intervention is performed, this will also lead to its death. The best way to prevent this is to manipulate the rat by grabbing it by the back of its neck, heads up. Although Britto et all believe that total fasting or only-solids deprivation does not induce gastric emptying in mice, a preoperative total fasting for 6-8 hours could reduce this risk. [9]

Cannibalism immediately after surgery is another issue to be considered. The rats need to be separated a few days after the operation until the wound is closed. Afterwards, they can be placed together and it would also be recommend not keeping them separated as they have a tendency to self-mutilate by chewing on the operated, senseless leg when left alone.

One difficult complication to treat is self-mutilation – either limb mutilation (in case of peripheral nerve injuries) or wound dehiscence caused by biting the threads which hold the wound tight. Hindlimb autotomy/autophagy represents the mutilation of the anesthetic foot by the animal which doesn't feel the limb and therefore doesn't recognize it as part of its body. Wall et all described degrees of hindlimb autotomy differentiating on the type of nerve injury (cut nerve and encapsulated in polythene tube, sectioning with immediate repair, nerve ligation and nerve crush). [10]

Prevention of self-mutilation until nerve regeneration occurs is therefore a necessity. Plastic head collars could be useful for dogs or other large animals but are not appropriate for the rat, as it can easily get out of this restraint due to its neck anatomy. Repelling solutions (such as quinine) applied on the limb or on the wound could prove effective because of its bitter taste. Al-Adawi et all also proved the efficiency of 6-hydroxydopamine injected in the ascending noradrenergic bundle 1 week prior to transection or N-(2-) Chloroethyl-N-ethyl-2-bromobenzylamine (DSP4) injection 24 h prior to transection. [11] Picric acid is another solution that showed better results in reducing limb autophagy compared to the commercial bite-deterrent chemical (denatonium benzoate). [12]

Another possible complication which fortunately did not occur in this project is infection. Although rodents are quite resistant to infection, it would be recommended that postoperative antibiotic be given and sterile conditions during the operation be used.

Graft versus host disease is another possible complication when using foreign allogen tissue. Although no such reaction was noted during the project, even without the use of immunosuppressant medication, this could become a serious problem when transplanting tissues which determine a strong antigenic reaction.

Even though the project was conducted in a restricted environment in a building located in the veterinary university campus especially dedicated to this experiment, rat contamination occurred. There were 2 possible explanations. One would be the human factor – the people who come in contact with these animals to feed and clean after the rats. The second explanation, although unlikely, could be the 2 windows located at 2,5m altitude in the rooms where the experiments took place. A fast diagnosis and rapid intervention were the key in saving the animals and the project in this case.

Conclusions

Animal experimentation requires not only feeding and cleaning, but also attending to the possible

complications generated by human intervention. When it comes to nerve surgery, the most frequent complications are self-mutilation (either wound dehiscence or autotomy of a limb that in no longer sensitive innervated).

This study shows that the rats that presented wound dehiscence were predominantly in the simple aortic conduct batch; the same batch manifested self-mutilation of the denervated inferior limb.

The laboratory animals present all possible complication of the surgical intervention, as well as health complications specific to the animals. However, some solutions which may apply to human patients may not be a proper solution for animals.

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Surgical management of Rolandic area meningioma in the era of intraoperative neurophysiological monitoring

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Keywords
Rolandic area, intraoperative neurophysiological monitoring, meningioma, tumour resection, motor cortex, cortical mapping

ABSTRACT

Introduction. The advantages and the necessity of intraoperative neurophysiological monitoring (IOM) in the surgery of motor area infiltrative tumours is well known. The use of this technique for Rolandic meningioma is still debatable. The absence or the loss of the cleavage plan and an infiltrative border make the dissection exceedingly difficult and increase the risk of new postoperative motor disfunction.

Materials and methods. We evaluated the impact of IOM, especially direct cortical stimulation on the degree of resection, new postoperative deficits, symptom remission and clinical-imagistic aspects at one-year follow up of 19 cases of Rolandic meningioma admitted in Third Department of Neurosurgery," Prof. Dr N. Oblu" Emergency Clinical Hospital, Yassi, Romania, between January 2014 and July 2018.

Results. More than half of the cases (57,88%) had epileptic manifestations as the main clinical symptom with the Jacksonian seizures being on the first place (31,57%), followed by progressive paresis (26,31%) and other nonspecific symptoms. Intraparenchymal preoperative oedema was observed in 36,84% of patients. The intensity of direct cortical stimulation was between 6-13 mA (median = 9mA; mode = 12mA). Simpson degree of resection was dominated by S3– 47,36% and S4 was obtained in 15,78% of cases. Postoperative the outcome was favourable for 73,68% patients with 5,26% motor aggravation and 10,52% new deficits. At one-year follow up no imagistic recurrence was observed and the permanent motor deficit was maintained in one of the three cases (5,26%).

Conclusion. Even though meningiomas are extranevraxial lesions and those located on the convexity have a low risk of complication, the absence of a clear dissection plan between the tumour and the adjacent motor cortex is associated with a high risk for new postoperative neurological deficits. Therefore, it is important to perform

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cortical mapping for Rolandic meningioma, to determine the location of the primary motor area and to protect it from mechanical and vascular trauma, during tumour resection.

Introduction

Resection of lesion located in eloquent areas e.g., primary motor area is associated with an increased risk of postoperatively neurologic deficits. For a good outcome it is mandatory, for us, to know the location of this area and to protect it from mechanical and vascular intraoperative injures. The landmarks offered by the preoperative radiological images are of great help, but not sufficient [10,35]. The continuous development of medical technology comes in our aid to perform maximal resection with minimal motor dysfunction, knowing the impact on overall survival and on the progression free survival [8,29,32].

On this line, intraoperative neurophysiological monitoring (IOM) which includes mapping procedures (direct / subcortical stimulation) and monitoring technique (evoked potentials) offers a real time feedback and helps to establish the location of the functional area from the operative field. If the use of IOM is clear for infiltrative lesions like gliomas, the necessity of it in cases of meningiomas remains questionable [2,21,31].

One functional area in which this lesion may appear is the central gyrus region. The definition of Rolandic meningioma is represented by the direct anatomical contact, observed on T2 Weighted magnetic resonance imaging (T2W-MRI) of the tumour with the precentral and postcentral gyrus [25]. The presence of the cleavage plan around the eloquent brain help protect it during resection. When this landmark is lost or its not present mechanical trauma and vascular alterations over the cortex may generate new motor deficits. An intraoperative evaluation of the surrounding brain with the enhancement of the primary motor area is important, with the purpose of maximal resection with minimal neurological dysfunction. This goal is desirable especially when the most common symptoms of presentation are the epileptic seizures and the nature of the lesion is with good prognosis [6,21,31].

We proposed in this article to present the impact of using IOM in meningioma surgery located in central gyrus region regarding the clinical and radiological postoperative evolution first day after surgery and at one year follow up period along with a review of the literature.

Materials and methods

The study group included patients with meningioma located in central region, diagnosed using contrast enhancement head MRI imaging, admitted in the 3rd neurosurgery department of '*Prof. Dr N. Oblu'* Clinical Emergency Hospital Iasi, between 1 January 2015 and 1 July 2018, who underwent surgical resection. *Inclusion criteria in the study group*: meningioma located in central gyrus region, imagistic diagnosed and histologically confirmed; age over 18 years; intraoperative use of IOM; consent to be included in the study. *Exclusion criteria from the study group*: other histological tumour subtypes localized in central region; cases to which conservative management was performed; patients with pacemaker; patients who failed to come for their one-year follow-up examination and incomplete cases data.

This technique was performed using the Nim Eclipse device from Medtronic. Direct cortical / subcortical stimulation was achieved by means of the short-train technique or train of five. The parameters used were: 3Hz, interstimulus interval = 4mseconds, length = 500μseconds. The intensity was included in the interval 6 – 13mA. The recording electrodes were placed in abductor pollicis brevis muscle (m.), biceps brachii m., orbicularis orris and oculi m., tibialis anterior m. and abductor hallucis m, depending on tumour precise location.

Results

76 patients with various histological tumour types were initially enrolled in the study group, but 6 of them were excluded because they did not come to the one-year follow-up examination after surgery and 4 were excluded because they had a pacemaker and we could not perform IOM. In the end, the group included 19 cases of meningioma with Rolandic location. The age distribution interval was between 25 – 73 years with a female dominance – 52,63% of all the cases. Most frequent symptom was Jacksonian seizure (31,57%), followed by motor deficit – progressive brachial/ crural paresis (26,31%), partial seizures (15,73%) and nonspecific manifestation like headache, intracranial hypertension and grand mall seizure (each 10,52%).

From the anatomical point of view 47,36% (9 cases) were located on the convexity, 47,36% were parasagittal and 5,26% (one case) had the insertion of the falx cerebri. 5,26% of the patients underwent preoperative embolization. Intraparenchymal oedema was observed in T2 / FLAIR MRI sequences in a proportion of 36,84% (7 cases). An illustrative is presented in **Figure 1**.

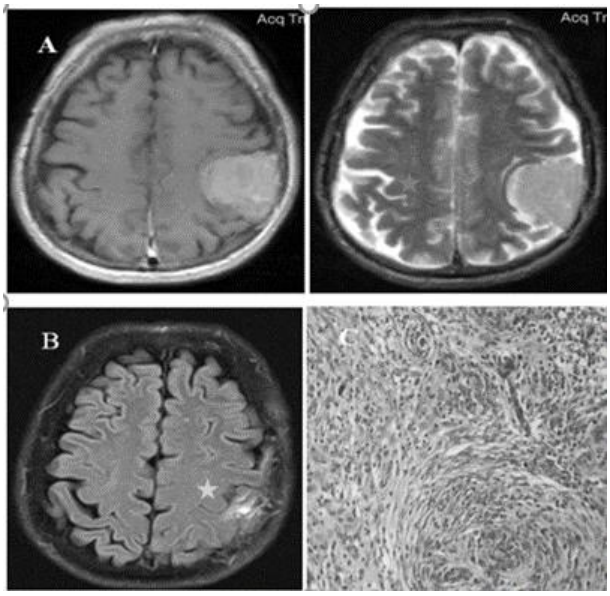

Figure 1. Clinical case: female, 48 years, Jacksonian seizures, no motor deficit, Rolandic lesion. **(A)** preoperative MRI (T1WI with enhancement and T2WI), yellow star = contralateral primary motor area (omega sign), no clear demarcation of the ipsilateral motor area, no perilesional oedema. **(B)** one-year postoperative follow-up MRI (T2 dark-fluid), pink star=reshaping of the motor area with normal morphology. **(C)** Meningioma grade II (WHO classification): densely cellularized lesion with meningothelial cells arranged in wide cords. (*Hemalaun-Eozina staining, X20*).

According to World Health Organisation (WHO) the histological result was classified as WHO grad I: 84,21% and WHO grade II: 15,78%. Simpson degree of resection was: S1 – 2 patients (10,52%), S2 – 5 patients (26,31%), S3– 9 cases (47,36%) and S4 – 3 cases (15,78%). The intensity of direct cortical stimulation was between 6-13 mA, with the following statistical parameters: median = 9mA and the mode = 12mA. Postoperative the outcome was favourable with symptoms resolution for 73,68% cases, stationary for 10,52% cases and with functional alteration for 15,78% cases (2 patients presented new neurologic deficit and one aggravated the initial motor disfunction).

One-year evaluation reveal favourable outcome in 89,47% and stationary in 10,52%. From the three cases with postoperative motor disfunction, in 5,26% of them persisted the deficit. No recurrence was observed on the control MRI and no tumour growth on the 15,78% of Simpson IV cases.

Discussions

Meningioma represent the most common benign primary brain tumour with an increasing incidence, being more frequent in elderly and in women [1,11,16]. Usually between the brain and the lesion there is a cleavage plan which allows a safe resection. When this plan is lost or it does not exist, vascular impairment and mechanical trauma of the brain tissue may be a consequence of tumour ablation. This is very important when the perilesional tissue is represented by functional areas, e.g., central gyrus region, hence the higher postoperatively motor deficit and an increased rate of complication for Rolandic meningioma compared with other convexity meningioma [3,9,18,23].

Perioperatively imaging techniques characterizes the relationship between the tumour and the eloquent cortex. Standard MRI, functional MRI, 3D tractography and neuronavigation system are important tools regarding the resection of lesions located in eloquent cortex, planning the approach and guiding further tumour ablation [20,22,27,30].

In some meningioma cases, the landmarks may not correspond intraoperatively because of the displacement of the normal anatomy induced by the tumour growth. In others the cleavage plan may be lost near the central gyrus region and the arachnoid may be invaded [5]. To avoid such situation where the dissection is difficult to realise without harming the surrounding cortex intraoperative neurophysiological monitoring is being used for a real time functional feedback. In a study from 2019 published by Raffa et al., it is evaluated even the advantage of combining the navigated transcranial magnetic stimulation with IOM for detection of the presence or the absence of the arachnoid cleavage plan and the functional tissue. The correspondence with the IOM results was in a percentage of 94,2% [28]. With all those tools available, in the literature there is still a controversy about the techniques association and intraoperative necessity of neurophysiological monitoring for all meningioma [25,26,31].

From the anatomical point of view Rolandic meningioma compresses convexity meningioma, falx, falx-sinus lesions of middle one third of the sagittal sinus in contact with precentral and postcentral gyrus and sinus. Beside the surrounding functional areas, the vascular representation is of the same importance e.g., Rolandic draining vein [6]. Because these lesions have a tendency of being smaller, the difficulty of the intervention can be underestimated and so may be associated with higher complication [25].

Motor area meningioma need special anaesthesia protocols when IOM is used, the aim being to avoid the medication that interacts with muscle relaxation. Synthetic opioids such as Fentanyl and sedative-hypnotic agents (Propofol) are preferred when cortical stimulation or evoked potentials are recorded, since those drugs can maintain a constant serum concentration with insignificant effect over motor response registration [14,15,24].

Usually, one of the most common presentation symptoms is represented by epileptic seizure (47,6% - Ostry et al.,2012; 38,46% - Bi et al., 2013; 42% - Deng et al.,2014) [4,6,25]. In our study this manifestation occurred in 57,88% of patients, with a dominance of Jacksonian seizures (31,57%). Especially for these patients with no motor deficit preoperatively it is important to determine the relation between the meningioma and the surrounding brain tissue.

The dominance of this clinical presentation is explained by the tumour mechanism of action. Being an extranevraxial lesion, it compresses the brain tissue inducing hemodynamical changes at the level of myelin, oxygenation and intracellular water. This is important because there is not a real loss of neurons and explains the remission of the symptoms after resection. Even the patients with preoperative motor deficits may improve the muscle strength postoperatively [17]. Though the meningioma is completely resected in some patients the outcome after the operation is stationary. The persistence of the seizures after the surgery is explained, in some cases by the cerebral changes induced by a slow-growing tumour with the appearance of epileptogenic foci e.g., hippocampal scleroses and cortical dysgenesis, beside local microenvironment abnormal discharges. In these cases, it seems that only the removal of the central gyrus region tumour is not enough [7,33]. In a study published by Deng et al., in 2014 from all 26 patients presented with epilepsy, after tumour resection 88, 46% were seizures free at mean follow up of 16 months under antiepileptic drug medication and one patient had seizures recurrence in less than 6 months postoperatively [6]. In our study, after symptoms remission the patient did not report any new seizure at the one-year follow up or recurrence.

When there is pial adhesions, brain invasion or irregular borders intracapsular resection is recommended to preserve the functional cortex which is usually identified by direct cortical stimulation (e.g., monopolar anodic stimulation – Ostry et al.,2012) [25]. In our study we performed brain mapping before starting to remove the meningioma to identify the primary motor area. Usually, this aria was modified being push by the tumour growth and surrounded the lesion. The intensity interval was between 6 – 13 mA, the most frequent threshold value which generated motor response was 13 mA. The cortical stimulation was repeated every time when the junction brain-tumour was reached, to ashore that further dissection does not affect the eloquent cortex. Intermittent minimal traction was applied.

The surgical aim is symptom remission and if it is the case to leave the smallest cortical layer of tumour to prevent neurological alteration, even though this means subtotal resection – Simpson IV [12,19]. On the one hand this approach is preferable because of the slow growth pattern of the lesion and because gross resection is associated with increased morbidity for the infiltrative borders type, on the other hand some studies found that Simpson resection grade is a predictor factor for recurrence. In this condition the intraoperative decision is tailored depending on the particularities of the case [13,36].

In our study Simpson IV was obtained at 15,74% of patients, all of them were located parasagittal with no cleavage plan and with positive stimulation response surrounding the tumour. Other characteristic of those three cases was the fact that it was observed an important venous component involvement, with the Rolandic vein being encased in tumour capsule and the superior sagittal sinus being partially obstructed. In other publication various result of subtotal resection were presented from 26,2% (Ostry et al., 2012) to 1,1% (Ottenhause et a., 2018) [25,26]. Ostry et al., mentioned that in some

patients the remanent tumour was not even detected on the postoperative MRI, the estimated volume being of 0,1cm³ and the Simpson IV grade of the case was based on surgeons' report. Usually, the residual layer was less than 0,5cm³ [25]. Even though Simpson grad IV was present in our result one the first place from the point of view of resection was Simpson grade II (47,36%) matching with the literature results.

It is important to keep in mind that clinical presentation with preoperative muscular strength dysfunction may alter the stimulation response, decreasing the technique accuracy. From our patients 26,31% presented progressive paresis and the intensity used to generate motor response was the highest from the study group. An aggressive traction and dissection, when the cleavage plan is lost, is associated postoperatively with a higher risk for motor deficit [17,34]. Ostry et al., in a study from 2012 observed that the difference of the threshold value between the direct cortical stimulation and the value obtained after stimulating through the mass lesion was ≤ 2 mA has an impact over outcome. In this situation he stopped the resection even though it was intracapsular, to prevent new motor deficits. When the motor evoked potentials are used, the need for an increased threshold to generate response is a warning signal [25].

How is to be expected, the motor preservation is the main goal in surgical resection of Rolandic meningioma. Starting from this idea some authors studied the prognostic factors for the risk of motor impairment (aggravation of the symptoms or new ones). Ottenhausen et al., found that a high rate of neurological deficit was associated with parafalcine insertion, large tumoral mass and perilesional oedema. Another negative prognostic factor was found to be the necessity for preoperative embolization and the involvement of the Rolandic drainage vein [26]. From our group of patients in one case it was necessary to perform an endovascular procedure, tumour's location being on the falx cerebri to facilitate the resection.

Progressive paresis as an admitting symptom beside disturbing the IOM is considered to be a negative prognostic factor for the motor outcome (47,2 % *vs* 22,2%, p = 0,017, Ottenhausen et al., 2018) [26]. In our group of patients in one case we had aggravation of the pre-existent deficit and new deficit was observed in 10,52% of the cases. The image control showed central gyrus region oedema and no haemorrhage.

Other values from the literature regarding the new motor deficit range from 7,69% (Lee et al., 2016) to 34,61% (Bi et al., 2013) [4,17]. The latter reference presents the results from 26 parasagittal central region meningioma microsurgical resected. No Simpson grade IV was found, only grade I (30,8%), grade II (46,2%) and grade III (23,1%) but as mentioned the aggravation was observed in one third of the cases. Therefor complete tumor removal was associate with a higher negative outcome. Another important fact is that the authors do not report the use of cortical stimulation or evoked potential generation [4].

The main postoperative outcome of our patients was favourable with symptom remission in 73,68%. Almost the same percentage was obtained and by Lee at al., in 2016 – 76,92%. The first place for clinical evolution is maintained and with 60,3% (Ottenhausen et al., 2018), 65,39% (Bi et al., 2013) and the high clinical amelioration was 81% (Ostry et al., 2012) [4,17,25,26].

An important remark it that at one year follow up period just one patient of the three with postoperatively aggravated or new deficit maintained the motor disfunction. Practically the permanent neurologic deficit for our group was 5,26%. Overall, the neurological outcome was favourable in 89,47% of the cases, no imagistic recurrence was observed on the control MRI but further follow up must be done.

Conclusions

Rolandic meningiomas, even though are extranevraxial lesions represents a challenge from the surgical point of view. A careful dissection is mandatory, the venous drainage must be preserved and the surrounding functional tissue must be protected from mechanical trauma. When the cleavage plan is lost precentral and postcentral cortex may be affected and secondary after the resection new motor deficits may appear. To prevent unwanted cortical damage intraoperative neurophysiological monitoring is used and if necessary, a thin layer of meningioma is left over the cortex.

Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Endodermal cyst of the cranio-cervical junction. A case report

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ABSTRACT
We report an extremely rare case of an endodermal cyst of the cranio-cervical junction located dorsally to the brainstem and upper cervical spine in a 27-year-old female presented with occipital headache, vertigo and pain in both shoulders. Neurological examination showed neck stiffness with bilateral XIth nerve palsy. Magnetic resonance imaging revealed a cystic lesion at the cranio-cervical junction and slight compression of the brain stem. The lesion was totally removed through the posterior approach. The histological diagnosis was endodermal cyst. To our knowledge, the only one such case has been reported in the literature.

Keywords
endodermal cyst,
cranio-cervical junction

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INTRODUCTION

Endodermal cysts can be found in literature by a variety of different names including neurenteric, epithelial, bronchogenic, enterogenous, respiratory and foregut cysts. These cysts are a benign congenital condition resulting from the persistence of an abnormal communication between endoderm and neuroectoderm at 3 weeks life of the embryo. This malformation is encircled by a mucosal secreting epithelioma mimicking the normal gastrointestinal epithelioma tractus (1). Exact histopathological diagnosis may be hard to establish, since there are many similarities with other cystic lesions such as Rathke cysts, colloidal cysts, and/or cystic teratomas (9). Intracranial locations are rare, and location of such cysts in the cranio-cervical junction is exceptional. They are located in the midline, in ventral or ventrolateral locations. Endodermal cysts may occur at any age, but there is a slight predominance of male patients in their forties. Since they are slow growing tumours, many patients have only mild symptoms relative to the tumour size. The main symptoms are due to compression and mass

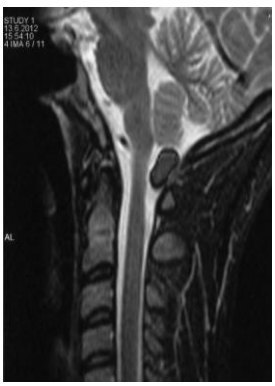
effect. However, cases of recurrent aseptic meningitis can be found in literature (2).

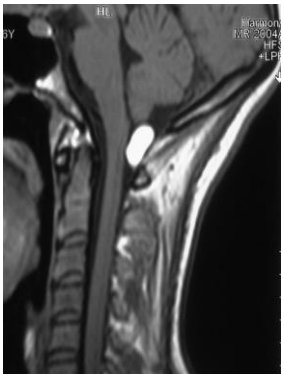
Neurenteric cysts are treated surgically. With only partial resection, endodermal cysts may recur at the original site on long-term follow-up (3-6). The incomplete resection may be associated with postoperative malignant transformation or widespread cranial-spinal dissemination. Almost all authors advocate the aggressive resection to reduce the possibility of endodermal cyst recurrence (7, 8).

Case report

We present a case of a 27-year-old woman admitted with a history of recurrent episodes of occipital headache, vertigo and pain in region of both shoulders of six months duration prior to admission. She had no difficulty with swallowing or speech, and the strength of all extremities, gait, and coordination were normal. The neurological examination presented only moderate neck stiffness with bilateral XIth nerve palsy. There was neither sensibility deficit nor extra neurologic signs.

Magnetic resonance imaging (MRI) of the cranio-cervical junction revealed a well-defined, round, intradural cystic lesion located dorsally to the spinal cord and the medulla, extending from the foramen magnum to the upper level of C1 lamina, with neither bony nor soft tissue associated abnormalities. T2-weighted images displayed a hypointense signal, and T1-weighted MRI demonstrated a hyperintense mass without enhancement. The lower medulla and C1 spinal cord were found to be slightly compressed in the posterior aspect in the sagittal image. This intradural extraaxial process was measuring 20,7 x 12,7 x 8,3 mm (Figure 1). Preoperative CT scan showed a high density area at the cranio-vertebral junction, well delimited, dorsal to the medulla and upper cervical spine. In our case the cyst appeared spontaneously hyperdense.





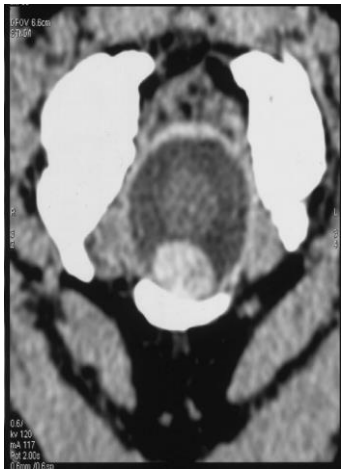


Figure 1. Cranio-cervical junction MRI showing intradural cystic lesion located dorsally to the spinal cord and the medulla.

The patient was operated in a prone position through a posterior approach and midline incision. Surgery consisted in a reduced sub-occipital craniotomy associated to partial C1 laminectomy. After opening of the dura a thin-walled yellowish cyst was noted below atlanto-occipital membrane, in the region of cerebellomedullaris cistern. It was floating in liquor, attached with bulbo-medulary junction only with thin aracnoidal connection. The lesion had not adhered to any other surrounding structures. Surgical excision was complete in one piece.

On pathohistological examination, the cyst membrane was underlined by unistratified cylindrical enteroid cells with basal nucleus and apical muco-secreting pole, with supra-nuclear acumulation of alcain-blue positive mucine. The diagnosis was endodermal cyst.

Postoperatively, the patient showed no neurological deficits. In the next few months' clinical signs resolved completely. Postoperative CT (Figure 2) and MRI revealed no evidence of a residual cyst.

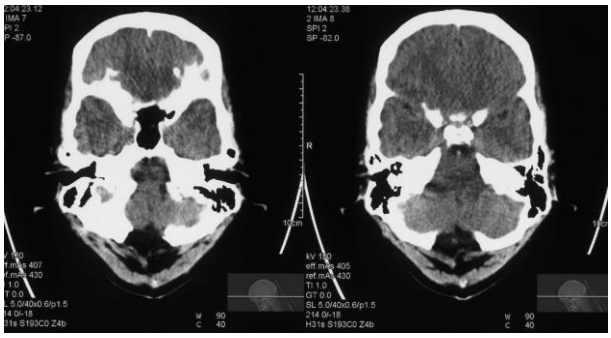


Figure 2. Postoperative CT scan showing complete resection of cyst.

Discussion

Endodermal cysts are congenital abnormalities belonging to notochordodysraphies which are result of an abnormal adherence between ectoderm and

endoderm. A failure during embryogenic development is probably responsible for cyst formation (1,9,10,11). The pathogenesis of this lesion is not clarified. However, the most convincing hypothesis is a dysgenesis of the endoderm from the neuroectoderm in the 3rd week of foetal development (12). Usually, these lesions occur at the lower cervical and upper thoracic region, and their ventral origin is suggested by defects in the vertebral bodies. The lesions may be either intradural or extradural (13). The present case is unusual because cyst is found in the cranio-cervical junction and exceptionally unusual because of dorsal location, representing the only one such case reported in the literature (14, 15, 16). They show slow growing rate, remaining asymptomatic for a long time, but without surgical removal they can produce a brain stem and spinal cord compression syndrome followed-up by a neurological impairment. In this case, according to our opinion, surgery was justified in order to achieve total removal of the cyst and to prevent recurrence, malignant transformation or subarachnoid dissemination.

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Dolichoectatic middle cerebral artery masquerading as cerebral cavernous malformation. A case report and review of literature

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Keywords
dolichoectasia, middle cerebral artery, anterior circulation, arteriopathy, tortuous artery

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ABSTRACT

Background. Intracranial dolichoectasia (IADE) is a rare vascular disease characterized by distension, elongation and tortuosity of an artery. IADE rarely involves paediatric aged groups. It is either asymptomatic or manifests as ischemic or haemorrhagic attacks.

Case description. A healthy, 30-year-old, female teacher presented with recurrent attacks of bi-frontal headaches associated with dizziness and dropping attacks of two-week duration. She was referred by her general physician to our institution of Neurosurgery Teaching Hospital in Baghdad, Iraq with a suspicion of medial temporal lesion on a cranial computed tomography (CT) scan. Magnetic resonance imaging study excluded the diagnosis suggesting a dolichoectatic middle cerebral artery that was confirmed by CT-angiography.

Conclusion. Dolichoectasia of the middle cerebral artery is a rare and benign lesion. However, it can masquerade as cerebral cavernous malformation or intracranial arterial aneurysm. Thus, careful radiological evaluation with the suggested diagnostic criteria are of paramount importance to prevent its misdiagnosis.

BACKGROUND

Intracranial arterial dolichoectasia (IADE) is sporadic angiopathy characterized by dilatation, elongation and tortuosity of an intracranial artery. IADE is approximately 0.1-6.5% prevalent in the general popula-

tion and 12 % in stroke patients [1]. IADE preferentially involves the basilar artery and posterior circulation; anterior circulation IADE constitutes only one third of all cases [2]. IADE is usually an incidental finding but symptoms may arise due to ischemia, hemorrhage or cranial nerve compression [3]. Although uncommon, hydrocephalus was also reported as a manifestation of IADE due to the obstruction of cerebrospinal fluid flow through the foramen of Monro or the cerebral aqueduct [4]. IADE may co-exist with several vascular pathologies such as abdominal aortic aneurysms, intracranial aneurysms and coronary artery disease [5]. A diagnostic criterion for dolichoectatic basilar artery was suggested by smoker et al, but no criteria for dolichoectasia in other intracranial arteries have been validated thus far [6].

Herein, we present a case of middle cerebral artery dolichoectasia, initially diagnosed as cerebral cavernous malformation along with proposed diagnostic criteria based on reviewing the available literature.

Case Scenario

A healthy, 30-year-old, female teacher presented with recurrent attacks of pulsatile bifrontal headache of two-week duration. Each attack lasts for more than one-hour and significantly impacted her daily activities. The headache is associated with profound dizziness and "dropping attacks"; assumed to be seizures by her general physician. The patient's EEG and video EEG were both normal. She was referred to the neurosurgery outpatient clinic at our institution with a suspicious medial temporal lesion on a cranial CT scan. On examination, the patient was pale but fully oriented with no remarkable neurologic deficits. Her brain CT scan showed a small rounded heterogeneous lesion with calcification at the medial temporal area; there was no evidence of peri-lesional edema. Initially, the diagnosis of uncal cavernous malformation was pondered. (Fig.1). In order to confirm this diagnosis, brain MRI with T2-gradient echo and MRA studies were ordered. The T2-weighted MRI study revealed lesional flow-void, the T2-gradient echo was negative and the MRA showed an abnormal vascular loop of the MCA within the lesion. These findings excluded the diagnosis of cavernous malformation and strongly suggested MCA aneurysm or dolichoectasia (Fig.2). Next, a computed tomography angiography (CTA) of the brain was obtained. The CTA revealed that the proximal part of the MCA was dilated, elongated, tortuous and formed a superior blind loop; findings that were consistent with the diagnosis of MCA dolichoectasia (Fig.3). Moreover, catheter cerebral angiography can be used to confirm the diagnosis in such situation but it is not feasible in our facility nor in many neurosurgical institutions around the world. Thereafter, patient was reassured that she had a "benign variation in the brain circulation rather than a critical pathology and that no intervention was indicated at the time". Laboratory investigations normal except for iron deficiency anemia. The patient was discharged and a follow-up was scheduled with her physician. At 6-month follow-up, patient was generally well, had already resumed her normal daily activities and received treatment for anemia. The headache was both minimal and occasional at this stage. Both CTA and MRI revealed no new significant findings.

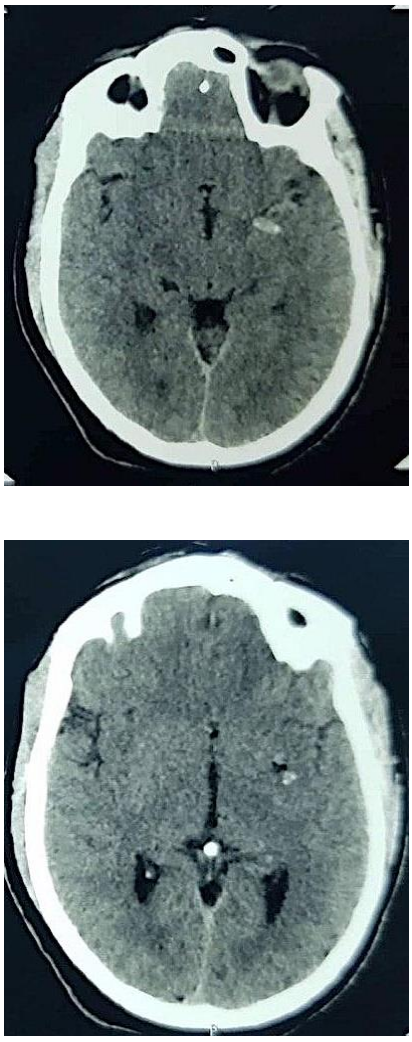
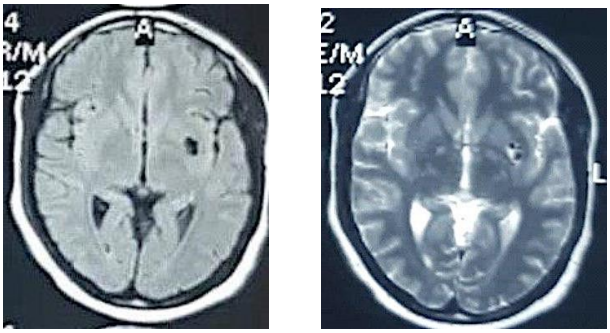
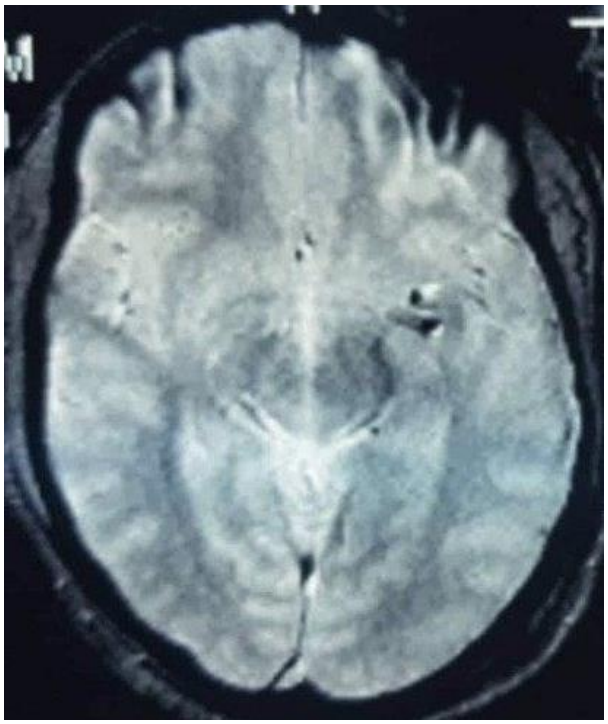


Figure 1. Cranial CT scan showing a heterogeneous, deep left-sided, temporal lesion of mixed density with no perilesional edema. Here, the initial diagnosis was cerebral cavernous malformation.



A. **B.**



C.

D.

Figure 2. Brain MRI showed deep left temporal lesion. **A:** FLAIR axial section: The lesion is hypointense with no perilesional edema. **B:** T2 axial section: The lesion contains signal voids that denoted the presence of vessels within the lesion. **C:** T2-Gradiant Echo axial view showing the absence of blood clots. **D:** MRA showing an enlarged and tortuous left MCA (sphenoidal segment) as compared with the right MCA with a superiorly projecting loop or a possible aneurysm.

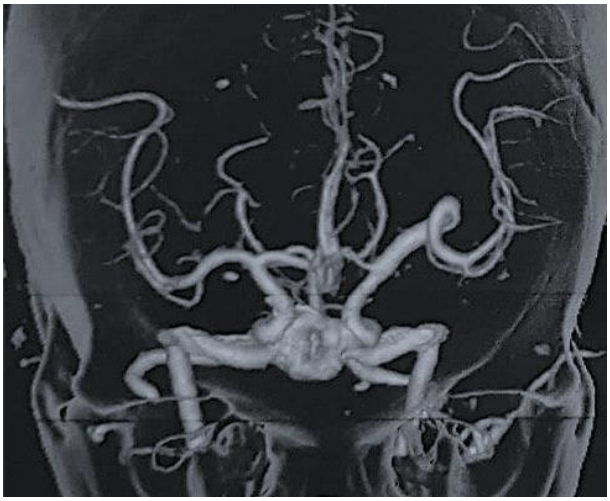


Figure 3. Brain CT angiography 3D reconstructed image showing an enlarged and tortuous left MCA (sphenoidal segment) as compared with the right MCA with a superiorly projecting loop, confirming the diagnosis of left MCA Dolichoectasia and excluding the presence of an aneurysm.

Discussion

the vertebrobasilar system is the most common site of IADE followed by internal carotid artery. IADE is a disease of all ages although its presentation in the pediatric age group is rare. It affects females more than males [2]. IAED may be asymptomatic or masked by an array of inconclusive manifestations such as headaches, strokes, seizures and focal deficits [4]. In this report, a 30-year-old female presented with recurrent bouts of headache and dizziness. A brain CT-scan revealed a calcified lesion, leading to a provisional diagnosis of an uncal cavernous malformation. Further imaging studies including MRA and T2-gradient ECHO- provided a better visualization of the vasculature and the brain parenchyma narrowing the differential diagnosis to an aneurysm or a dolichoectasia. Finally, CTA images showed dilated, distended and tortuous vessels and excluded the differential of an aneurysm.

IADE is commonly mistaken with other vascular pathologies, such as dural fistulas or Arteriovenous malformations [7]. Therefore, multiple imaging modalities are often required to reach the definitive diagnosis of dolichoectasia especially if it is located distally in the anterior circulation. Nakahara et al

reported a case of MCA dolichoectasia, initially diagnosed as a terminal-ICA, saccular aneurysm using antero-posterior and lateral CTA views. However, the reverse waters view suggested the correct diagnosis of a dolichoectatic MCA rather than an ICA aneurysm; this study highlights the importance of multiple CTA views in the diagnosis of IADE [8]. Several efforts attempted to establish a solid platform for diagnosing anterior circulation dolichoectasia depending on a multi-modal diagnostic approach. Some authors have recommended the co-utilization of additional radiological techniques such as digital subtraction angiography to capture the real-time flow properties of the aberrant vessel [9,10]. Dolichoectatic MCA is a benign lesion in general. However, treatment is usually indicated when there is a co-existing pathology. Surgical manipulation of the enlarged vessel may lead to complications such as hemorrhage or ischemia [10]. In this study, we treated the patient conservatively using simple analgesics which enabled her to resume her normal activities. Our approach is comparable to the one described in the literature of MCA dolichoectasia (**Table 1**). However, the initial false interpretation of medial temporal cavernous malformation, then MCA aneurysm rendered this case report to be of a critical value regarding differential diagnosis of MCA dolichoectasia [8,10]. Based on the aforementioned literature analysis, we suggest 3 features that can be considered as alarming criteria for the diagnosis of MCA dolichoectasia, these include: atypical clinical presentation, enlarged parent vessel and unusual location of the lesion.

We recommend a multi-modal diagnostic approach to determine the most appropriate management along with long-term clinical and radiological follow-up for monitoring of a less likely but possible lesion enlargement.

Table1: Literature review of dolichoectatic middle cerebral artery

Author	Sex	Age, year	Presentation	Radiologic findings	Treatments
Brinjikji et al [11]	F	19	Asymptomatic, found incidentally	MCA dolichoectasia with superimposed multilobulated aneurysm, mild preceding stenosis	Conservative
Feliciano et al [12]	M	42	Headache associated with left-sided weakness and intermittent nausea and vomiting	MCA dolichoectasia and a cluster of aneurysms with right basal ganglia hemorrhage	Conservative
Abe et al [13]	M	32	Asymptomatic, found incidentally after a motor-vehicle accident	MCA dolichoectasia	—
Nakahara et al [8]	F	59	Left hyposmia and mild intermittent occipitalgia	MCA dolichoectasia	No surgery, no medication
Kanemoto et al [14]	F	41	Seizures and anxiety	MCA dolichoectasia with cavernous hemangioma	Cavernous hemangioma resection

Tokunaga et al [15]	F	58	Right hemiplegia, homonymous hemianopia, hypertension	Left putamen hematoma and bilateral MCA dolichoectasia	—
Puca et al [16]	F	32	Ischemic stroke at the age of 7 y	Old ischemic lesion and MCA dolichoectasia	No surgery, no medication
Maruya et al [17]	F	40	Subarachnoid hemorrhage	A saccular aneurysm on a dolichoectatic MCA	Surgical clipping of the aneurysm
Guo et al [10]	M	43	Ischemic stroke 3 y ago	MCA dolichoectasia	No surgery, antiaggregating therapy
Current study	F	30	Headache and dizziness	MCA dolichoectasia	Conservative
M = Male; F = Female; MCA = Middle cerebral artery					

Conclusion

MCA dolichoectasia is a rare and benign lesion. However, it can masquerade as cerebral cavernous malformation or intracranial aneurysm. Thus, careful radiological evaluation along with the suggested diagnostic criteria are of a paramount importance to prevent its misdiagnosis.

Abbreviations

IADE; Intracranial arterial dolichoectasia, EEG; electroencephalogram, CT; computed tomography, MRI; Magnetic resonance imaging, CTA; computed tomography angiography, MCA; Middle cerebral artery.

Declarations

Acknowledgements: None.
Authors' contributions: SA wrote the primary manuscript. ZA, SH participated in its coordination, supervision, and revision of the manuscript. SH conceived of the study and collected the data. ZA, AJ helped to draft the manuscript. SH, NA, NH diagnosed the case. All authors read and approved the final manuscript.
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The two stages surgery in the management of central neurocytoma. Case series of 10 patients

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Abstract

Central neurocytoma is an uncommon benign tumour of the central nervous system. The intraventricular location close to the Monro foramina and the attachment to septum pellucidum are characteristics for diagnosis. The encasement of vascular structures represents a surgical challenge. We report a series of 10 cases of central neurocytoma operated at our department 06 of those was operated in two stages intentionally in order to avoid post-operative complications and to obtain complete removal.

Keywords
central neurocytoma, ventricular tumour, immunohistochemical markers

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Introduction

Central neurocytoma (CN) is an extremely rare benign tumour of central nervous system accounting for only 0.1 to 0.5% of brain tumours [1]; although described for the first time by Hassoun et al in 1982 [2]; since then, we dispose poor data about theses tumours in the literature [1]. The intraventricular location is the main site of development of these lesions [1, 3]. The brain MRI is an important tool for diagnosis; however, the certainty is obtained by histological examination; in which the differential diagnosis is made with oligodendroglioma and ependymoma. Surgery represents the only effective option to deal with this kind of lesions, with usually good results, associated with conventional radiation or radiosurgery in case of atypical finding.

Materials and methods

We report a retrospective study of 10 cases of central neurocytoma treated in our department over a period extending from 2003 to 2019. All patients underwent computerized tomography (CT) scans and magnetic resonance imaging (MRI) on T1, T2, FLAIR, and T1 injected sequences.

Results

The study includes 10 patients aged between 22-60 years old, with average age of 30.5 years. The sex ratio was 3F/2M.

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Clinical presentation

Increasing intracranial pressure (ICP) symptoms were the main clinical presentation observed in six patients, associated to visual disorder in seven patients; other symptoms were less frequent: seizures were found in two patients, cognitive disturbance in sthree patients, and decreased consciousness in one patient.

Imaging

The computerized tomography (CT scan) showed in the majority of cases heterogeneous lobulated lesion, located frequently in the frontal horn of the lateral ventricle adherent to the septum pellucidum and frequently invading this one, the lesion was associated in most cases with biventricular dilation. The magnetic resonance imaging (MRI) showed the characteristic aspect of this lesion: isointense on T1 weighted imaging, iso or hyperintense on T2 weighted imaging with heterogeneous enhancement due to the cystic and calcic components after gadolinium injection; showing a "soap bubble" characteristic aspect.

Treatment

Hydrocephalus management

Six patients consulted with hydrocephalus treated with different modalities: ventriculo-peritonealshunt (VP-shunt) was used in two patients; endoscopic third ventriculostomy (ETV) was performed in one patient; Rickham reservoir was placed in one patient (**Table 1**).

Table 1: Hydrocephalus managements

Method	Number of patients
VP-shunt	2
ETV	1
Rickham reservoir	2
Direct approach	1

VP-shunt: ventriculo-peritoneal shunt, ETV: endoscopic third ventriculostomy

Management of the lesion

All patients were operated with open approaches, the trans-frontal trans-ventricular approach was used in all patients combined to the trans-callosal approach in three patients. Six patients were operated intentionally in two stages. A complete resection was obtained in six (06) patients and subtotal resection in four (04) patients. The resection was limited in the remaining four (04) cases because of the infiltration of the trigone and encasement of the major venous vessels.

Table 2: Surgical approaches

Patients	Approach		Outcome and Complications
	1st stage	2nd stage	
Patient 1	TFTV	TFTV	Recidivism
Patient 2	TFTV	TFTV	Worsening of the cognitive disturbance
Patient 3	TFTV	None	None
Patient 4	TFTV	Transcallosal	None
Patient 5	TFTV	TFTV	None
Patient 6	TFTV	None	None
Patient 7	TFTV	Transcallosal	None
Patient 8	TFTV	Transcallosal	None
Patient 9	TFTV	None	None
Patient 10	TFTV	None	None

TFTV: trans-frontal trans-ventricular

Pathological findings

The diagnosis of CN was based on microscopic examination and several immunohistochemistry markers such as synaptophysin, GFAP, Olig2, NSE, chromatogramine, Ps100. Patients with Ki-67 antigen (Mib1) ≥8% was considered as atypical CN. This finding was observed in three patients.

Adjuvant therapy

Conventional radiotherapy was used for the three patients with atypical CN whereas surgery was preferred in recurrence with low grade lesion. We didn't experience stereotactic radiosurgery in our series as well as chemotherapy.

Mortality and morbidity

We noted that one patient presented a worsening of his cognitive disturbance (memory loss) while we didn't observe any death in our series. Although we reoperated one patient for recidivism three years later. (table2)

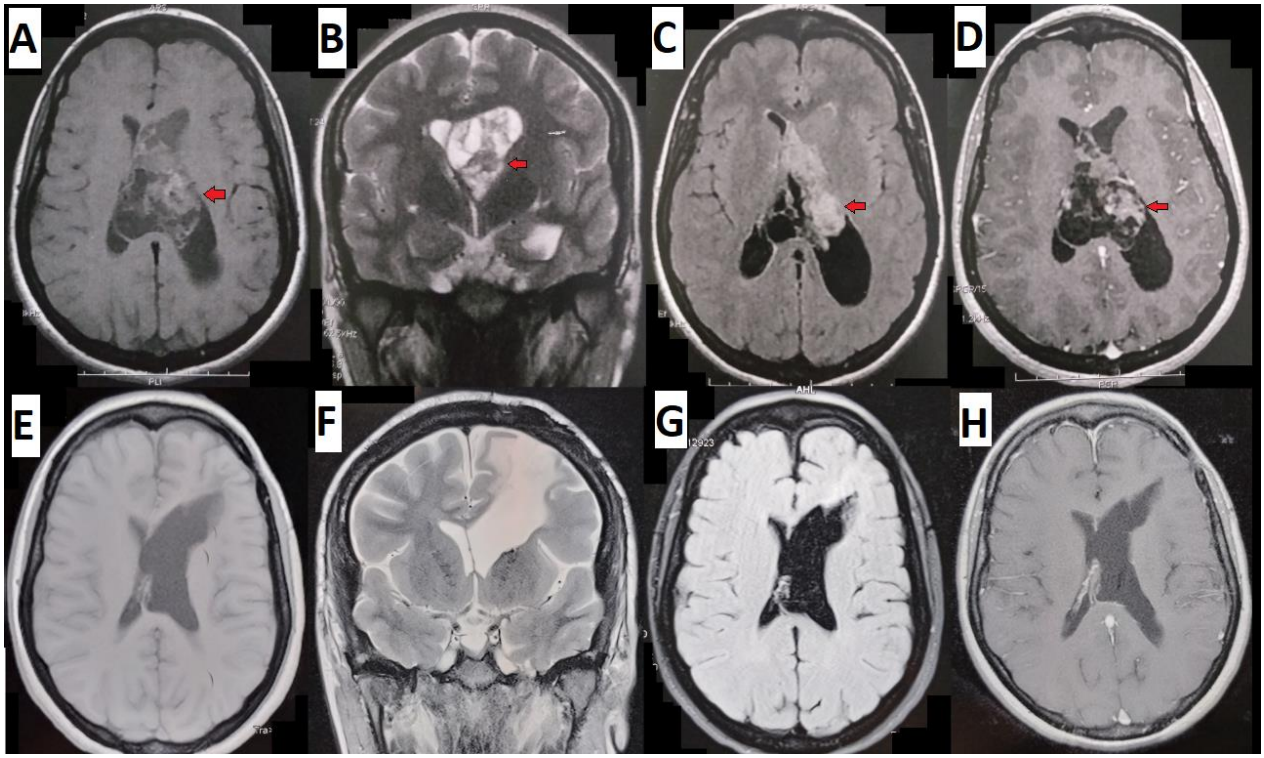

Figure 1. 30 years old female, with six months history of headache vertigo and visual disturbance with progressive worsening, at the admission the patient was conscious presenting visual acuity at 1/10 and 5/10, there was also a stage III papilledema in both eyes. Brain MRI objectified a 55 mm intraventricular process located on the left lateral horn, isointense on T1 WI, hyperintense on T2 and FLAIR sequences, with heterogeneous enhancement due to those images were defined a "soap bubble" aspect characteristic for neurocytoma (A, B, C, and D). The patient was operated and the lesion was totally removed through a left trans-frontal trans-ventricular approach. Pathological study confirmed the diagnosis of benign neurocytoma in post-operative there was a disappearance of headache and vertigo; the control imaging performed four years later showed no recidivism (E, F, G, and H). (A and E: T1 WI; B and F: T2 WI; C and G: FLAIR sequences; D and H: T1 injected images).

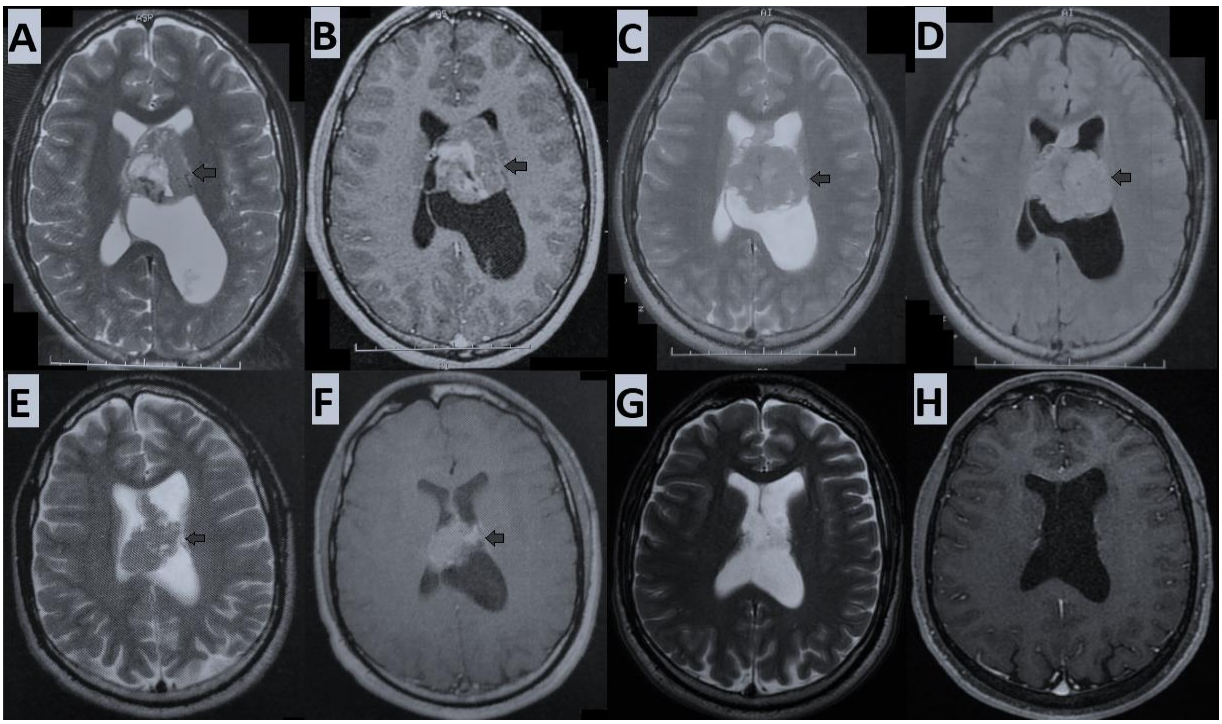

Figure 2. 22 years old male with one-month history of severe headache clinical exam at the admission found conscious patient without neurologic deficit there was no papilledema. Brain MRI objectified a process in the left ventricular frontal lateral horn measuring 33 X 45 mm with heterogeneous isosignal in T1WI, T2 WI, and FLAIR sequences with heterogeneous enhancement after gadolinium injection (A, B). The patient was operated and the lesion was subtotaly removed through a left Trans frontal Trans ventricular approach. One year later a control brain MRI objectified a re-expansion of the lesion it measured 50 X 50 X 42 mm (C, D), this time a total removal of the tumour was planned to be performed in two stages first a subtotal removed was performed through the same approach. Three years later the brain MRI objectified the persistence of the residual amount of the tumour measuring 23 X 34 mm (E, F) so the second stage of the removal was lunched and as planed the total removal obtained through the same approach. The brain MRI control images performed four later objectified no evidence of recurrence (G, H). A, C, E, and G axial T2 WI b; B, F, and H injected sequences; and C: FLAIR sequence).

Discussion

The central neurocytoma represents a very small proportion of brain tumours (0.1-0.5%), mostly in the lateral ventricle (77%),[2] with sometimes extension to the third ventricle (26%) [6] and rarely an exclusive localization in the third ventricle. As in our series it occurs frequently at the third decade with extremities ranging from (8 to 67) years old [7,8]. Most studies attest that there is no correlation between gender and incidence of central neurocytoma [5,9,10,11]; a slight female predominance was noted in our study, also higher incidences of this lesion was mentioned in some studies in Japan, Korea and India [8,12,13]. The clinical presentation is dominated by increasing intracranial pressure signs due to obstructive hydrocephalus by obliteration of the foramen of Monro associated to cognitive disturbance. Seizures, decreased consciousness and vision problems are less frequent. We consider that the cognitive disturbance is due to the close relation of the tumour to the trigone which is frequently infiltrated by the lesion (..).In radiological findings this lesion is mostly located in the anterior half of lateral ventricle appears to be isodense in computerized tomography (CT) scans associated to hyperdensities indicating calcifications which occur in up to 50% of all cases[5, 14].In magnetic resonance imaging (MRI) the central neurocytoma appears isointense on T1 weighted imaging, iso-hyperintense on T2 weighted imaging; and with heterogeneous moderate enhancements after contrast agent injection which is the classic "*soap bubble*" aspect [15]. Surgery is the only effective treatment for this kind of lesions and complete resection is associated with better rates of survival and local control, with five-year survival rate of 99% for gross total resection (GTR) and 86% for subtotal resection (STR) [19].

The trans-frontal trans- ventricular approach as well as the anterior trans-callosal approach offers the best surgical corridor to all lesions located in the frontal horn of the lateral ventricle [20]. We noted in patients operated in two stages that the resection was safer and easier comparing with those operated in single stage, this can be explained by the devascularization of the lesion in the first stage. Due to its histological similarities with other ventricular tumors such as ependymoma oroligodendroglioma the CN is frequently not easy to diagnose, the immunohistological markers are very useful in the diagnosis of this lesion and synaptophysin is the most specific one [13]. Adjuvant therapies are indicated in case of atypical, incomplete resection or inoperable recurrence neuocytoma; tow modalities are used conventional radiotherapy and stereotactic radiosurgery; with no statistically difference between both therapies. [16, 18]

Conclusion

The CN is usually a benign tumour of the central nervous system in which the surgical treatment is the only efficient option with very good results in term of survival rates and local control. Conventional radiotherapy or stereotactic radiosurgery can be considered in cases of atypical neurocytoma. The two stages surgery adopted in our department can be a good and safe strategy to deal with this kind of haemorrhagic tumours.

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Multilocular hydrocephalus

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Keywords
multilocular hydrocephalus, hydrocephaly, endoscopic neurosurgery, operative approach

ABSTRACT
Multilocular hydrocephalus is an entity that occurs relatively frequently in neurosurgical practice. We are present an editorial letter with a mini-review of the pathophysiology, surgical, and medical treatment.

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Multiloculated hydrocephalus (MH) has also been termed as a multiseptate hydrocephalus, polycystic hydrocephalus, interventricular septum and can be unilocular or multiloculated. [5,6,9] MH is characterized by the presence of septations or obstructions within the normal ventricular system, leading to cerebrospinal fluid (CSF) accumulation due to a lack of communication between ventricles [4,6,8,10,11.] Although the etiology and pathogenesis not clearly known, the presence of septations has been considered to be caused by a fibrous adhesion within the ventricles or by inflammation leading to sub ependymal gliosis leading to glial bumps and septations leading to Ventricular obstruction[4,8,9] .

Many etiological factors have been shown to associate with multiloculated hydrocephalus such as many intracranial processes as infection, intracranial hemorrhage, bacterial or fungal meningitis, congenital malformations, birth trauma, tumors, intracranial surgery, among others [2, 6, 8,10,11]

Histologically, ventricular septum it is origins from a glial protrusion

in ventricles[4]. The clinical presentation is determined by the most frequent manifestations of complicated hydrocephalus, such as: enlargement of the head, convulsions, neurological impairment, sign of the setting sun (inability to look upwards, observed with higher frequency in infants), headache or mental retardation[3,7]. On the other hand, in the worst scenario, many patients may have the intracranial pressure (ICP) increased, presented as a consequence of the expansion or enlargement of the ventricles (ventriculomegaly) [3,10]. Computed tomography (CT) and magnetic resonance imaging (MRI) allow visualization of the multiple cavities with CSF and irregular dilations with multiple septations (Figure -1)[2,4,9,10.] the complications may be obtained by catheters and interventions to relief the symptoms caused by raised intracranial pressure, however, the primary goal is to establish communication between existing compartments and thereby achieve the diversion of the CSF [8,10]

Treatment seeks to restore communication between isolated intraventricular compartments, in order to create a single cavity and implement a single bypass [11] .Treatment options include placement of multiple bypass systems, endoscopic fenestration of localized compartments, septostomy, third endoscopic ventriculostomy, stereotactic aspiration, or craniotomy for the microsurgical fenestration of localized compartments or combination of several surgical principles.[2,3,4,10] This mentioned open surgical and endoscopic approach effective at improving adequate function of CSF derivation. Furthermore, endoscopic techniques have the advantage in decrease time of surgery, need of transfusion and length hospital stay[1].The craniotomy and open surgical approach show a better success rate in severity and/or refractory chases[1,2]

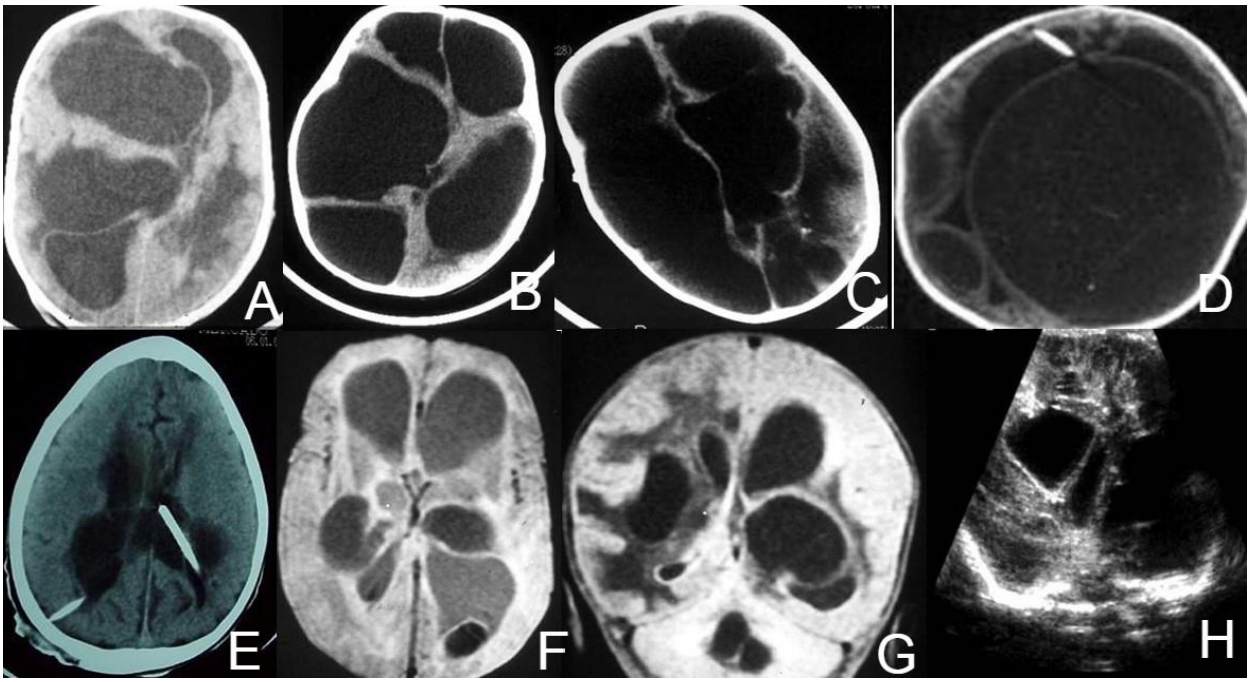

Figure 1. CT scan (A-E), MRI (F and G) and USG images showing characteristic imaging appearance of multiloculated hydrocephalus i.e., dilated ventricle and multiple septations.

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Safety of metoclopramide in traumatic brain injury patients. A systematic review of literature

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ABSTRACT

Background: One in every three related-injury deaths in United State are linked directly to traumatic brain injury (TBI), for which it is considered as a leading cause of death. Traumatic brain injury took place due to severe head assault to a hard object, with headache and vomiting being amongst the most common presenting symptoms. Metoclopramide is an old antiemetic agent that has been used widely for nausea and vomiting in TBI patients.

Aim: A systematic review of the literature to investigate the safety of metoclopramide in treating traumatic brain injury patients.

Methods: A literature review was conducted in 6 databases, we determine the pertinence of a study to the inclusion criteria by assessing the title, keywords, and abstracts. Five studies were found to be relevant. Data were extracted using multiple variables that were formulated incongruent with the study aim and then further analyzed.

Results: The collective sample size was 93 patients with an average of age 38.5 years. 51.6 % were male and 48.6% were females. Most patients received 10 mg metoclopramide IV with a percentage of 77.4%. While only 22.5% received 20 mg IV metoclopramide. Seventy-one patients received metoclopramide alone and 22 received combination therapy. Headache was the most common reported side effect (46.2 %), followed by anxiety and drowsiness with (39.7%) and (27.9 %); respectively. Fatigue reported in (24.7%), while dystonia was the least common and developed only in 5.3%.

Conclusion: Metoclopramide is a common medication used to treat TBI patients in the emergency department. However, the review demonstrated that the central nervous system (CNS) side effect is excepted. Alternative options with lower CNS side effects may be better tried.

Keywords
traumatic head injury,
metoclopramide,
safety,
side effect,
headache,
vomiting

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BACKGROUND

One in every three related-injury deaths in the US are linked directly to TBI, for which it is considered as a leading cause of death (1). As for paediatric cases the prevalence across countries varies from 47 and 280 per 100,000 children, more than 80% of which are minor head injuries with GCS of 14-15(2). Traumatic brain injury took place due to

severe head assault to a hard object, which then can be classified into mild, moderate, and sever using GCS (3). Moreover, the main causes of TBI are road traffic accidents (RTA), falling, physical violence, exercise-related head injuries among others (1,3). Patients with TBI usually present to the emergency room (ER) with headache, nausea, and vomiting (4). Other common presentations are dizziness, blurred vision, loss of consciousness, amnesia, and disturbance in concentration (1,2,4). As for headache, 1 in every 4 patients reported persistent headache syndrome (4). TBI patients were treated with antiemetic agents for their symptoms. Metoclopramide (4-amino-5-chloro-2-methoxy-N- (2 dimethylamino methyl benzamide) is an old antiemetic agent that has been used widely for nausea and vomiting as well as other gastrointestinal disorders (2). It is an antidopaminergic agent, centrally and peripherally acting, in order to enhance upper gastrointestinal motility without affecting its secretion (3). Metoclopramide administration through PO takes about 1-2 hours for maximum plasma concentration while it takes only 15min on an IV root (2,3). It is metabolized by the hepatic Cytochrome P450 CYP2D6 enzyme (2). The drug has multiple side effects such as; dystonia, restlessness or anxiety, fatigue, drowsiness, confusion, insomnia, and flushing (2,3). Our main aim is to study the safety of metoclopramide in treating TBI cases by reviewing the literature.

METHODOLOGY

Literature search and formulating selection criteria

This study is a literature review with the main aim being to study the safety of metoclopramide in treating TBI cases. We searched Pubmed, EBSCO, Proquest, ScienceDirect, Wiley Online, and Springer for pertinent studies. Moreover, we determined the pertinence of a study to the inclusion criteria by assessing the title, keywords, and abstracts. The keywords we used were; Traumatic Head Injury, Head Injury, Brain Injury, Subdural Injury, Epidural Injury, Metoclopramide, Safety of Metoclopramide, and Metoclopramide side effect. Furthermore, the inclusion criteria were; all English literature and articles about TBI that used metoclopramide and reported drug side effects while we excluded any articles that are non-completed, repeated, or did not meet any of the aforementioned criteria.

Data Extraction

Data were extracted using multiple variables that were formulated incongruent with the study aim. The variables are; article type and author's name, number of patients, the average age, gender, the dose of metoclopramide, drug combination, drug side effects, mechanism of injury, GCS, and duration of follow up. All of which were gathered in a table and were set for analysis.

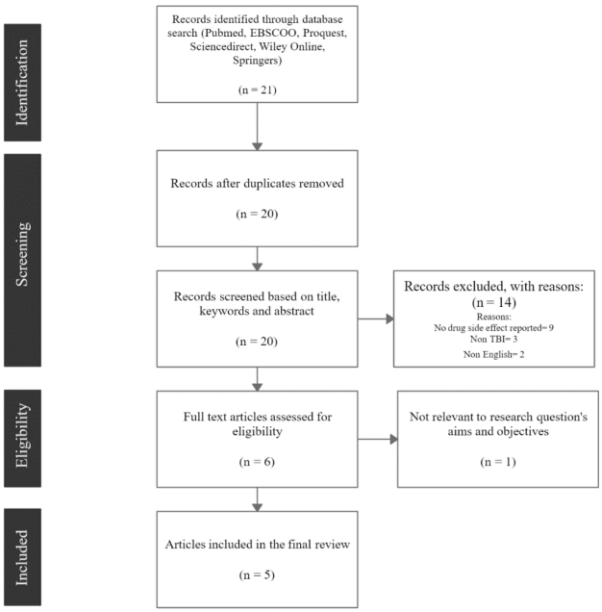

Figure 1. PRISMA flow diagram show Methodology characteristic of included study

Figure 1 represents flow chart depicting the study selection process. Of 21 relevant studies, one of them was found to be a repetition, 14 were not eligible and one was irrelevant to the research aim. 5 pertinent literature were studied thoroughly for data extraction.

Data Analysis

Data were collected in an EXCEL sheet, formula builder was used to calculating simple mathematic, including the total number of patients, the number of females and males, and the percentage of each, total number of side effects reported. SPSS has been used to calculate the mean of age and the days of follow up using a bar of weight cases.

RESULT

Our study included 5 articles, as shown in Table 1. Two studies were randomized controlled, one was

prospective, and two case reports. There were variations in the drug side effects reported in each study. Two studies used Diphenhydramine 25mg and Cisapride as a combination thereby, while the remained used metoclopramide alone. All the studies used 10 mg IV metoclopramide except one study used 20 mg IV. Headache was the most common reported side effect by 2 studies. There was some missing data especially on the mechanism of injury.

Our sample size was 93 patients with an average of age 38.5 years. 51.6 % were male and 48.6% were female (Table 2). Most patients received 10 mg metoclopramide IV with a percentage of 77.4%. While only 22.5% received 20 mg IV metoclopramide. Seventy-one patients received metoclopramide alone and 22 received combination therapy. Headache was the most common reported side effect (46.2 %), followed by anxiety and drowsiness with (39.7%) and (27.9 %); respectively. Fatigue reported in (24.7%). While dystonia was the least common and developed only in 5.3%.

Discussion

This is the first systemic review study of metoclopramide side effects on patients with TBI. There is a lack of clinical trial which study the side effect of metoclopramide in patients with TBI. Our study identified 93 patients who received metoclopramide after TBI. The average age of patients was 6.9 years (4-69). Male was relatively higher than female in our sample size as 51.6% of our sample size were male compared to 48.4% female. Comparing done to identify the incidence and management of moderate to a severe head injury which showed that male to female ratio is 2:1(5). This might be due to the type of our research as it is a systemic review and most of our data were collected from prospective and clinical trial research. A previous study on the identification of the efficacy of metoclopramide in TBI, showed that the leading causes of TBI were RTA, followed by fall (6). In comparison to our study fall and trip were the highest.

In our review, 77.4% received 10 mg metoclopramide intravenously, and 22.5% received 20 mg intravenously. This dose was supported by the recommendation of the European Medicines Agency that the maximum daily dose of Metoclopramide is between 10 mg to 30 mg in order to decrease the risk of neurological and other adverse effect (7). Metoclopramide is a prokinetic agent that have been widely used in critically ill patient to improve gastric motility and the symptoms of head concussion, nausea, and vomiting (8). However, the concerns of metoclopramide's safety have been raised (9). One of the studies included in our review showed that the effectiveness of metoclopramide and ondansetron was similar. However, because of the incidence of the complications in patients treated with metoclopramide were higher than ondansetron, they concluded with the suggestion to use ondansetron instead of metoclopramide inpatient with TBI (10). In TBI patient with an enteral feeding problem, the use of erythromycin instead of metoclopramide in some situation has been studied which show there is a significant decrease in high gastric aspirate volume with the use of erythromycin compared to metoclopramide (11).

In the current systemic review, the most common symptom was the headache as it is presented in 45.2% of the sample size [10,12]. In contrast to a survey study done by *Hale.T* which showed that among 32 participants in the study, 1-7% of participants complained of some central side effects ranging from dizziness and headache. We can see that patients with TBI are more susceptible to develop a headache and other neurological side effects, including extrapyramidal side effects, from metoclopramide compared to others (13). In our review, the incidence of anxiety and drowsiness were 37 patients (29.0%) and 26 patients (27.9%), respectively. Fatigue was only represented in 23 patients (24.7%)(10)(12). While another systemic review study done to study the use of metoclopramide in diabetic gastroparesis, showed that fatigue, drowsiness and lethargy were presented in 10% of patients (14). Dystonia was represented in 5 patients (5.3%). The incidence of dystonia in the previous systemic review was in an approximately 0.2–6% of patients who received metoclopramide (14). These side effects may explain by the ability of metoclopramide to cross the blood-brain barrier easily (15).

The early signs of an increased ICP are headache, vomiting or nausea, ocular palsies, and altered level of consciousness. Side effects of metoclopramide overlap with raised ICP symptoms, since it is subtle it is difficult to recognize a rise in ICP unless you investigate it. In our literature review, a case report

identifies an increased in ICP from baseline of 15 - 20mmHg to 36mmHg following a 10mg intravenous metoclopramide and the same dose in the following day reports another increases to 34 mmHg (16). Such side effects raise a question of the safety of the metoclopramide in patients with TBI. Inconsistent with our results that found an increased susceptibility for neurological side effects after

metoclopramide administration in TBI patients. A controlled randomized clinical trial is recommended to exploit the relationship between raised ICP and metoclopramide.

Limitations:

The limitation of the study includes the lack of high evidence studies as there were only two randomized controlled trials and one prospective study. publication bias was not done because of the same reason. In addition, the lack of long term follows up was also noticed. In addition, in 75.2% of cases, the mechanism of injury was not mentioned.

CONCLUSION

Metoclopramide is a common medication used to treat TBI patients in the emergency department. However, the review demonstrated that the CNS side effects are excepted. Alternative options with lower CNS side effects may be better tried.

Table 1. Summary of Metoclopramide and TBI studies

Article type	Author Year of publication	No. of patients	Age	Gender		Dose of metoclopramide	Combination	Side effect	Mechanism of injury	GCS	Duration of Follow up
Controlled, randomize, double blind clinical trial	Majid Zamani et al. 2015	60	36.1	M F	33 27	10 mg, IV	NA	- Headache 30/60(30%) - Drowsiness 26/60(43.3%) - Fatigue 23/60(38.3%) - Anxiety 37/60(61.7%) - Dystonia 5/60 (8.3%)	NA	14-15	NA
Prospective, randomize, controlled, double-blind	Tarik Zafer Nursal 2007	10	43	M F	8 2	10 mg, IV	NA	5/10 develop complication *	TBI not defined	11-6	5 days
Prospective	Benjamin W 2018	21	45	M F	5 16	20 mg, IV	Diphenhydramine 25mg	headache 12/19 (63%)	- Trip/fall 9 - Impacted stationary object 4. - Projectile 4 - Assault 3 - RTA 1	NA	5 days
Case report	Simon Deehan 2002	1	22	M	1	10 mg, IV	NA	- Increase ICP - Raised MAP	RTA	3	4 days
Case report	Thomas Altmayer, 1996	1	22	M	1	10mg, IV	Cisapride	None	RTA	9	69 days

GCS: Glasco coma scale
RTA: road traffic accident
*Not defined but none of which were extrapyramidal symptoms

Table 2. Summary of Metoclopramide and TBI studies finings

Number of patients		93
Average of age		38.5
Gender	Male	48(51.6%)
	Female	45(48.4%)
Treatment	Metoclopramide only	71(76.3%)
	Metoclopramide and Diphenhydramine	21(22.5%)
	Metoclopramide and Cisapride	1(1.1%)
Dose of metoclopramide	10 mg, IV	72(77.4%)
	20 mg, IV	21(22.5%)
Side effect	Headache	42(45.2%)
	drowsiness	26(27.9%)
	Fatigue	23(24.7%)
	Anxiety	37(29.0%)
	Dystonia	5(5.3%)
	Increase ICP Increase MAP	1(1.1%)
Mechanism of injury	Not defined	70(75.2%)
	RTA	3(3.2%)
	Trip/fall	9(9.7%)
	Impacted stationary object, assault	7(7.5%)
	Projectile	4(4.3%)
	Undefined complication	5(5.3%)
Average of the follow up		6.9(4-69)

Abbreviation

TBI: Traumatic brain injury
ICP: Intracranial pressure
CNS: Central nervous system
GCS: Glasgow Coma Scale
ER: Emergency Room
RTA: Road Traffic Accident
MAP: Mean Arterial Pressure

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Pre-hospital care: demography, current profile and future trends. Improving the health of traumatic brain injury patients

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Keywords
pre-hospital care, hypoxia, hypotension, ambulance, intubation, traumatic brain injury

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ABSTRACT

Introduction. Traumatic brain injury (TBI) is a major public health problem throughout the world. It is one of the leading causes of mortality and disability as a consequence results in a great financial burden on societies. Damage to the brain following trauma does not occur only at the moment of injury but also develops over a period of hours to days with the further secondary insult of the brain.

Methods. This was a prospective study done between April 2017 to March 2019. A total of 2134 patients were enrolled for this study with a collection of data in a formatted proforma. All the patients of trauma with clinical or radiological evidence of head injury coming to the trauma centre were included.

Results. In our study patient, mortality was 6.79% in patients receiving pre-hospital care compared to 12.03% in patients not receiving adequate pre-hospital care. 29.42% were in the age group of 21–30 years. RTA (overall 64.45%) was the most common mode of injury in the age group 21–30 years with 81.36% cases. Mortality in first emergency care provider by ambulance paramedics was 5.69% and member of the public was 10.10%.

Conclusion. It was observed that mortality was higher in patients not receiving adequate pre-hospital care. Early resuscitation facilities at the site of the accident have to be introduced and improved with the execution of rapid transportation to trauma care centres.

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INTRODUCTION

Traumatic brain injury (TBI) is a major burden on the health care system in developing countries like India. It is one of the leading causes of mortality and disability worldwide as a consequence results in a great financial burden on societies. Research in the area of neurological trauma has shown that the totality of damage to the brain following trauma does not occur at the moment of injury but develops over a period ranging from hours to days. Brain injury occurs with further insult from secondary causes like hypotension, hypoxia, cerebral

edema, raised intracranial pressure, and expansion of the mass lesion. The incidence of TBI has increased significantly in the last 30 years but the mortality has decreased as a result of better management and availability of health care services.[1,2] In developing countries there is a large number of lives lost due to lack of pre-hospital care whereas in developed countries life expectancy has increased [3] due to advancements in pre-hospital and better understanding of pathophysiological processes in TBI.

To achieve better outcomes an early critical intervention in delaying or preventing secondary brain insults and maintaining cerebral perfusion is of paramount importance. This can be done with simple measures done just after trauma following ATLS guidelines with the prevention of hypotension and hypoxia. Evidence-based guidelines have been developed for the management of traumatic brain injury and implemented over the past decade, particularly within the intensive care unit (ICU) environment. However, the uncertainty of the efficacy of pre-hospital advanced life support interventions remains as such. In pre-hospital care, the standard management procedure for severe traumatic brain injury varies from case to case due to divergent scene conditions and characteristics. Multiple factors such as mechanism of injury, severity, and pattern, location of the accident, mode of transport, the time interval between trauma and first care and experience and skill level of paramedic contribute to this varied response.[4]

As a consequence of this uncertainty in the efficacy, further investigations and researches are the need of the hour. While pre-hospital management of severe TBI has become progressively more advanced, many challenges are remaining especially in the early recognition and treatment of severe brain trauma by ambulance paramedics. The expeditious transport of patients with brain injuries to an appropriate facility and the prevention of secondary insult is of increasing importance in the reduction of mortality and morbidity in brain trauma patients.[5] It is crucial that the first health care provider must be familiar with the complex presentation of severe traumatic brain injury patients in the initial stages of injury. Early recognition and response to traumatic brain injury can significantly impact on neurological outcome. Paramedics must have a sound knowledge of the interventions which may minimize secondary insult with the pre-hospital treatment of hypoxemia and hypotension being crucial components of traumatic brain injury management.

This study can be used to formulate new guidelines and plans to tackle the delay in first care to patients with TBI.

Methodology

The study was conducted at a level 1 trauma center of SMS medical college, Jaipur, India between April 2017 to march 2019. Overall, 2134 patients were enrolled for this study with a collection of data in a formatted proforma from admission to discharge. The data was collected from patients and their relatives. The ethical committee clearance was obtained prior to the commencement of the study. All the patients of trauma with clinical or radiological evidence of head injury or associated other injury coming to the trauma center were included.

It was a prospective observational study. Data of individual patients were collected in the form of age, sex, mode of injury, mode of transportation, distance from the hospital, Care providers, Safety equipment used by the vehicle, duration in reaching the hospital, pre-hospital care, Glasgow Coma Scale (GCS), saturation of peripheral oxygen (SpO2), systolic blood pressure (SBP) at admission and Glasgow Outcome score (GOS) at time of discharge. Based on GCS, TBI cases were graded as mild (13-15), moderate (9-12), and severe (<8). This neurosurgical center is one of the leading institutes of India and Asia catering to both urban and rural populations.

After researching various literature published, we could conclude that this study is one of the largest in the world and is unique with maximum variations in population.

RESULTS

During the period from April 2017 to March 2019 data from 2134 TBI patients was collected. The mean age was 31.65+ 15.1 years. In our study 69.89% were males and 31.11% were females **(Table 1)**. Males were 2.21 times more common than females. Most patients affected were in the age group of 21–30 years (29.42%) followed by 31–40 years (22.68%). Road traffic injury (64.45%) was seen as the most common mode of injury in the age group 21–30 years (81.36%) followed by injury due to fall (21.41%) which mostly affected the age group of 0–10 years

(71.44%) and above 60 years (33.80.%) **(Table 2).** Most of the patients were attended by the members of public as a first responder (77.41%) **(Table 3)** and transported to definitive treatment centers in ambulances (66.82%) **(Table 4)** but most of them not received care in the form of vitals monitoring, intravenous (IV) fluid administration and airway protection at the site of trauma and during transportation**.** Safety devices such as helmets, seat belts, and child restraint were used in 27.03% patients only **(Table 5).** Alcohol consumption while driving is 14.53% **(Table 6)**. Time duration to reach definitive treatment centers was <1 hour in 3.13% of patients, between 1 and 4 hours in 16.16% of patients, between 4 and 12 hours in 56.04% and >12 h in 24.65% of patients **(Table 7)**. 32.29%, patients were primary referrals, and 67.71%, patients were secondarily referred to our study center **(Table 8).** The overall mild injury was seen in 49.11% cases, moderate in 31.02%, and severe in 19.87% **(Table 9)**.

Table 1. Different age groups and outcome

Age in years	The total no. of cases n (%)	Out come Alive Death n=1901(%) n=233 (%)	
Age yrs.(mean)	31.65+ 15.1	33.24 ± 14.5	41.36 ± 17.8
0-10	191(8.95)	183 (8.58)	8(4.18)
11-20	233(10.91)	221 (10.36)	12(5.15)
21-30	628(29.42)	554 (25.96)	74(11.78)
31-40	484(22.68)	428 (20.06)	56(11.57)
41-50	232(10.87)	192 (8.99)	40(17.24)
51-60	153(7.17)	139 (6.51)	14(9.15)
>60	213(9.98)	184 (8.62)	29(13.61)
Total Male Female	1470(68.89) 664(31.11)	1311(89.19) 590(88.85)	159(10.81) 74(11.14)

Table 2. Incidence of mode of injury in different age groups

Age (years)	Total cases n(%) n=2134	mode of injury RTA Fall Assault Sports Others n(%) n(%) n(%) n(%) n(%)				
0-10	191 (8.95)	41 (21.47)	130 (68.06)	Nil	12 (6.28)	8 (4.19)
11-20	233 (10.92)	128 (54.93)	54 (23.17)	15 (6.43)	24 (10.3)	12 (5.15)
21-30	628 (29.43)	511 (81.36)	43 (6.85)	29 (4.61)	5 (0.79)	40 (6.36)
31-40	484 (22.68)	357 (73.76)	69 (14.26)	34 (7.02)	Nil	24 (4.96)
41-50	232 (10.87)	144 (62.06)	54 (23.27)	26 (11.20)	Nil	8(3.44)
51-60	153	71	35	45	Nil	2(1.31)
	(7.17)	(46.41)	(22.87)	(29.41)		
>60	213 (9.98)	124 (58.21)	72 (33.80)	13 (6.10)	Nil	4 (1.88)
Total	2134 (100)	1376 (64.48)	457 (21.41)	162 (7.59)	41 (1.92	98 (4.60)

Table 3. First emergency care provider

Care providers	No of patient n (%)	Outcome Alive Death n (%) n (%)	
Member of public	1652 (77.41)	1485 (89.89)	90 (80.35)
Ambulance officer or paramedic	123 (5.76)	116 (94.30)	7(5.69)
Relatives	247 (11.57)	210 (85.02)	37 (14.98)
Medical retrieval team	Nil	Nil	Nil
Unknown	112 (5.24)	90 (80.35)	22 (19.64)

Table 4. Mode of transportation

Mode	First Hospital Total no of cases N=1445(%)	Study center Total no of cases n(%)	Outcome Alive Death n(%) n(%)	
Ambulance	432 (29.90)	1426 (66.82)	398 (92.13)	34 (7.8)
Private vehicle	1013 (70.10)	708 (33.18)	1503 (88.30)	199 (11.69)

Table 5. Safety equipment used

Equipment	No of patient n(%)	Outcome Alive Death n(%) n(%)	
Helmet- Urban Rural	204(20.90) 139(68.13) 65(31.87)	189(92.64) 131(94.24%) 58(89.23%)	15(7.35) 8(5.76%) 7(10.77%)
Seatbelt	168(78.50)	157(93.45)	11(6.54)
Child restraint	Nil	nil	Nil
Unknown	495(23.20)	447(9.03)	48(96.97)

Table 6. Substance abuse

	No of patient n(%)	Outcome Alive Death n(%) n(%)	
Alcohol involvement	310(14.53)	243(78.39)	67(21.61)
Alcohol breath on admission	213(10.00)	184(86.38)	29(13.62)

Drug involvement	10(0.47)	8(80.00)	2(20.00)
Using mobile phone at time of accident	43(2.00)	35(81.40)	8(18.60)
Prior head injury	43(2.00)	33 (76.74)	10(23.25)
Multiple addiction	46(2.16)	33(71.74)	13(28.26)
None	1469(68.84))	1365(92.92)	104(7.08)

Table 7. Time to arrival at hospital

Time to arrival at hospital –	First hospital n (%)	Study center n (%)	Outcome Alive, n(%) Death, n(%)	
<1 hrs	1364(63.92)	67 (3.13)	59 (88.05)	8 (11.94)
1-4 hrs	585 (27.41)	345 (16.16)	328 (95.07)	17 (4.92)
4-12 hrs	123 (5.76)	1196(56.04)	1040 (86.96)	156 (15.00)
>12 hrs	62 (2.91)	526 (24.65)	474 (90.11)	52 (09.89)

Table 8. Correlation of SBP and SpO2 and outcome

Systolic blood pressure	No of patient (%)	Outcome Alive, n(%)	Death, n(%)
>90 mmHg	1885(88.33))	1745(92.57)	140(7.43)
<90 mmHg	249(11.69)	156(8.20)	93(37.35)
SpO2 -			
<90%	339(15.89)	216(63.72)	123(36.28)
>90%	1785(84.11)	1675(93.84)	110(6.16)
First CT			
Primary hospital	456(21.36)	425(93.20)	31(6.79)
Study center	1678(78.63)	1476(87.96)	202(12.03)
Referral -			
Primary	689(32.29)	632(91.73)	57(8.27)
Secondary	1445(67.71)	1269(87.82)	76(12.18)

Table 9. Severity of injury

GCS on admission	Total no of cases, n (%)	Outcome Alive, n (%)	Deaths, n (%)
Mild (13-15)	1048 (49.11)	1036(98.85)	12 (1.1)
Moderate (9-12)	662(31.02)	608(91.84)	54 (8.15)
Severe (<8)	424 (19.87)	257(60.61)	167(39.38)

Discussion

With rapid industrialization, the cases of TBI are rising, and so does its severity. But the advancement in pre-hospital care is lacking in developing countries. Different studies have shown that early resuscitation and pre-hospital care are cardinal to better outcomes in TBI. Mortality and morbidity of the severely injured patient can be reduced significantly by directly transporting them from the scene to Level I trauma centers. Early identification and prompt management lead to a better survival rate in cases of TBI. This can be achieved through pre-hospital care which was non-existent in India.[6-8]

In our study, the incidence of head injury was highest in the age group 21-30 years i.e. 29.42% and commonest mode of injury were as RTA in 64.45% cases followed by fall from height in 21.41%. Similar studies conducted by Meena et al.[9] and Phonprasert et al.[10] showed 69.52% and 58% of cases were due to RTA respectively. Gururaj et al.[11] in his study claimed 60% of cases were due to RTA and 20-25% cases were of falls. Thus, RTA was found to be the most common mode in almost all studies. [9-11] It was most probably due to excessive congestion of traffic on roads, less traffic sense, poor conditions of the road, not using helmet by bike riders, and not following the road traffic rules.

Alcohol consumption while driving is also a contributing factor for increasing RTAs in young adults. In studies by Esser et al.[12] and Gururaj[13] the percentage of alcohol consumption was 17.9% and 14.50% respectively which is comparable to our study which is 14.53%. The patient using a helmet more often sustain milder head injuries, whereas, a patient without a helmet was having more severe injuries. Alcohol consumption was associated with more severe head injuries and high mortality of 21.61% compared to 7.08% in patients not using any drug and alcohol.

In our study private vehicle was the most common mode of transport at the first hospital while the ambulance was the most common mode at the study center. There was clearly a decrease in mortality of patients transported by ambulance (7.80%) than by private vehicle (11.69%), the difference was due to early identification and less time taken to reach the hospital and early treatment resulting in decreased secondary insults.

Prevention of hypoxia and hypotension is of utmost importance with the maintenance of cerebral perfusion. The presence of leads to multiple cascades of events leading to increased cerebral edema decreased cerebral perfusion, decreased

tissue, and vital organ perfusion. These all contribute to poor outcomes. In our study patients with SBP, less than 90 mmHg on admission had a mortality of 37.35% than patients with SBP, more than 90 mmHg 7.43 % mortality. The mortality in patients with SPO2 less than 90% was 36.28% compared to 6.16% in patients with SpO2 above 90%. Our study suggested that most of the primary or first hospitals overlooked the importance of monitoring oxygen saturation and blood pressure with increased chances of missing hypoxia, hypotension, thereby undervaluation of important secondary changes in the brain ultimately increasing the risk of worse outcomes. In the primary hospital CT scan had done in 21.36% and mortality 6.79% and study center 78.63% and mortality 12.03 %. Patients with their CT brain done at the first hospital within 4 hours after injury performed better. Early CT brain is a critical step in managing TBI cases with early information about operative intervention required, thus preventing further insult to the brain. Thus it is very critical for the emergency staff to be well versed with an indication of CT brain in trauma patients. For providing good pre-hospital care there are needs for intensive training of medical personnel and adequate resources at primary and secondary level health care facilities.

Time lapsed in reaching the hospital is also a significant factor determining the outcome. There is a major part of critical time lost in transportation. The prognosis of TBI is excellent if the patients get appropriate treatment in the golden hour. Our study noted that around 3.13%, 16.16%, 56.04%, and 24.65% of patients reached the hospital in less than 1 hour, 1-4 hour, 4-12 hour, and more than 12 hours respectively. In a comparative study by Gururaj,[13] only 25% reached hospital within 3 hours and 20% reached after 24 hours. The time interval between the time to arrive at the injury site and the hospital is one of the deciding factors between life and death. The overall mortality was found to be 10.92% as compared to 16% by both Phonprasert et al.10 and Narwade et al.[14]

The maximum severity of the injury was shifted to the hospital by private vehicle, without any vital monitoring. It was observed that mild, moderate, and severe TBI cases were 49.11%, 31.02%, and 19.87% respectively. A study by Natarajan et al.[15] showed the total number of mild, moderate, and severe injuries were 42%, 30%, and 28%, respectively. In our study, it was observed that mortality was highest in severe TBI (39.38%) and 1.1% in mild TBI.

In our study patient, mortality was 6.79% in patients receiving pre-hospital care compared to patients 12.03% in patients not receiving adequate pre-hospital care. This clearly signifies that pre-hospital care is a crucial step in managing TBI patients.

Chennai had 8.16% mortality, Bangalore had 8.6% and 5.5% mortality rate in 2002 and 2005 respectively whereas the mortality rate in Delhi was 10.49%. In recent years the mortality has decreased due to the availability of better health care facilities. With intensive studies and data registry in the USA and other western countries, they have formed better pre-hospital guidelines for trauma patients thus are able to avoid preventable deaths and disability.

Our study showed that patient with TBI need aggressive management in the form of, victims reaching the hospital in the shortest possible time, taking care of airway by use of laryngeal mask/endotracheal tube intubation, oxygenation and iv infusion for maintaining perfusion pressure for prevention of secondary brain injuries like hypoxia, hypotension, and cerebral edema. We can apply this data to develop new action plans and public awareness programs and developing adequate neurotrauma care protocols for aggressive management of patients with poor admission GCS score.

CONCLUSION

It is recommended that essentially, the outcome in TBIs can be improved by attending to priorities of reaching the victims in the shortest possible time, and evacuating them to hospital, taking care of airway, oxygenation and maintaining total perfusion pressure through judicious IV infusions. Depending upon the skills of Emergency Medical Technician / Paramedic, the use of Laryngeal Mask Airway / Endotracheal Tube can be considered. Infrastructure in the form of dedicated trauma centers, well-equipped ambulances with trained trauma staff, should be developed.

Abbreviation

TBI- Traumatic brain injury, ICU- intensive care unit, GOS-Glasgow Outcome Score, GCS- Glasgow Coma Scale, SBP-systolic blood pressure, SpO2 - saturation of peripheral oxygen.

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Conflicts of interest
There are no conflicts of interest.

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Encephalitic syndrome revealing cerebral gliomatosis in an adolescent

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ABSTRACT

Cerebral gliomatosis is a rare glial tumour which is defined by a diffuse and not very destructive infiltration of the encephalon by the glial neoplastic cells in the absence of individualizable tumour mass (Sanson et al., 2005).

The clinical and radiological presentation is often misleading and not very specific, and the diagnosis is rarely mentioned. Histological diagnosis remains difficult. Finally, gliomatosis poses a specific therapeutic problem compared to other glial tumours due to the toxicity of panencephalic radiotherapy and the impossibility of achieving surgical reduction of the tumour (Sanson et al., 2005).

Data from the literature show a median overall survival of 14.5 months, a higher frequency of oligodendroglial forms. The prognosis is linked to age, functional status, histological grade, oligodendroglial differentiation (Sanson et al., 2005).

We report the observation of a gliomatosis occurring in a 14-year-old boy, having presented focal subintral epileptic attacks accompanied by hemiparesis. Flair sequence brain MRI showed a left fronto-temporo-insular hyper signal. The brain biopsy revealed gliomatosis. The evolution was favourable after radiotherapy. Gliomatosis is a diagnosis to be systematically evoked in the presence of a diffuse cerebral affection. Its etiopathogenic mechanism is unknown, and evolution is unpredictable (Millan. BS et al., 2010).

Keywords
encephalitic syndrome, cerebral gliomatosis, adolescent

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INTRODUCTION

Cerebral gliomatosis is a condition initially described by Nevin in 1938 (Nevin et al., 1938), characterized by diffuse infiltration of glial tumor cells invading a large part of the brain, bilaterally (possibility also of the marrow), with absence of individualizable tumor mass (Nevin et al., 1938).

It is a rare neurosurgical pathology, since less than 300 cases are reported in the literature (Sanson et al., 2005), which can occur at any age, more frequently in adults between 40 and 50 years (MILLAN. BS et al., 2010). The clinical signs are non-specific and the imagery is often misleading, which can simulate a large number of non-neoplastic neurological medical pathologies (inflammatory or infectious encephalitis, angeitis, leukodystrophies) (Sanson et al., 2005). Its radiological and histological diagnosis is difficult because of the absence of identifiable tumor mass and its diffuse character. (MILLAN. BS et al., 2010). Gliomatosis also poses a problem of specific therapeutic

management by comparing them to other glial tumors (its diffuse nature, surgery is excluded, radiotherapy is poorly tolerated since it often involves the entire brain, chemotherapy is possible unlike other gliomas) (Sanson et al., 2005).

We report a case of gliomatosis in a 14-year-old boy, diagnosed in pre-mortem using MRI and brain biopsy data, the clinical and radiological picture of which was misleading, simulating an acute limbic encephalitis picture.

Observation

A 14-year-old boy immediately developed serial, drug-resistant focal seizures with temporal spread, and then developed right hemiparesis. The examination showed right hemiparesis, with no disturbance of consciousness, no signs of intracranial hypertension, or meningeal syndrome.

Magnetic resonance imaging (MRI) revealed a hyper signal on the Flair and T2 sequences, without contrast enhancement, unilateral, on the left, touching the fronto-temporo-insular white matter (Fig. 1). The GES highlighted left hemispherical brain pain, without paroxysms (Figure 2). The cytochemical study of the CSF revealed a slight hyperproteinorachia at 0.5 g / l, as well as a lymphocytosis at 30 elements / mm3, and the immunological study did not show a chronic inflammatory process. All serologies were negative (Herpes, HTLV1, syphillis, HIV, Lyme ...), and the autoimunity balance was also negative.

The patient received Methylprednisolone IV (1g / day for 5 days) with an oral relay (1mg / kg / day), combined with anti-epileptics (Levetiracetam 3g / day, Lamotrigine 200mg / day). The evolution was marked by a persistence of the epilepsy attacks, an appearance of headache and oculomotor disorders (diplopia, left exophthalmia), see obnubilation. Control MRI showed an aggravation of the lesions with mass effect and bilateralization of the hyper signal (Figure. 3). The brain biopsy was done urgently and returned in favor of a gliomatosis (oligodendrogliale). The child was treated with radiotherapy, with disappearance of disturbances of consciousness and seizures, and persistence of hemiparesis.

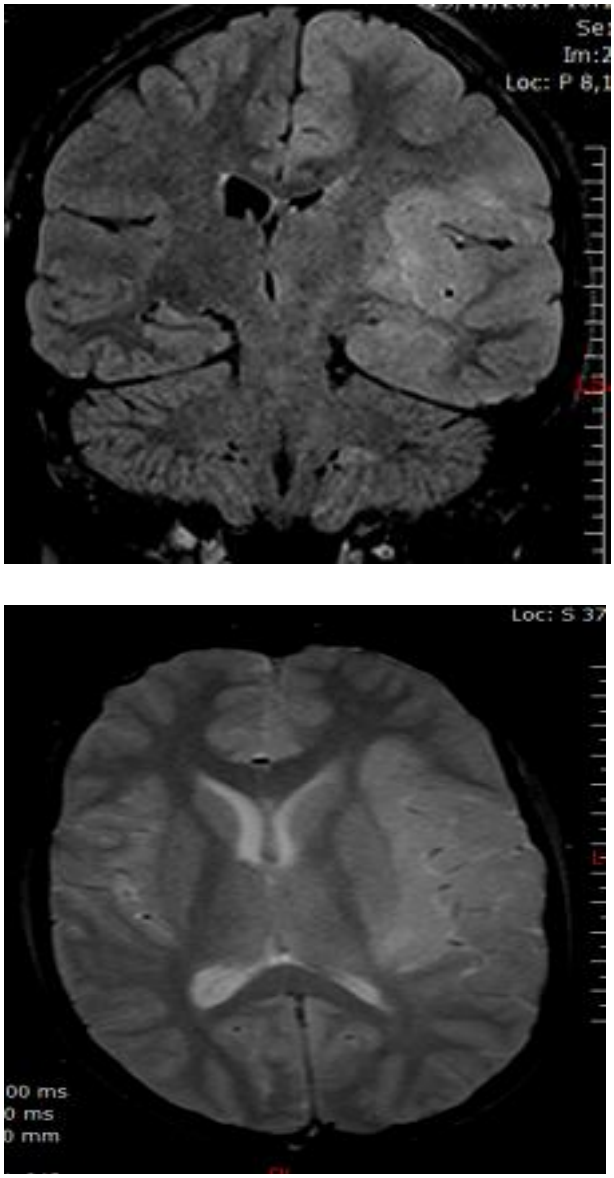

Figure 1. Cerebral MRI: a: coronal section, Flair sequence / b: transverse section, T2 sequence: left fronto-temporo-insular hyper signal.

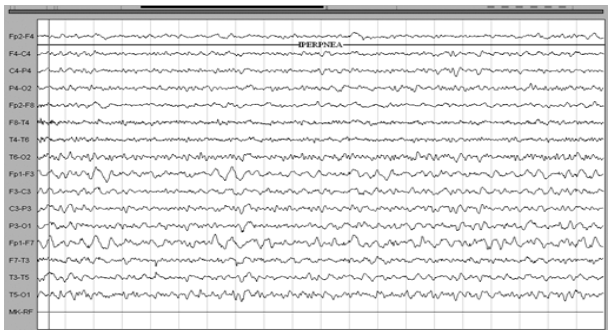

Figure 2. EEG. Left hemispherical pain (theta delta waves more marked on the left anterior regions).

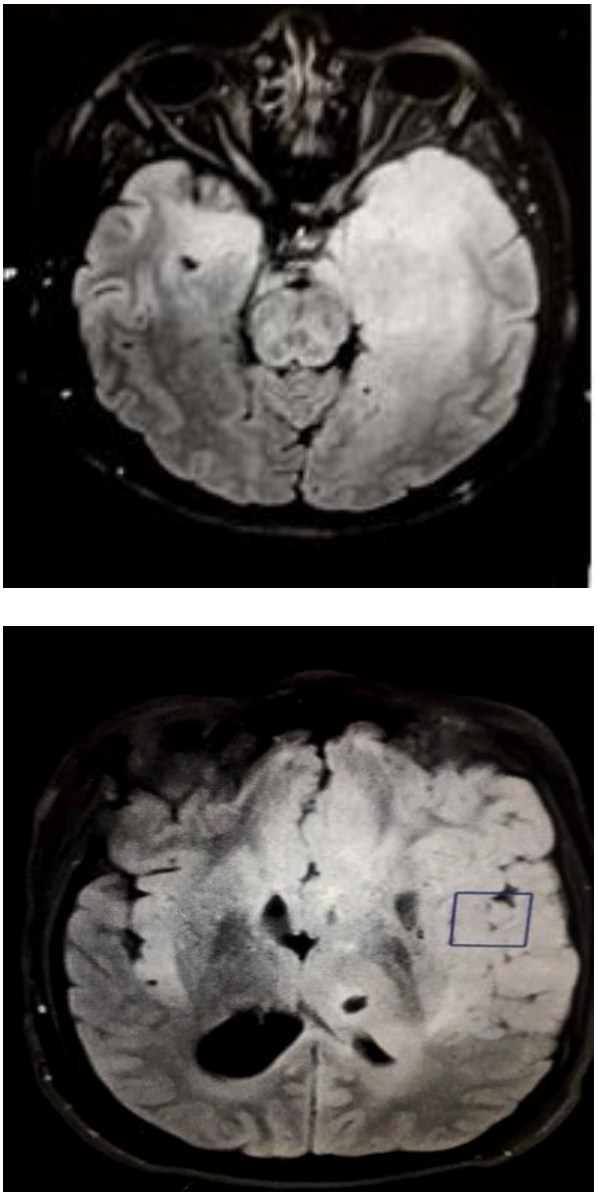

Figure 3. Control brain MRI (FLAIR sequences, cross section): extensive hyper signal affecting the fronto-temporo insular white matter, bilaterally, with mass effect.

Discussion

We report a case of cerebral gliomatosis, the diagnosis of which was based on imaging and brain biopsy data and whose evolution was favorable with disappearance of epilepsy attacks, improvement in disorders of consciousness and hemiparesis.

Primary gliomatosis often poses diagnostic difficulties because its clinical presentation is not very specific. The most frequent modes of revelation were epilepsy, the occurrence of cognitive disorders, intracranial hypertension (headache), the presence of focal deficits (ARTIGAS. J, et al., 1985, Sanson et al., 2005). It was in 1986 that the first premortem diagnosis of gliomatosis was made on the combined brain biopsy and MRI data (Troost D, et al., 1987). The incidence is higher in humans (in fact common to all gliomas) (Sanson et al., 2005) and, more specifically in gliomatosis, a younger age of onset in humans (jennings et al., 1995).

In MRI, the Flair and T2 sequences are essential, they show an extended bilateral hyper signal of white matter and gray nuclei, which can extend to the brainstem and the spinal cord (Peretti-Viton P, et al., 2002), and gadolinium intake is generally absent (Sanson et al., 2005). It is defined as "an infiltrating process, encompassing at least three lobes, without contrast enhancement or less than 1 cm" (Sanson et al., 2004). The brain scan, including with injection, may be normal, but a careful examination may show suggestive abnormalities (discreet ventricular asymmetry, discreet poorly limited hypodensity, appearance of diffuse cerebral edema with small ventricles, and diffuse erasure of the furrows, or, in an elderly patient, the absence of atrophy of the brain scanner) (Sanson et al., 2005). The diagnoses most often mentioned were: multiple sclerosis, leukoencephalopathy of unknown cause, encephalitis, progressive multifocal leukoencephalitis, vasculitis, Behçet's disease (Sanson et al., 2005). Although not specific, certain aspects are suggestive of gliomatosis: the presence of a discrete mass effect, the thickening of the corpus callosum, the asymmetrical character of the hypersignal, the heterogeneous and "flaky" character of the hypersignal, better visible in T2 as in FLAIR, the associated impairment of the gray matter, in particular of the thalamus and the loss of the boundaries between the white matter and the gray matter (Sanson et al., 2005).

The clinical and radiological differential diagnosis includes all diffuse encephalopathies of various causes (infectious, vascular metabolic and tumor) (Peretti-Viton P, et al., 2002). This is the case of our patient who presented a misleading picture with clinical and para-clinical signs (MRI, EEG, CSF) of acute limbic encephalitis.

The diagnosis by histological study by biopsy is still essential, but often proves difficult, and sometimes non-contributory due to the low cell density, and the preservation of the normal architecture (Sanson et al., 2005). The histological grade is sometimes difficult to determine (Sanson et

al., 2004). (astrocytic, oligodendroglial, polymorphic aspect...). According to the literature, oligodendroglial gliomatosis is considered rare (Balko et al., 1992), unlike some authors where the majority of gliomatosis is of oligodendroglial type (Sanson et al., 2005), as was observed in our patient. The extremely diffuse aspect of tumor infiltration could explain the fact that the brain biopsy is sometimes not very contributory. Glioma cells do not have the capacity to cross the vascular basement membrane (limiting metastases by hematogenous or lymphatic route) (Tonn et al., 2003), but they have the capacity to migrate very far into the neuron (Tonn et al., 2003; Bellail et al., 2004).

Spontaneous evolution is extremely variable ranging from less than 1 month to 16 years (Artigas, 1985, Cervos-Navarro, 1987, Louis. DN, et al., 2007). Survival appears to be linked primarily to clinical factors: gender, age and Karnofsky's functional index. The prognosis also appears to be linked to histological characteristics (Sanson et al., 2005). Our case had a favorable evolution with follow-up for 08 months, marked by a regression of clinical signs (epilepsy attacks, disturbances of consciousness, oculomotor disorders). The criteria which seem in favor of a good evolution are criteria of clinical response (disappearance of convulsions, regression of cognitive disorders and headache) or radiological (reduction of the range of the hyper signal, regression of the mass effect) (Sanson et al., 2004, 2005).

Exeresis is not possible because of the extent of gliomatosis (Sanson et al., 2005), and radiotherapy has a major neurotoxicity, since it often involves the entire brain (Crossen et al., 1994). This is why some authors have proposed treating these patients with chemotherapy alone as first-line treatment, which has the advantage of better tolerance (Sanson et al., 2004).

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Brain radionecrosis after radiation therapy for atypical meningioma. An unexpected treatment outcome. Case report

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Keywords
atypical, meningioma, radiation necrosis, radiotherapy, resection, spectrosco py

ABSTRACT

Introduction. Atypical Meningioma (AM) is at high risk of local failure. The role of radiation therapy (XRT) as an adjuvant to surgical resection is incompletely defined. The most deleterious consequence of brain-directed XRT is radiation necrosis. Brain radionecrosis (BRN) after AM has been rarely reported. The relevant literature is reviewed, highlighting its diagnostic challenges.

Case presentation. We report a 25-year-old male with a BRN after adjuvant XRT for AM, which has been misdiagnosed as a recurrent neoplastic lesion upon magnetic resonance spectroscopy (MRS) examination. Surgery and histopathological description were made and yielded a definitive diagnosis of BRN. The patient was treated by dexamethasone with concomitant hyperbaric oxygen therapy (HBO2). The patient showed a further progression of the disease. Therefore, he was elected to receive bevacizumab. However, the patient finally died for refractory brain edema.

Conclusion. BRN is a relatively rare instance after XRT for AM. There is no single modality that can reliably distinguish BRN from tumour recurrence. Therefore, reaching an early prompt treatment decision is challenging.

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INTRODUCTION

Meningiomas are extra-axial tumors that represent 30% of all primary brain tumors (1). The most common locations are along the cerebral falx and over the cerebral convexity, such in the case reported here (2). AM falls under the World health organization (WHO) Grade II tumors, accounting for 20% of all meningiomas (1-3). The distinction of AM is given to the meningeal tumor that exhibits high mitotic rate and brain invasion (1, 3). The median age for AM patients at diagnosis is 56 years (3). AM has a female predominance and a high predilection for recurrence (1-3).

Currently, AM's treatment guideline entails the combination of maximum safe surgical resection and XRT (1-3). Despite the absence of solid evidence to support XRT for AM, several studies have reported encouraging results (1, 2). XRT has been shown to improve AM prognosis with a median 5-year progression-free survival of 54.2% ranging from 38% to 100% after XRT (1). Nevertheless, XRT carries a risk of radiation necrosis (1, 4-16).

Herein, we report a case of BRN after adjuvant XRT for AM, which has been misdiagnosed as a recurrent neoplastic lesion upon the MRS examination.

CASE PRESENTATION

A 25-year-old male presented with a nine-month history of intermittent headache, described as 'generalized pressure' and dizziness. The symptoms had become more severe, and weakness on the left side extremities started to progress over the last week. The vital signs were stable, and the patient was fully conscious. Neurological examination showed no abnormality aside from mild left hemiparesis (Grade 4/5 Medical Research Council).

Cranial computed tomography (CT) scan revealed an enhancing extra-axial mass in the right frontal region, which contained multiple foci of calcification. There was significant peritumoral edema. Cranial magnetic resonance imaging (MRI) showed an iso-intense mass, with an area of low-intensity corresponding to the calcification observed on the CT scan (**Fig. 1**). Magnetic resonance arteriogram and magnetic resonance venogram showed multiple feeding arteries mainly from the anterior cerebral arteries and, to a lesser extent, from the distal right middle cerebral arteries with multiple, prominent draining veins. Based on the radiographic appearance, a diagnosis of right frontal convexity meningioma was made.

The patient underwent a craniotomy with total resection of the mass. The postoperative Cranial CT scan reported no residual tumor with a regression of brain edema (**Fig. 2**). The histopathology was AM (WHO grade II) (**Fig. 3**). This case discussed in the multidisciplinary tumor board. Accordingly, the patient was referred for XRT for a total dose of 60-Gy (30 fractions of 2-Gy) over six weeks duration, all delivered with intensity-modulated technique.

The patient reported new-onset of generalized seizures and worsening of left hemiparesis (Grade 3/5 Medical Research Council) three months after completion of XRT. An electroencephalogram revealed epileptic discharges over the right frontal derivations. Cranial MRI reported an iso-signal poorly defined lesion in T1 and T2 sequences compromising the right frontal lobe with extensive central necrosis and peri-lesional edema (**Fig. 4**). Additionally, a ring, cut green-paper enhancement, was seen involving the genu of the corpus callosum (**Fig. 4**). A confirmatory MRS study was used. The metabolites studied were choline (Cho), which appeared at 1.4ppm, N-acetyl aspartate (NAA) at 0.65ppm, creatine (Cr) at 0.6ppm, and lipid at 1.3ppm (**Fig. 5**). Using multi-voxel MRS, the Cho/NAA ratio > 2.15 and Cho/lipid>1 were favoring a recurrent neoplastic lesion.

Nonetheless, surgery and histopathological description were made and yielded a definitive diagnosis of pure BRN (**Fig. 6**). The lesion was non-vascular and intra-axial involving the right frontal lobe parenchyma and deep, abutting the frontal horn of the lateral ventricle. The patient had improvement of neurologic function after surgical resection.

However, the patient was readmitted due to breakthrough seizures and worsening of left hemiparesis. A high dose of dexamethasone was initiated with concomitant HBO2. The patient showed a further progression of the disease. Thus, he was elected to receive four cycles of 5mg/kg Bevacizumab intravenously every two weeks. However, the patient finally died for refractory brain edema.

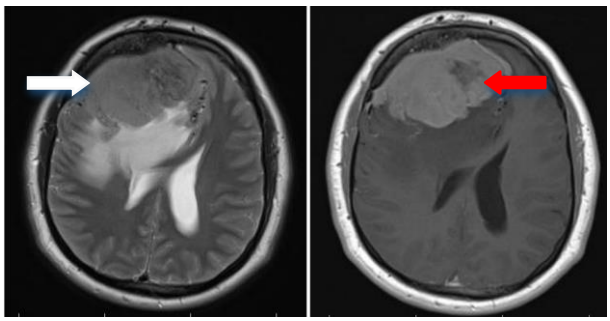


Figure 1. Preoperative, MRI brain of the lesion showing iso-intense signal (White arrow) in the T2-weighted sequence. The tumor homogeneously enhanced with areas of central hypo-intensity (Red arrow) in post-contrast, T1-weighted images.

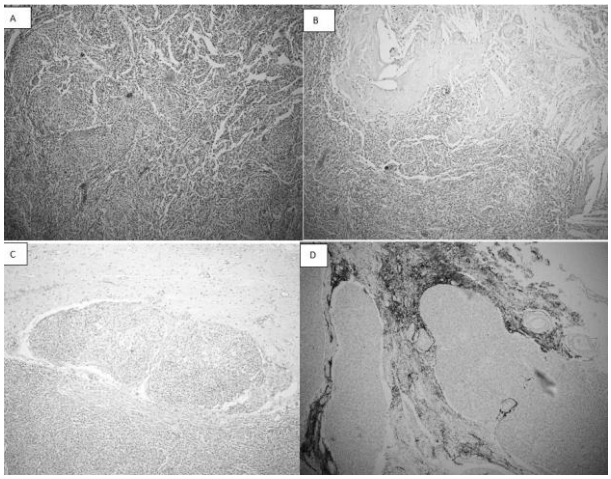


Figure 2. Sections from atypical meningioma show syncytial pattern along with areas of necrosis,10X(A&B). Brain invasion noted in H&; E stain and highlighted by GFAP immunostain,10X(C&D).

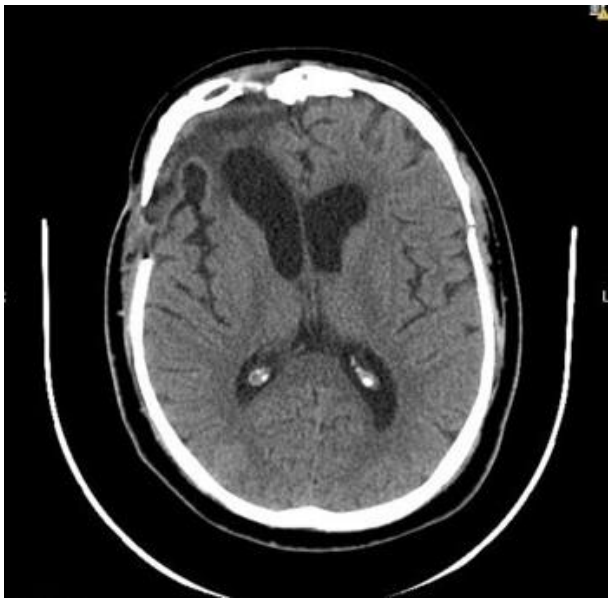
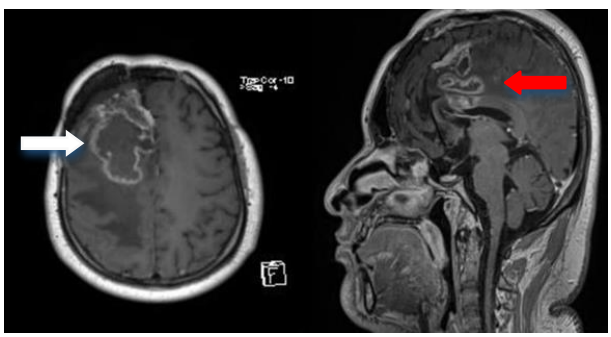


Figure 3. A Postoperative CT scan of the brain showing total excision of the tumor with regression of brain edema.



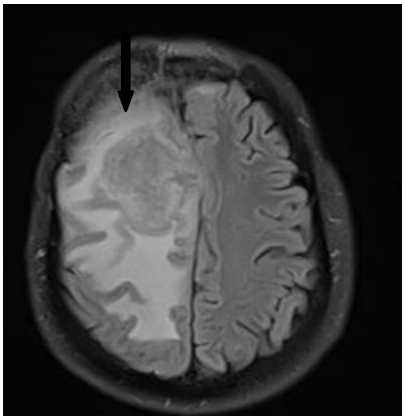


Figure 4. MRI brain of the lesion showing an ill-defined, peripheral enhancing lesion (White arrow) with central necrosis in post-contrast, T1-weighted sequence. The genu of the corpus callosum was also enhanced (Red arrow)—the lesion iso-intense (Black arrow) in the T2-weighted sequence, surrounded by extensive, vasogenic edema.

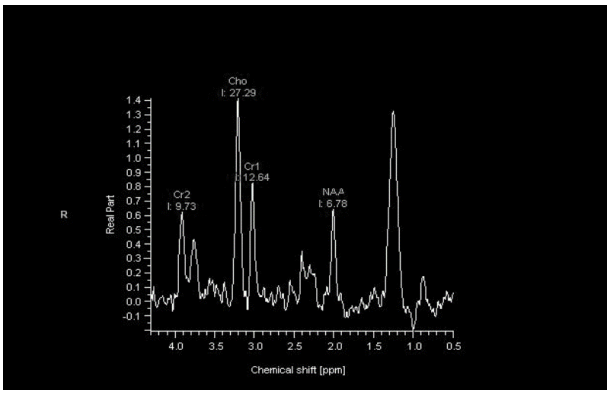


Figure 5. Magnetic resonant spectroscopy showed a high elevation of Cho and depression of NAA.

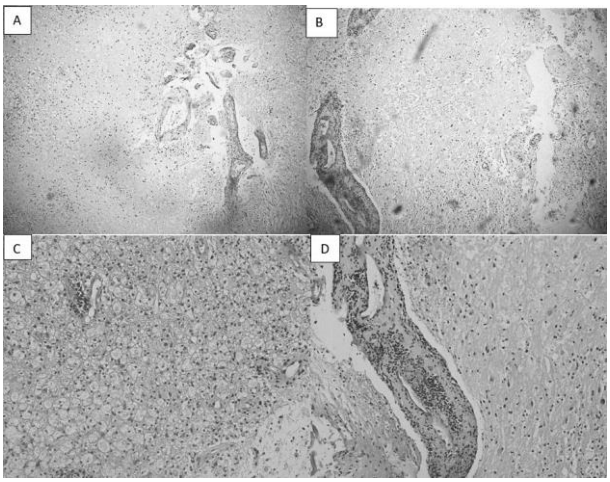


Figure 6. Post RT resection specimen is entirely submitted, and sections show areas of necrosis, mixed inflammation,10x(A&B).

Infiltration by foamy histiocytes,20x(C) and vasculitis, 20x(D). No neoplastic pathology noted.

Discussion

The incidence of BRN ranged from 3.4% to 16.7% for AM after XRT (1). It peaks at two years after XRT and pursues a regressive course in most cases (5, 6). It regresses 40% at six months and 76% at 18 months from the onset of BRN's radiological changes (6). There is a myriad of reasons for this, including total radiation dose, dose per fraction, treatment duration, irradiated volume, and concurrent use of chemotherapy (4-6). Wang TM et al. implicated a radiation injury susceptibility gene (Cep128) as an underlying mechanism of BRN, as it tightly interacts with multiple radiation-resistant genes (7) .

The pathophysiology of BRN is not well understood. However, two main theories suggested. The first theory postulates that irradiation damages endothelial cells by upregulating ceramide. Thus, results in vascular insufficiency and infarction (4, 6, 8, 9). Hypoxia caused by endothelial cell damage leads to the liberation of hypoxia-inducible factor 1α and vascular endothelial growth factor (VEGF) (4, 6, 8, 9). VEGFs induce new vessel formation, but these tend to be leaky capillaries, resulting in perilesional edema (6, 8, 9). The second theory postulates that necrosis arises due to direct injury of the brain parenchyma, especially glial cells. The glial injury causes demyelination and white matter necrosis (4, 6).

The clinical features of BRN vary depending upon the location and size, including features of increased intracranial pressure. The characteristic findings are seizures, hemiparesis, headache, vomiting, poor concentration, and altered level of consciousness (4-6, 10). The literature also reported neurocognitive impairment (hippocampus), especially in children, which includes poor academic performance, distorted self-image, and psychological distress (6, 11).

MRI of the brain will demonstrate some degree of contrast enhancement surrounded by edema (4-6, 9, 10). Although, the patterns of enhancement described in the literature as swiss cheese, cut green-paper or soup bubble, are believed to favor BRN, these patterns posse a 88% negative predictive value (12). MRS is used to assess the metabolite composition of the lesion (6, 13, 14). On MRS, the peak of Cho and the depression of NAA and Cr correlated with a neoplastic lesion than BRN. Anbarloui et al. demonstrated that Cho/NAA > 1.8 or Cho/lipid ratio >1 had increased odds of being a pure neoplastic lesion rather than pure necrosis, with sensitivity and specificity of 73% and 75%, respectively, for Cho/NAA ratio, and 87% for Cho/lipid ratio (13).

Our patient's MRS failed to differentiate BRN from tumor recurrence. The study revealed a neoplastic lesion, and the histopathology was purely BRN. Why there was such a non-concordant finding, it is not clear. Hellstrom J et al. found 51/208 cases of clinically indicated MRS to have false-positive MRS findings (14). As demonstrated by this study, MRS findings are not accurate when compared to the histopathology findings.

Positron emission tomography (PET) scan uses 18F-fluorodeoxyglucose (FDG) to assess the tissue activity (4, 6, 10). Necrotic tissue will demonstrate low FDG uptake (4, 6, 10). However, a PET scan may not distinguish BRN when epileptic activity coexists. Sasaki M et al. reported the case of 37 years old female with ependymoma treated by surgery and XRT, complicated later by BRN, presented with seizures, and the PET scan was showing abnormally high FDG uptake (10).

As the viable tumor has an intact vasculature, perfusion MRI can predict tumor recurrence (4, 6, 12, 14). Sugahara et al. suggested that a relative cerebral blood volume (rCBV) >2.1 favors tumor recurrence, while an rCBV value <0.6 favors radiation necrosis (15). However, we could not be able to spare time for this advanced imaging method. We applied surgical intervention to relieve the mass effects and to obtain a histopathology specimen.

BRN responds well to conservative management if diagnosed early (4, 6, 9, 12). Corticotherpay is the first option to treat these cases (6, 9, 12). Other supportive treatments include antiplatelet, anticoagulant, and a high dose of vitamins (6, 9). HBOT utilized to improve tissue oxygenation and neovascularization (4, 6). Several studies found that Bevacizumab, an anti-VEGF monoclonal antibody is effective in treating radiation-induced brain edema (4, 6, 8, 9). However, the safety of Bevacizumab warrants further validation as the only randomized control trial published by Levin VA et al. in 2011 involved a limited number of 14 patients (9). If the conservative management fails or significant mass effects exist, then surgical extirpation is mandatory

(4, 6, 9, 12). Recently, laser interstitial thermal therapy (LITT) has become a treatment option for lesions that are difficult to access or for patients who are not candidates for surgery (16). A review study by Katherine G et al. documented a favorable clinical response after LITT for BRN (16). Unfortunately, none of the mentioned treatment approaches utilized halted the progression of BRN in this patient.

Conclusion

This case highlights the fact that BRN is a potential complication of XRT for AM. There is no shadow of a doubt that a diagnosis of BRN is a matter of high importance in all settings since misinterpretation can result in delays in treatment and thus noticeable morbidity and mortality. There is no single modality that can reliably distinguish BRN from tumor recurrence. Thus, multimodality approach is highly recommended.

Abbreviations

AM: Atypical meningioma; XRT: Radiation therapy; BRN: Brain radionecrosis; MRS: Magnetic resonance spectrometry; HBO2: Hyperbaric oxygen therapy; WHO: World Health Organization; CT: Computed tomography; MRI: Magnetic resonance imaging; Cho: Choline; NAA: N-acetyl aspartate; Cr: Creatine; VEGF: Vascular endothelial growth factor; PET: Positron emission tomography; FDG: 18F-fluoro-deoxyglucose; rCBV: relative cerebral blood volume; LITT: laser interstitial thermal therapy.

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Traumatic isolated intracerebellar haematoma without any supratentorial lesion. A rare entity. Management strategy

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ABSTRACT

Purpose. Pure isolated cerebellar haematoma of traumatic aetiology, without associated posterior fossa sub- or epidural haematomas and without supratentorial bleed is a rare entity. We conducted this retrospective study to analyse the management strategy of isolated traumatic intracerebellar haematoma without supratentorial lesion in our institute.

Methods. We retrospectively reviewed records of more than 15000 head injury patients in our department of neurosurgery between January 2014 and November 2019. In this isolated intracerebellar hematoma patients are 60. Patients were divided into two groups assessed by the GCS score at the time of presentation – Group A (GCS>13) Group B (GCS lesser than or equal to 13). Group A treated conservatively and B surgically. Group A subdivided according to the size of hematoma into1st (> 3cm) and 2nd (<3 cm). Group B subdivided according to GCS into 1st (<8) and 2nd (8-13).

Results. Most Group B, subgroup 1st (GCS<8) patients found to be associated with poorer outcome (60 %) and subgroup 2nd (GCS 8-13) had only 10 %. Group A subgroup 1st (> 3 cm hematoma) has associated with poor outcome (28.57%) and Subgroup 2nd (< 3 cm) has 4.34%. GCS score at the time of admission, hematoma size, hematoma location, the timing of surgery were important factors for outcome.

Conclusion. We concluded that hematoma size is > 3 cm and GCS > 8 patient should operate within 12 hr. Patient of GCS < 8 results of surgery are poor (60%.). If the size of hematoma < 3 cm, lateral hematoma and GCS >13 should be treated conservatively. The factors which may be associated with the poor outcome are Low GCS score at the time of admission (<8), the large size of hematoma (>3cm), median location and delay time of surgery(>12hr).

Keywords
traumatic intracerebellar hematoma,
GCS,
hematoma size

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INTRODUCTION

Haematomas of the posterior fossa are by themselves uncommon and account for only 3.7% of all head injuries. (according to Liau)13. Approx 0.6-0.82 % cases have cerebellar hematoma without other posterior fossa lesion3,10,14. But isolated intracerebellar hematoma without supratentorial lesion is very rare (approx 40-50% of isolated cerebellar hematoma). As in 9/21-42.85% in bhardwaj et al5 and 8/18 -44.44% in devella et al6. In our study it is 60 (50%).

The clinical presentation of cerebellar haematoma may be readily apparent with classic signs including ataxia, nystagmus and signs of increased ICP like headache, lethargy and nausea and vomiting. Treatment options for this pathology are still evolving.

These hematomas may be totally asymptomatic, with a sudden increase in size can lead to rapid deterioration of neurological status[18].

Previously tested predictive factors in different studies include are size of hematoma, haematoma location (superficial vs. deep), haematoma volume, GCS of patient, degree of fourth ventricle and cistern deformation and assosiated hydrocephalus [9,15,21].

Previously there was difficulty in diagnose the posterior fossa ICH due to lack of CT but with the increasing use of computed tomography (CT) for screening of all head trauma patients, increasing number of cases have been reported to be diagnosed even before the appearance of symptoms and have thus been treated in a timely manner[14,22].

The cerebellum has four functionally important deep cerebellar nuclei (the dentate, emboliform, globose and fastigial nuclei) embedded in the white matter in its centre[8]. The locations of the deep cerebellar nuclei span the vermis and the innermost or medially approximately one third of each hemisphere. So it is devided into medial and lateral group / deep and superficial group.

We conducted this retrospective study to analyze the management statergy of isolated traumatic intracerebellar haematoma in our institute and study the factors which could be associated with the outcome. (like Mode of trauma,GCS,Hematoma size,Timing of surgery,Hematoma location etc).

MATERIALS AND METHODS

We retrospectively screened and (where required) reviewed records of more than 15000 head injury patients who were admitted in our Department of Neurosurgery between January 2014 and november 2019.In this approx 120 patients (0.8%) had intacerebellar hematoma without any other posterior fossa lesion, and in this isolated intracerebellar hematoma without supratentorial lesion are in 60 patients (approx 50 % of Cerebellar ICH without posterior lesion). Only these 60 patients are included.

Hematoma volume was assessed by using formula A*B*C/2, where A is maximum transverse diameter of hemorrhage on CT, B is anterioposterior diameter, and C is number of CT slices showing hematoma[12].

Patients were divided in to two groups based on their level of consciousness assessed by the GCS score at the time of presentation – Group A with GCS score greater than 13 and Group B with GCS lesser than or equal to 13. Group A patients were treated conservatively and group B treated surgically.

Data on patient age, gender, GCS score, mechanism of injury, timing of surgery, CT scan findings, management strategy and outcome were gathered and analyzed. These all factors detail given in **Table A**. The mode of injury were broadly categorized as road traffic accident (RTA), fall from height and assault.

Table 1. Demographics and factors associated with isolated traumatic intracerebellar hematoma

S.N	Factor Studied	Details Of Factor	Group A	Group B	Total
1	Number Of Patient		30	30	60
2	Age (Mean Age)		8-60(30)	8-60(36)	
3	Male/Female Ratio		3:1	3:1	
4	Mechanism of Injury	RTA	15	22	37
		Fall from height	12	7	19
		Assault	3	1	4
5	GCS	<8		10	10
		8-13		20	20
		>13	30		30
6	Time of Surgery	<12 hr		22	
		12-48 hr		5	
		>48 hr		3	
7	Cerebellar Hematoma Size	>3 cm	7	27	34
		2-3cm	10	3	13
		<2 cm	13	0	13
8	Hematoma Location	Medial or deep 1/3 and vermis	5	10	15
		Lateral or superficial 2/3	25	20	45
9	Status of Fourth Ventricle	Normal	27	6	33
		Compressed	3(mild)	24	27
10	Surgical treatment	Sub Occipital Craniectomy	4(after worsening)	27	31
		VP Shunt	4(after worsen	3	7

CT scan findings included clot location, size (largest transverse diameter of clot, categorized as > 3 cm or < 3 cm, or clot volume categorized as > 15 ml or < 15 ml), other associated findings and status of the fourth ventricle (normal vs. compressed)

According to all these criteria Group A devided into 2 subgroups according to size of hematoma . 1st has >3 cm and 2nd has < 3 cm size of hematoma. Group B also devided into 2 subgroups according to GCS . 1st has GCS< 8 and 2nd has GCS 8-13.

We also included timimg of surgery after injury in surgical group B and from time of worsen in Conservative group A. Timing devided into <12 hr, 12-48 hr and > 48 hr.

We also asses the location of hematoma and devided patients into medial 1/3rd /deep and superficial /lateral 2/3rd location in cerebellum.

Surgical treatment (sub-occipital craniectomy) and insertion of ventriculoperitoneal (VP) shunt was documented. Six month follow-up reports of all patients who turned in for the follow-up were also analyzed. Outcome was documented as favorable or poor based on the Glasgow Outcome Scale at the time of hospital discharge (GOS-HD). GOS 5 was counted as favorable whereas GOS 1-4 counted as poor response.

RESULTS

There are 7 patients in group A subgroup 1st (~ > 3 cm size clot). 5 patients out of 7 (71.4%) , worsened and required surgical treatment (3 sub occipital craniectomy, 2 VP shunt). In these patients 1 expired due to sudden worsening . 1 patient has poor GOS and persist in severe disable stage. Both has delayed surgery and (between 12-48 hr) . Rest 3 patients has good outcome because of early diagnosis and early surgery . So poor outcome is 2/7- 28.57%.

In Group A subgroup 2nd has 23 patients(clot size <3 cm) . In which 3 patient of 2-3 cm clot size (30%) has worsened between 4-6 days , repeat scan suggesting of sudden increase in size in one patient and obstructive hydrocephalus in all 3. Urgent surgical intervention done (with in 12 hr) .VP shunt in 2 patient and suboccipital craniectomy in 1 patient. In this 1 patient expired 1 month after sub occipital craniectomy due to chest infection. Rest 20 patient has good recovery by conservative treatment. So poor outcome is only 1/23- 4.3%.

In group B(surgical group) , subgroup 1st(GCS < 8) has 10 patients , in which 8 patients has hematoma size more than 3 cm (even 5 patients has hematoma size 4-5cm) and 2 patient has size < 3 cm but in midline .In these 10 patients 3 expired and 3 has severe morbidity. Rest 4 patients survived with favourable results. So 6/10 -60 % has poor outcome inspite of surgery. This result included in **Table B**.

Table 2. Results

S.N	Factor Studied	Detail of factor	Outcome			Mortality
			Poor outcome (GOS 1-4)	Favourable Outcome (GOS 5)	Total	
1	Group A (GCS > 13) (Conservative treatment)	Subgroup 1st (size >3 cm)(5 /7patient worsens and operated)	2 (28.57%)	5	7	1
		Subgroup 2nd (size~,< 3 cm) Only 3/23 patient worsens and operated)	1(4.3 %)	22	23	1
2	Group B (GCS ~<13) (Surgical Treatment)	Subgroup 1st (GCS< 8)	6(60 %)	4	10	3
		Subgroup 2nd (GCS-8-13)	2(10 %)	18	20	1
3	Timing of surgery	<12 hr	3(12 %)	22	25	1
		12-48 hr	5(50 %)	5	10	2
		>48 hr	3(100 %)	0	3	3
4	Location of hematoma	Deep/medial 1/3rd	7(46.66%)	8	15	5
		Superficial/lateral 2/3rd	4(8.88%)	41	45	1

GCS 8-13 included 20 patients , in which 19 patients has hematoma size > 3cm and rest 1 has size 2-3 cm near midline. Only 1 patient expired and 1 has severe morbidity out of 20 patients .One who expired , operated after 12 hr and One patient who has severe morbidity has associated chest infection. So 2/20 – 10% has poor outcome after surgery .

Total 38 patient has undergone surgical procedure from which 8 operated in group A after worsening and all 30 operated in surgical group B.

Out of 3 patients who operated after 48 hr, all 3 patient expired.

(3/3 -100 %). Between 12 -48 hr 10 patient operated In which 2 expired and 3 patient has severe morbidity (5/10-50%). But all 25 patients which are operated before 12 hr had comparable favourable results(1 expired and two has severe morbidity).(3/25-12%). Patient expired in early surgery had chest infection.

VP shunt required only in 3 patients in group B which has hematoma size 2-3 cm, GCS(8-13) and has midline location. VP shunt also done in 2 patient in subgroup 2nd in group A. There is 5 patients in vermis or median ICH in group A and 10 patient in group B. rest all are located laterally.

The poor outcome in our series at the time of hospital discharge in GCS <8 was 6/10- 60%. . Domenico D'Avella[7] study shows 58.7% poor outcome in GCS<8 .

Poor outcome was higher, 60% (6/10) in GCS < 8 in Group B as against 10 % (2/20) in GCS 8-13 in Group B.

Mortality was 13.33% (4/30) in Group B and only 6.66% (2/30) in Group A. Poor outcome in group A is 3/30-10% and in group B is 8/30- 28.6 %. (in this <8 GCS is 60%, and GCS 8-13 has 10%) So it indicated that GCS is the most important predictor for prognosis in cerebellar ICH , either operate or not and second is size.

We have added pictures of preoperative cerebellar hematoma and postoperatively (after suboccipital craniectomy with hematoma evacuation). **Fig. 1, 2** (1st patient of 40 yr male), **Fig. 3, 4** (2nd patient of 42 yr male).

Figure 1. Pre-operative CT of a 40 yrs. male

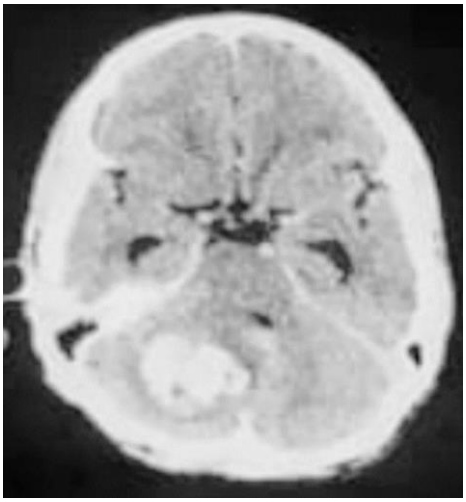


Figure 2. Postoperative CT after sub occipital craniectomy

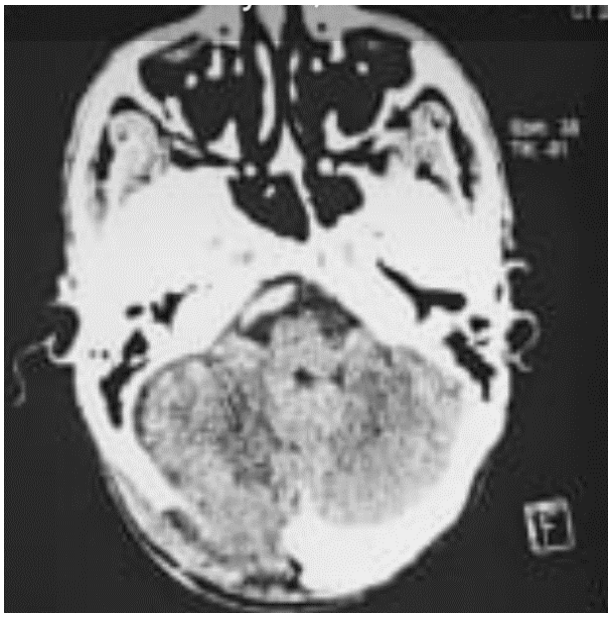


Figure 3. Preoperative CT of a 42 yrs. male

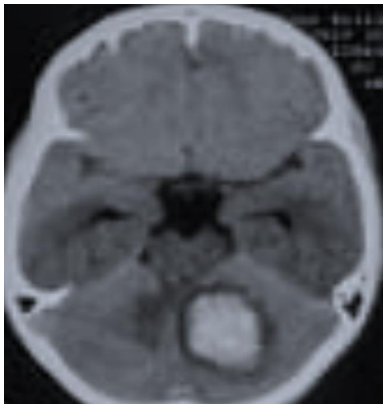
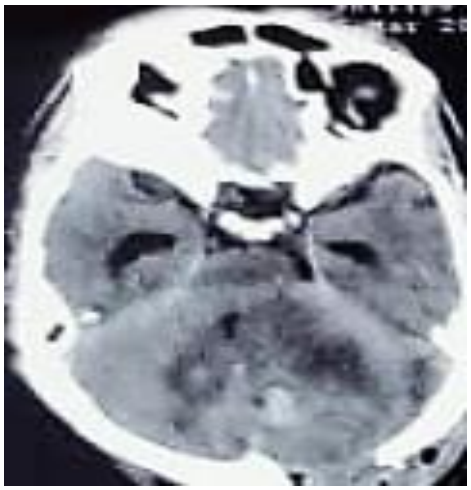


Figure 4. Post-operative scan after suboccipital craniectomy



Discussion

In our study, RTA was the most common 37/60(61.16%) and most damaging mechanism of injury. In this study fall from bike and pillan rider are the most common mechanism of injury. Bhardwaj et al has 15/21(71.14%)[5], Harsh et al has 15/23 (65.21%)[23].

Second most common is fall from tree in this tribal area which are more (19/60 -31.66%) in comparision to other studies. Bhardwaj et al has 6/21(28.57%), Harsh et al 5/23(21.73%).Last mode of injury are assault.

Fall from height was more common amongst children[1] while assault was more commonly associated with women and the elderly. But in our study , there are history of fall from tree and height in adult also[20].

Benign course of intracerebellar hematomas may be more frequent than appreciated so not all traumatic hematomas of the cerebellum require surgery[17.] So it is to be decided in which patient we should operate or not to operate.

In accordance with other studies on this topic, CT scan was extremely valuable in predicting patient outcomes[20].

Clots greater than or equal to 3 cm in diameter, GCS<8, deep/meadial 1/3rd hematoma location and timing of surgery were all shown by our study to predict a poor outcome.

Outcomes were worse for patients has GCS < 8 in subgroup 1st in Group B[7,15,25]. Such patients were critically injured and their brain function was already compromised at the time of admission.

In accordance with previous studies on this topic our data showed GCS at initial presentation to be the most predictive clinical tool [5,6,7,21,23,25]. Domenico d'Avella et al[7] suggest that A GCS score of less than 8 was the most powerful adverse prognostic factor (58.78% probability of poor outcome as sole covariate) . In our study poor outcome is 60% in GCS <8. With supratentorial lesion it is it is 84.61% in harsh et al and 88.78% in d'avella et al.

Mortility was 3/10 (30%) in which 2 patent has median cerebellar hematoma . all 3 had delayed surgery. .Rest 3 patient which has poor outcome in which 2 patient has median hematoma and 1 had delayed surgery.

Outcome is good for GCS 8-13 with surgical treatment. Only 1 patient expired in which hematoma was median and one patient has poor outcome had delayed surgery (12-48 hr).

Delayed surgery after 48 hr had worst outcome (100%), between 12-48 hr had poor outcome (50%). Early surgery within 12 hr had poor outcome only 12.0%. So Early surgery is good always . it indicated that timing of surgery is one of the most prognostic factor for outcome[5,7].

11 patients has poor outcome , in these 7 patient had medial hematoma. so 7/11 (63.63 %) of poor outcome had medial hematoma. Bhardwaj et al has (62.5%) and S. Takeuchi et al[21] has 9 patient has medial hematoma in 10 poor outcome patient(9/10-90%).So maximum poor outcome occurs in medial and deep hematoma lesion which are also in our study.

Total medial hematoma is 15 patients in which 7 patients had poor outcome (7/15-46.66%) and superficial hematoma in 45 patients in which only 4 patients has poor outcome (4/45-8.88%). It indicates that medial/deep hematoma has poor outcome[5,15,23]. In group A subgroup 1st 7 patients has hematoma size > 3 cm and 5 worsened (5/7- 71.42%) and then operated .. Subgroup 2nd has size < 3 cm only 3 patient worsened (3/23- 13.04%) , which is also due to midline position. So it is proven that size is important prognostic factor[4,5,7]. Hematoma of > 3 cm size should operate early whether GCS > 13.So size is important factor to take decision of surgery.

Poor outcome in patient of size> 3 cm in group A is 2/7 -28.57% due to sudden worsening and late surgery . But in < or equal to 3cm poor outcome is only 1/23- 4.3% which is also due to midline hematoma and chest infection. So size is most important factor and equal and less than 3 cm size can treated conservatively[4,5,7,15,23].

But in group B , all patient operated , so we can not compare size factor for decision of surgery.

Though trauma is the obvious cause, specific mechanism for this type of injury remains unclear. Takeuchi et al.[21] created a classification system for the types of trauma causing cerebellar haematomas. Their three classes included coup injuries, countercoup injuries and acceleration-deceleration injuries.

This classification system proved useful in predicting the site of haematoma, with coup injuries thought to be more common[19,24] causing only superficial bleeds while countercoup injuries resulted in deep cerebellar bleeds.

In all patients undergoing surgical intracerebellar

clot evacuation sub-occipital craniectomy was done , it is best procedure [2,16] and preferred over sub-occipital craniotomy as posterior fossa has less space for accommodation of any post-operative bleeding or post-operative edema.

Some may note our use of VP shunts over external ventricular drains (EVDs) for certain patients experiencing hydrocephalus resulting from cerebellar haematoma. VP shunt was chosen over EVD placement because in our clinical setting EVDs have allegedly been found to more frequently result in infections as ventriculitis and meningitis three to four days post-EVD placement. However, patients developing acute hydrocephalus need drainage of CSF usually for a period of more than two weeks during which the clot resolves and perilesional edema subsides[23].

HCP can be associated with traumatic intracerebellar clots but not always [17,22]. Karasawa et al[11] mentioned of acute HCP in 20% of intracerebellar hematomas, while in our series it was 16.6%.

Total poor outcome is in 11 patients so 11/60-18.33% which is very less in comparision of other studies because in this study only isolated intracerebellar hematoma taken without supratentorial lesion and 50 patients had GCS > 8[5,6,7,15,21,23]. It also indicates that GCS and associated lesion are important prognostic factor.

Conclusion

In an attempt to study the factors which may be associated with poor outcome in isolated intracerebellar haematoma cases we found that GCS score at the time of admission(<8), large size of hematoma(> 3cm), Hematoma location(deep/medial 1/3rd) and delay time of surgery (>12hr) has poor prognosis.

We also concluded that if hematoma size is > 3 cm and GCS > 8 patient should operate, and should operate early within 12 hr.

Median hematoma should be operated and operated early (whether size is 2-3 cm with ventricle compression) because chances of worsening more. But overall prognosis for deep hematoma was poor. Patient of GCS < 8 irrespective to size of ICH s results of surgery are poor(60%.)

We also concluded that if size of ICH >3 cm and has ataxia and other symptoms and whether the patient is conscious ,but should operate , because chance of worsening is present there or had close observation for 4-5 days and operated immediately after worsening .

If GCS > 13 and ICH < 3 cm size , patient should treated conservatively and at least 15 days follow up should needed. After 15days there is very less chance of worsening.

The overall prognosis is better than other studies because we exclude other supratentorial lesion and 50 patients has GCS > 8. It also conclude that if there is no associated lesion chances of low GCS is less.
But the most important thing is that it is the rare study in which only true intracerebellar hematoma without supratentorial lesion included.

Conflict of interest

There is no conflict of interest to disclose.

Informed consent

Informed consent was obtained from all individual participants included in this study.

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Dorsolumbar angiolipoma. A rare case report and review of literature

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Keywords
spinal extradural tumour, spinal angiolipoma, angiomyolipoma

ABSTRACT

A 55-year-old female was presented with complaints of tingling sensations of the bilateral lower limb with spastic paraplegia for last one year. Her pre-operative contrast MRI study of Dorsolumbar Spine was suggestive of extradural angiolipoma. She underwent D11, D12 and L1 Laminectomy and a mildly vascular yellowish globular extradural mass was found which was excised completely and dural decompression was achieved. Post-operatively, the patient's neurologic symptoms improved.

Conclusion: Spinal angiolipoma is considered a rare benign entity which emulates malignancy. It should be included as a differential diagnosis of the spinal epidural tumour with fat component and a high degree of vascularisation. surgical removal of this epidural tumour through a proper and comprehensive approach provides complete and permanent recovery.

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INTRODUCTION

Spinal angiolipoma and angiomyolipoma are rare tumors, there incidence was noted only 0.14% of all tumors of the spinal axis. It is difficult to distinguish them from spinal lipoma, as they are found mainly in adults. They are localised almost exclusively in the dorsal epidural space of the thoracic spine [4]. They are not associated with any malformation. These lesions usually show no tendency to involve the surrounding tissue although some may show infiltrative process into the bony compartment of the vertebral column [5, 14].

We are reporting a rare case of angiolipoma of the dorsolumbar spine in a 55-year-old female patient that was diagnosed by pathological examination following surgical resection, and discuss the imaging findings of angiolipoma published in literature.

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Case report

A 55-year-old female were admitted in our hospital with complaints of tingling sensation of bilateral lower limb with spastic paraplegia for last one year.

Her neurological examination was showing paraplegia with diminished sensations over B/L lower limbs. Knee and ankle jerks were exaggerated with significant increase in tone. Her MRI (magnetic resonance imaging) dorsolumbar spine was showing signal of the fat and blood vessels. The fatty content was hyperintense on both T1- and T2-weighted images (similar to the signal of subcutaneous adipose tissue) and hypointense on fat-suppressed images. The vascular component was hypointense on T1-weighted and hyperintense on T2-weighted, and showed intense enhancement with Gd-DTPA infusion (Figure 1).

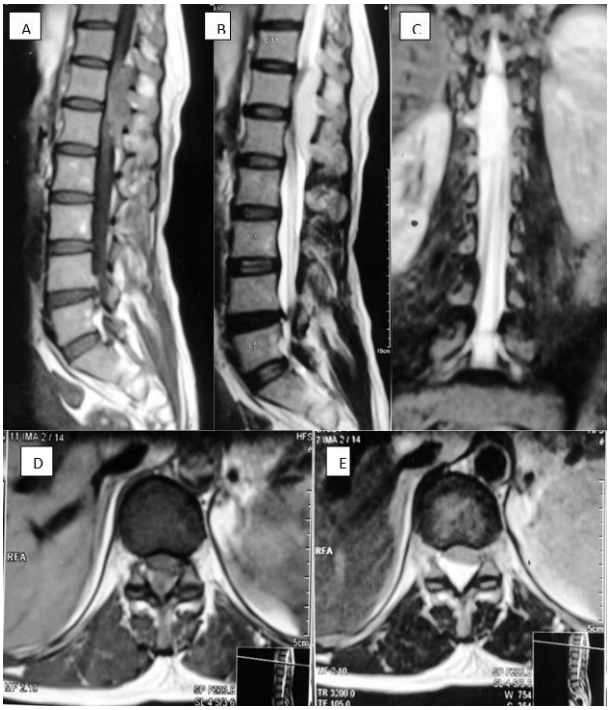

Figure 1. Spindle shaped extradural contrast enhancing on T1W Contrast (1A, D) and hyperintense on T2W (1B,C,E).

She was planned for laminectomy with decompression of cord under general anaesthesia. She underwent D11, D12 and L1 Laminectomy and a mildly vascular yellowish globular extradural mass was found which was excised completely and dural decompression was achieved

On histopathological Examination. Microscopic examination revealed sheets of mature adipocytes arranged in lobules divided by delicate intervening fibrous septae showing numerous thick-walled blood vessels without elastic lamina. No evidence of malignancy was noted, so histopathology diagnosis of angiolipoma was given (Figure 2).

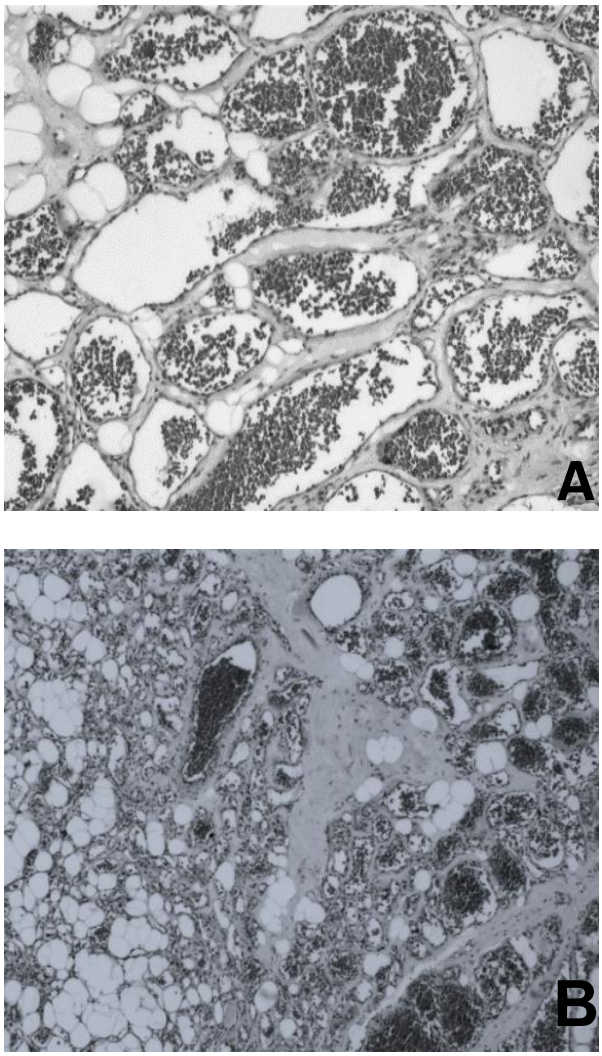

Figure 2. Photomicrographs show mature adipose tissue and proliferated vascular tissue with thin septation and foci of fibrosis (A; H&E, 100X, B; H&E, 400X).

Post-operative Course. The patient's neurologic symptoms improved immediately. On second post-operative day, her power in bilateral lower limb improved to 4/5. She was discharged on fifth post-operative day. On two months follow up, no signs of recurrence and neurological deficits were noted.

Discussion

Howard and Helwig described angiolipoma as one entity in 1960 [7]. They said that the majority of these

tumors are found in subcutaneous vessel, muscle, bone and kidney and it was noted that they have no tendency to recur after excision. More than 50 cases of spinal angiolipoma and angiomyolipoma have been reported [1-3, 6, 8-11]. After reviewing following clinical and radiologic characteristics were noted:

1) These tumors are occurs in middle aged patients usually;
2) These are mostly located in the dorsal epidural space;
3) They grow in a spindle shape along the spinal canal;
4) They lack the associated malformations; and
5) They are mostly benign and result in a good postoperative outcome.

Most of spinal angiolipomas are found to be non-filtrating hence complete excision is the rule. In a few reported cases the tumor merges to the extradural fat so that it is difficult to differentiate tumor from the fat [12].

The pathogenesis of Angiomyolipoma (AML) and Angiolipoma is not clear. Two major theories have been given previously regarding the pathogenesis. One is that primitive pluripotent mesenchyme cells (which provides a common origin to adipose, smooth muscle, and vascular endothelial elements) are developed into tumor by ill-defined stimuli (trauma or other causes). Another theory is that the tumor is a congenital malformation or true hamartoma [7].

It was noted in most patients with spinal AML and angiolipoma that they have complaints of neurological symptoms related to spinal cord compression, such as weakness of the extremities and abnormal sensation below the level of lesion [3]. It was observed that there exists a relationship between pregnancy and accelerated onset of neurologic symptoms in several cases of epidural spinal angiolipoma [13].

For radiological assessment of spinal AML and angiolipoma, previously conventional radiograph, myelography, or CT were used for the purpose of preoperative diagnosis. Recently in such cases MRI were employed. Both spinal AML and angiolipoma appear as elliptical shaped soft tissue mass with heterogeneous marked enhancement at epidural space of thoracic spine. Fat component with high signal intensity on T1-weighted image is often visualized in cases of spinal angiolipoma [8]. However, infiltrative properties such as invasion to adjacent bone or extension to perilesional space and ventral location have been mentioned as distinctive features of AML compared to major patterns of angiolipoma according to Sakaida et al [14].

Such kind of lesions includes differential diagnosis of fat-containing tumor (such as lipoma, lipomatosis, and liposarcoma), prominently vascular tumor (such as spinal epidural hemangioma), and other T1-high signal intensity lesion (such as epidural hematoma). Epidural lipoma or lipomatosis is an abnormal accumulation of unencapsulated adipose tissue in the extradural space. Because of their fat components, they also display hyper intensity on T1-weighted images and intermediate intensity on T2-weighted images [12]. However, they present with typical Y configuration (with circumferentially compressed dural sac) and show no definite contrast enhancement pattern. Well-differentiated liposarcoma is a rare fat-containing tumor of the spinal canal. It frequently has irregular thick-ended septa. It contains regions of hyperintense signal (compared to fat) on T2-weighted images which are rare in spinal AML [8, 12, 14].

Conclusion

Spinal angiolipoma is considered as rare benign entity which emulates malignancy. A sufficient attempt must be made to reach a correct preoperative diagnosis by using reliable imaging techniques such as MRI. It should be included as a differential diagnosis of spinal epidural tumor with fat component and high degree of vascularisation. It can be believed that surgical removal of this epidural tumor through proper and comprehensive approach provides complete and permanent recovery.

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Comparative analysis of anterior third ventricle approaches

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ABSTRACT

Background. Third ventricle tumors are uncommon and account for only 0.6 - 0.9% of all the brain tumors[7]. In 1921, Dandy was the first neurosurgeon who successfully removed a colloid cyst from the third ventricle through a posterior transcallosal approach. Despite their unfavourable locations, these tumours can be removed successfully by proper knowledge of anatomical landmarks and by choosing the appropriate approach.

Methods. We performed a retrospective analysis of all patients (17 patients) who underwent surgery for anterior third ventricular masses between March 2018 to March 2020 in the Dr Ram Manohar Lohia Institute of Medical Science Lucknow, Uttar Pradesh.

Results: The most common symptom in our cases was headache, which was present in all (100%) patients, nausea/vomiting in 7 (41%), history of recurrent episodes of drop attacks in 4 (23%), h/o seizure in 2 (11.7%), visual disturbance in 1 (5.4%), memory disturbance in 1 (5.4%) and urinary incontinence in 1 (5.4%) patient. 6 patients were operated with transcallosal-transforaminal approach, 1 patient was operated with transcallosal interforniceal approach, 3 patients were operated with transcortical-transforaminal approach, 1 patient was operated with subfrontal translamina terminalis approach, 1 patient was operated with transcallosal-transchoroidal approach, 5 patients were operated with endoscopically. Gross total excision was achieved in 15 (88%) patients while in 2 (11.7%) patients subtotal resection was done due to their adherence to choroid plexus and optic chiasm. The most common post-operative complication was endocrine dysfunction in the form of diabetes insipidus.

Conclusions. Anterior Third ventricular tumours are mostly benign and best treatment modality is surgical resection. When we analyzed the results of various approaches, we found that despite their unfavourable location, the results were satisfactory for different tumours of different location in the anterior third ventricle, when treated with the carefully planned microsurgical or endoscopic approach with proper knowledge of anatomical landmarks.

Keywords
third ventricle, transcallosal

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INTRODUCTION

Third ventricle tumors are uncommon and account for only 0.6 - 0.9% of all the brain tumors[7]. Third ventricle includes wide variety of lesions ranging from benign to malignant. Majority of intra-ventricular tumors

are benign, surgery is therefore preferred and is curative. Most common entities for this location are colloid cysts, astrocytomas and craniopharyngiomas. Others lesions for this location are arachnoid cysts, pituitary adenomas, subependymomas, germinomas, central neurocytoma, teratomas, dermoids, meningiomas and choroid plexus papillomas[12,18]. Third ventricle can be divided into anterior and posterior third ventricle on the basis of an imaginary line connecting foramen Monro to aqueduct sylvius. Common tumors originating from anterior third ventricle are astrocytomas and craniopharyngiomas; from the posterior third ventricle are meningiomas, choroid plexus papillomas and colloid cysts at the level of foramen monro[8]. Anterior Third ventricular tumors can be classified as primary and secondary tumors.

Primary tumors: originating purely intraventricular - ependymoma, choroid plexus papilloma, colloid cysts.

Secondary tumors: originating adjacent to third ventricle and secondarily expand within the ventricular cavity – pituitary adenoma, craniopharyngioma, meningioma.

Patients of anterior third ventricular mass usually presents with symptoms secondary to hydrocephalus such as headache, vomiting, blurring or diminution of vision.

In 1921, Dandy was the first neurosurgeon who successfully removed a colloid cyst from the third ventricle through a posterior transcallosal approach, and stated that no treatment short of total removal could have any possible value in the treatment of tumors in this region[10]. The anterior transcallosal approach was suggested by Ehni who used this approach for different pathological entities[11.]

Third ventricular tumors are difficult to treat due to their deep location and proximity to vital neural structures such as thalamus, hypothalamus and vascular structure such as internal cerebral vein and medial posterior choroidal artery. Despite their unfavorable locations, these tumors can be removed successfully by proper knowledge of anatomical landmarks, pre-operative planning and by choosing appropriate approach.

There are various approaches to anterior third ventricle including transcortical-transventricular approach through foramen of monro[22], Interhemispheric – transcallosal - interforniceal approach[2,5], Interhemispheric - transcallosal-transchoroidal trans-velum interpositum approach[9,14], subfrontal trans - laminaterminalis approach[21]and Endoscopic approach.

Common surgical complications are seizure following transcortical approach, memory deficit and venous cortical infarct following transcallosal approach. Other postoperative complications are mutism, hematoma, and hemiparesis. Some study suggests that unilateral damage to fornix produces no deficit. The inter-forniceal approach to a lesion of third ventricle carries the potential risk for bilateral damage o fornix, but memory deficit is usually transient by this approach[4,3].

Method

We performed a retrospective analysis of all patients who underwent surgery for anterior third ventricle mass between March 2018 to March 2020 in the Dr Ram Manohar Lohia Institute of Medical Science Lucknow Uttar Pradesh. 17 patients underwent for surgery of anterior third ventricular mass. We reviewed case sheets, radiological images, pathological reports, surgical reports of all the patients. We also collected data regarding their demographic data, preoperative symptoms and signs, surgical approaches, histopathological reports and postoperative complications.

Results

In our study we reviewed case sheets of 17 patients, who were operated for anterior third ventricle approaches in Dr Ram Manohar Lohia Institute of Medical Sciences Lucknow during a time period from March 2018 to March 2020. In our study there were 12 males and 5 females, age ranged from 9 years to 54 years with mean age of 27 years. Maximum patients (9) were in the age group of 20-30 years.

The most common symptom in our cases was headache, which was present in all (100%) cases, nausea/vomiting in 7(41%), history of recurrent episodes of drop attacks in 4(23%), h/o seizure in 2(11.7%), visual disturbance in 1(5.4%), memory disturbance in 1(5.4%), urinary incontinence in 1(5.4%). One patient presented with altered mental status [Table-1].

Symptoms	No of patients
Headache	17(100%)
Nausea/vomiting	7(41%)
h/o drop attacks	4(23%)

h/o seizure episode	2(11.7%)
Visual disturbance	1(5.4%)
Memory disturbance	1(5.4%)
Urinary incontinence	1(5.4%)

Table 1. Clinical presentation of patients of anterior third ventricle mass.

Surgical approaches	No of patients
Transcortical transforaminal	3
Transcallosal transforaminal	6
Transcallosal interforniceal	1
Transcallosal subchoroidal	1
Subfrontal translaminar	1
Endoscopic excision	5

Table 2. Surgical approaches in patients with anterior third ventricle mass.

Histopathological report	No of patients
Colloid cyst	11
Craniopharyngioma	4
Central neurocytoma	2

Table 3. Histopathological report.

6 patients were operated with transcallosal-transforaminal approach, 1 patient was operated with transcallosal interforniceal approach, 3 patients were operated with transcortical-transforaminal approach, 1 patient was operated with subfrontal translamina terminalis approach, 1 patient was operated with transcallosal-transchoroidal approach, 5 patients were operated endoscopically [Table 2]. Gross total excision was achieved in 15(88%) patients while in 2(11.7%) patients one of craniopharyngioma and one of colloid cyst subtotal resection was done due to their adherence to choroid plexus and optic chiasm.

The most common post-operative complication was endocrine dysfunction in the form of diabetes insipidus in 4 patients and cortisol insufficiency and hypothyroidism in 1 patient due to hypothalamic injury. All four patients of post op endocrine dysfunction were of craniopharyngioma. 3 patients develop post-op seizure in the evening of day of surgery, 2 patients in which post-operative seizure developed were operated by transcortical approach and 1 patient was operated with transcallosal approach.

Histopathological reports of 11 patients were colloid cyst, craniopharyngioma was found in 4 patients and central neurocytoma was seen in 2 patients [Table 3].

Discussion

In current study of anterior third ventricular mass, in maximum patients 11(64%) the diagnosis was colloid cyst and most common symptom was headache seen in 100 % patients, vomiting in 41% patients and history of recurrent drop attacks in 23 % of patients. Similar results were reported by many authors[13,20].

The choice of the third ventricular tumors approach basically depends on the location of tumor, differential diagnosis, size, patient's clinical status and anatomical knowledge. It should be underlined that, although several corridors to the third ventricle exist, they all demand the incision of the neural tissue which may be relatively free from the underlying disease. Endoscopic approach remains the commonly used approach for the treatment of colloid cyst with chances of re-operation for residual cyst, but more cost effective and safer than open craniotomy for the resection of colloid cyst.

Surgical approaches

Transcallosal approach

Transcallosal approach allow removal of tumor from anterior third ventricle by incising the corpus callosum longitudinally in the direction of corpus callosum less than 2.5 cm (to avoid disconnection syndrome) between the two pericallosal artery at the level of foramen of monro. Genu of internal capsule touches the wall of ventricle in the area lateral to foramen of monro near the anterior pole of thalamus. Retraction should be done at this level minimally to avoid hemiplegia. After incising the corpus callosum we have multiple options to reach the third ventricle. We use trans-foraminal approach in 6 patients, in which 4 patients were of colloid cyst, 1 was of craniopharyngioma and 1 was of central neurocytoma, in all the cases foramen monro was already dilated, there was no need of enlarging the foramen of monro. Gross total excision was achieved in 5 cases; in one patient of craniopharyngioma gross total resection was not achieved due to adherence to choroid plexus and chiasma. Radiotherapy was given later to this patient. We used inter-forniceal approach in 1 patient of craniopharyngioma, located just behind the foramen of monro in midline. The point of entry was approximately 2 cm posterior to

foramen of monro to preserve the hippocampal commissure to avoid temporary or permanent problems with memory function. In this approach the body of the fornix is split in the midline, in the direction of its fibers, to expose the velum interpositum[3,15,27]. We used transchoroidal approach in 1 patient of craniopharyngioma, the entry was through the tenia fornicis as it has advantage that large veins like a thalamostriate vein which drains the internal capsule and central part of hemisphere and choroidal arteries can be dissected laterally, avoiding injury to these vessels. The transchoroidal and interforniceal approaches have the advantage of giving access to the central portion of the third ventricle behind the foramen of Monro by displacing it, rather than transecting the fibers in the fornix[19,29]. Transcallosal approach is superior to transcortical approach as it is not dependent on ventricle size, more direct and avoid incision over cortex. **(Figure 1)**

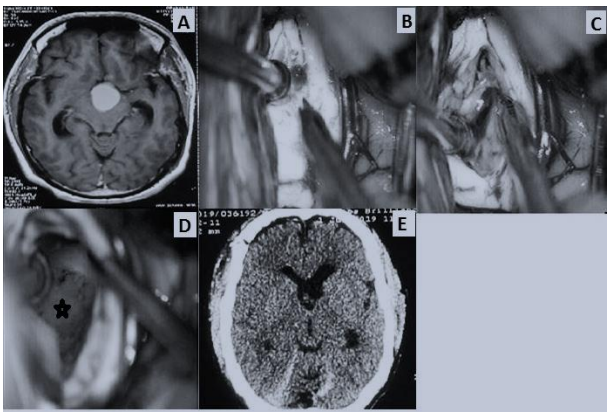

Figure 1. (A) Pre-operative contrast MRI axial scan showing contrast enhancing third ventricular mass (B) Anterior callosotomy between two pericallosal artery (C) Opening the right lateral ventricle(D) Lateral ventricle entered and tumor( )identified (E) Post-operative CT scan showing complete tumor removal.

Transcortical approach

We used transcortical-transforaminal approach in 3 patients. Out of 3, the diagnosis in 2 patients was colloid cyst and in one patient it was central neurocytoma. We entered through right middle frontal gyrus, after reaching lateral ventricle we used transforaminal corridor to remove the tumor as it is a natural orifice to enter third ventricle. Enlargement of foramen of monro was not required in any of the case as it was already dilated due to hydrocephalus. Gross total resection was achieved in all cases. Post-operative complication in the form of seizure developed in two patients. **(Figure 2)**

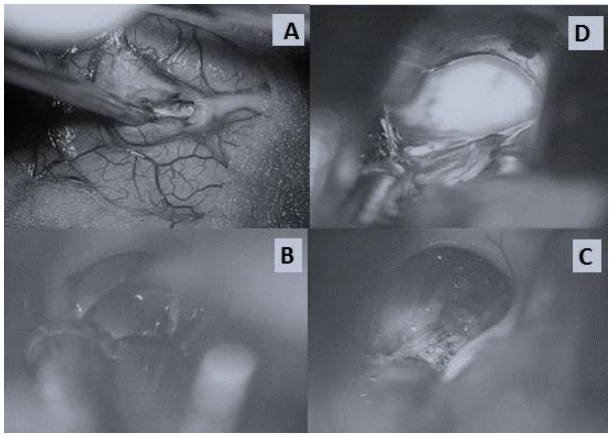

Figure 2. (A) Cortical incision around 1.5 cm in right middle frontal gyrus (B) Entry into right lateral ventricle and identification of cystic mass (C) Excision of cystic mass (D) Complete excision of mass.

Subfrontal translamina terminalis approach

We used subfrontal translamina terminalis approach in one patient of craniopharyngioma which was located in antero-inferior part of anterior third ventricle. After passing the planum sphenoidale, the optic nerves, the chiasm, and both internal carotid arteries are visualized. A1 was identified bilaterally and after incising the lamina terminalis above the chiasm up to the anterior commissure, tumor was seen which was internally decompressed initially and the remaining part of tumor was excised later**. (Figure 3)**

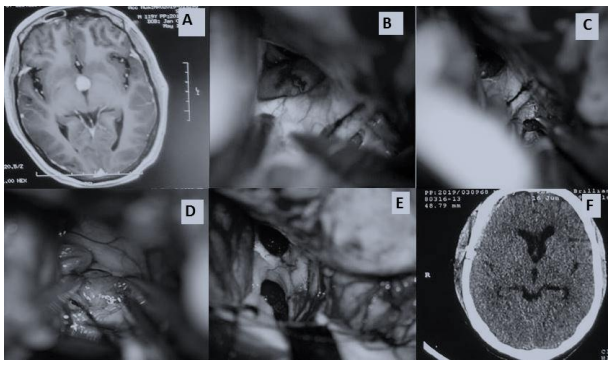

Figure 3. (A) Pre-operative Contrast MRI axial cut showing enhancing mass in third ventricle. (B) Identification and excision of the tumor in pre-chiasmatic and (C) optico-carotid cistern (D)Opening of lamina terminalis and excision of mass (E) complete excision achieved (F) Post-operative scan showing complete excision.

Endoscopic approach

We used endoscopic approach in 6 patients, diagnosis of all patients were colloid cyst. The colloid cyst of the third ventricle is an ideal tumour for endoscopic removal due to its cystic nature. Hydrocephalous was present in all cases which helped us to cannulate the lateral ventricle through planned burr-hole on right side. After reaching the colloid cyst, choroid plexus which was attached to colloid cyst was coagulated. After cauterisation of cyst wall, we opened the cyst wall applying endoscopic micro-scissor and then content was aspirated after that cyst wall was excised with minimal traction.in one patient cyst wall was densely adhered to the choroid plexus which was left in-situ after coagulation to prevent recurrence. **(Figure 4)**

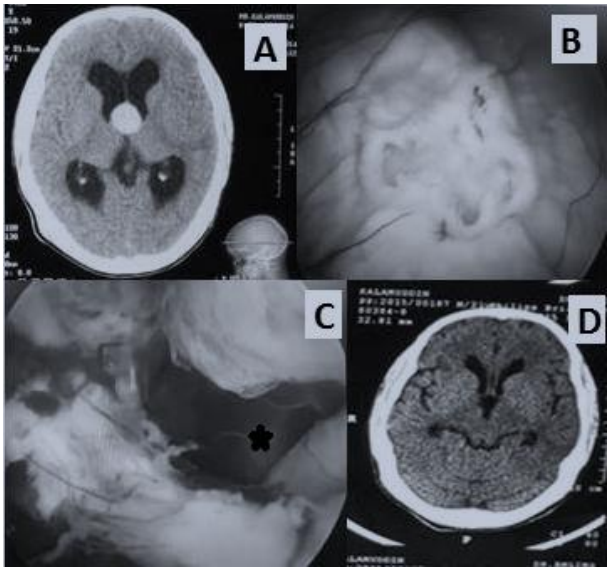

Figure 4. (A) Pre-operative CT scan showing hyperdense mass in third ventricle (B) Endoscopic view of mass filling the third ventricle, wall of the tumor cauterized at foramen of monro (C) Endoscopic view of the third ventricle after complete excision of mass and third ventriculostomy. Basilar artery seen in prepontine cistern ( ) (D) Postoperative scan showing complete excision.

Post-operative complications

In our retrospective study of anterior third ventricular mass patients we encountered with two complication. First complication was post op seizure which was seen in three patients of which two were operated with transcortical approach, one patient was intubated due to seizure and was extubated next morning and one was operated with transcallosal approach, concluded that there are less chances of post-operative seizure in transcallosal approach. In our study in 66% of patient of transcortical approach post op seizure developed which is very high, may be due to a smaller number of cases operated with transcortical approach. The incidence of postoperative seizures in the transcortical-transventricular approach in some series ranges from 11 to 13%[6,1,16,17]. Another complication was endocrine dysfunction in the form of diabetes insipidus in 4 patients which was transient and cortisol insufficiency and hypothyroidism in 1 patient due to hypothalamic injury, in these patients hormone replacement was given. All four patients of post op endocrine dysfunction were of craniopharyngioma. In multiple studies hormonal replacement therapy was required in approximately 80% of the children.[28,23,25,26,24].

Conclusion

Anterior Third ventricular tumors are mostly benign and best treatment modality is surgical resection. When we analyzed the results of various approaches, we found that despite their unfavorable location, in all techniques the results were satisfactory for different tumors of different location in anterior third ventricle, when treated with carefully planned microsurgical or endoscopic approach and with proper knowledge of anatomical landmarks with minimal complication. Transcallosal approach is a safer route, superior to transcortical approach as it is not dependent on ventricle size, direct and avoids incision over cortex. Transcortical approach had more chances of post-operative seizure. Endoscopic approach is good if done by an experienced hand but have limitation of wide visualization. Tumors originating from the antero-superior part of the third ventricle can be easily approached through a transcallosal transforaminal route, whereas lesions arising from the anteroinferior portion of the third ventricle might be safely and effectively approached through subfrontal translamina terminalis approach. In most of the craniopharyngioma patients, post-operative hormone replacement therapy usually needed.

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Spontaneous spinal hematoma. Experiences from a tertiary care centre in South India

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ABSTRACT

Background. Spontaneous spinal hematoma (SSH) is a rare condition that can result in severe functional disability and even death. But early detection and prompt intervention can substantially reduce the morbidity. We present a series of seven operated cases of SSH.

Methods. All operated cases of SSH between 2017 and 2019 were studied. The demographic and clinical features, risk factors and imaging features were analyzed. The functional outcome at discharge and 6 months were assessed.

Results. Seven operated cases of SSH with mean age 35(SD-20.9) were studied. Six cases were spontaneous spinal extradural hematomas (SSEDH) and one case was spontaneous spinal subdural hematoma (SSSDH). The most common site was cervicothoracic. Risk factors associated with SSH were thrombocytopenia, pregnancy, and necrotising pancreatitis. Two patients had preoperative Frankel's grade A-B, three had grade C and two had D. The mean interval between the onset of symptoms and surgery was 4.7days.

The functional outcome was dependent on the pre-operative functional status of the patient. Patients with SSEDH and thrombocytopenia had a poor outcome.

Conclusion. SSH even though spontaneous may be associated with risk factors. The presence of thrombocytopenia and preoperative functional status predicted outcome. This is the only single institution case series to report thrombocytopenia as a factor predicting poor outcome.

Keywords
spontaneous spinal hematoma, outcome, thrombocytopenia, pregnancy

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INTRODUCTION

Spontaneous spinal hematomas (SSH) are relatively rare and the majority of spinal hematomas are due to trauma. SSH includes both spinal extradural hematoma as well as subdural hematoma. The incidence of spontaneous spinal extradural hematoma (SSEDH) is around 0.1/100000 and that of spontaneous spinal subdural hematoma (SSSDH) is still rarer (1)(2). These conditions usually present as emergencies with rapidly progressive neurological deficits. Prompt recognition and early intervention is very important for a better outcome. Spinal hematoma was defined spontaneous when there was

no associated trauma, iatrogenic injury (secondary to procedures like lumbar puncture, epidural catheter insertion), or post-operative spinal hematoma.

Materials and methods

Setting: Department of Neurosurgery, Government Medical College, Kozhikode, Kerala which is a 3000 bedded teaching hospital in south India where around 2000 neurosurgical cases are operated annually.

Cases: All operated cases of spontaneous spinal hematomas during 2017-2019

All operated cases of SSH during the study period were studied. History was taken to assess any risk factors like hypertension, coagulopathies or bleeding diathesis. Duration from the onset of symptoms to surgery was noted. A neurological examination was done and the preoperative functional status was assessed by Frankel's grade. All patients were evaluated with 1.5T MRI with contrast and MR angiography. The site of the bleed was assessed from MRI and the number of spinal segments involved was noted. All patients underwent standard decompressive laminectomy and evacuation of bleed. Laminectomy was done at the level of maximal cord compression. A maximum of two-level decompressive laminectomy was done. After surgery, the functional status was reassessed at discharge and 6 months. All patients with improvement in Frankel's functional scores were taken as a good outcome.

Representative cases

Case 1

A 75-year-old male who was on treatment for necrotizing pancreatitis developed sudden onset of neck pain followed by weakness of bilateral upper limbs and lower limbs. The patient had numbness of the body up to the neck. There was also associated urinary retention. On examination, there was grade 3 power of upper limbs and grade 2 power of lower limbs and blunting of all sensations below the clavicles (Frankels grade C). His routine blood workup showed elevated prothrombin time with an INR of 2.3, platelet count and activated partial thromboplastin time were normal. His S Amylase was 4300. MRI of the cervical spine showed T1 and T2 hyperintense signal from C2 to C6 with cord compression (Figure 1) suggestive of SDH. After correcting the coagulopathy with fresh frozen plasma transfusions, we proceeded with C4C5 decompressive laminectomy. Dura was bulging with underlying hematoma and was opened in the midline. Thick SDH was evacuated. Postoperatively the lower limb power improved to grade 3 (Frankels grade C). At 6 months follow up both lower limbs and upper limbs had grade 4 power (Frankels grade D).

Case 2

24-year-old 34 weeks pregnant lady presented with complaints of sudden onset neck pain and rapidly progressive weakness of both lower limbs. On examination, she had grade 2 power of both lower limbs and sensory loss below the nipple level (Frankels grade C). Her routine blood investigations were within normal limits. MR imaging of the spine showed T2 intermediate signal lesion noted involving left posterolateral epidural space at C7-T1 vertebral level suggestive of hematoma (Figure 2). The management difficulty in view of 34 weeks completed pregnancy with regards to positioning as well as chances of intrauterine death were well explained. She was taken for ceaserian section and after the procedure, in the same sitting C7T1 laminectomy was done in the prone position and the hematoma was evacuated. Postoperatively patient showed improvement in motor power. The baby was shifted to the neonatal ICU for further care. At 6 months follow up the patient was able to walk with support and do her day-to-day activities (Frankels grade D).

Case 3

A 25-year-old male patient presented with fever for 10 days and sudden onset of back pain for one day. He developed rapidly progressive weakness of lower limbs with urinary retention. On examination, he had grade 0 power of both lower limbs and there was sensory blunting below the nipple (Frankels grade B). His lower limb reflexes were absent and plantar was mute bilaterally. On routine blood profile, his platelet count was 17000 but markers for dengue were negative. MR imaging of his spine showed cervicothoracic C5-T11 region spinal anterior extradural hematoma with spinal canal compromise and cord compression. After correcting the platelet count with platelet transfusion, we proceeded for surgery. T4 T5 two-level decompressive laminectomy was done (at the level of maximum cord compression). Postoperatively patient remained

with the same preoperative motor power. At six months follow up the lower limbs were spastic with flexor spasms and no spontaneous power (Frankels grade B). He is still on a urinary catheter.

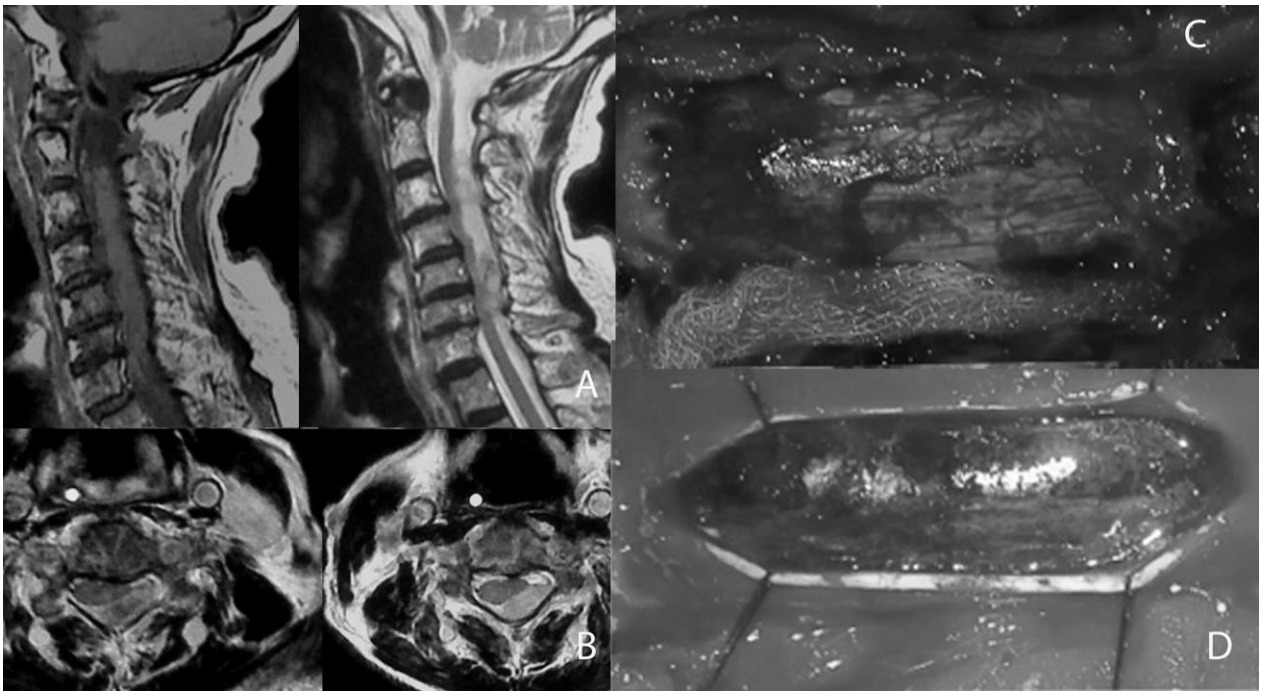

Figure 1. A- T1 T2 sagittal MR section of the cervical spine showing spinal SDH extending from C2-C6 B- T1T2 axial MR sections C- Per operative image showing bluish bulging dura with underlying hematoma D- dura is kept open with thick SDH.

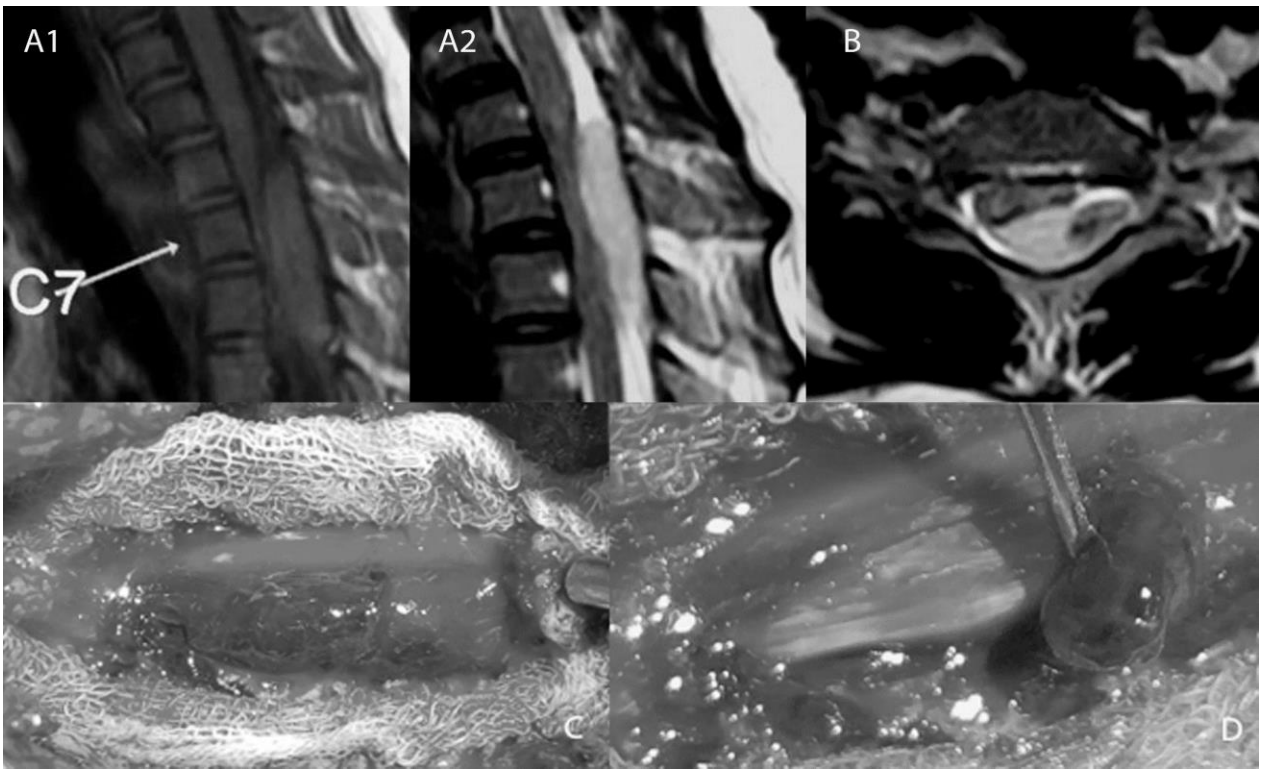

Figure 2. A1, A2- T1 and T2 sagittal MRI of the cervical spine showing SSEDH extending from C6-D2; B- axial MR sections showing SSEDH; C, D – per operative images of decompressive laminectomy and hematoma evacuation.

Cases	Age	Sex	Risk Factor	Platelet count/µl	INR	Pre-op Frankel's Grade	Type of SSH	Spinal Level of SSH (segments)	Time from onset to maximal weakness (hours)	Duration till Surgery (Days)	Frankel's Grade at discharge	Frankel's Grade 6 months follow up
1	25	M	Thrombocytopenia	17000	1.1	B	EDH	C7-D11 (13)	6	1	B	B
2	29	M	Nil	4.4 lakhs	1	D	EDH	D1-D2 (2)	72	5	E	E
3	24	F	Pregnancy	4.2 lakhs	0.8	C	EDH	C7-D1(3)	12	2	C	D
4	75	M	Necrotising Pancreatitis	3.3 lakhs	2.3	C	SDH	C2-C6 (5)	24	2	C	D
5	30	M	Thrombocytopenia	15000	1.2	A	EDH	C7-D1(3)	8	2	A	A
6	12	M	Thrombocytopenia	10000	0.9	C	EDH	C7-D3 (5)	10	2	C	C
7	50	F	Nil	2 lakhs	1.1	D	EDH	C5-D4 (8)	12	1	E	E
INR- International normalized ratio												

Table 1. Demographic and clinical characteristics of the patients

Results

Of the 7 cases, the mean age was 35± 20.9 and 5 (71%) were males (**Table 1**).

Thrombocytopenia was the most common risk factor and was present in three of our patients. One patient was 34 weeks pregnant and another had necrotising pancreatitis with coagulopathy. Two of them had no known identifiable risk factor. One patient had SSSDH while the rest had SSEDH. The most common level affected for SSEDH was cervicothoracic (n=5). The SSSDH was purely cervical. The craniocaudal extension of the hematoma was variable with the longest involvement of 13 spinal segments and the shortest of two segments. Of the SSEDH one patient had anterior spinal EDH and the rest had posterior spinal EDH. All patients had local back pain as the first symptom which heralded the onset of neurological deficits. Five of the patients with Frankel's grade less than 'D' had urinary retention. Five patients had preoperative Frankel's grade A-C and two had 'D'. All patients were operated at the earliest once the general conditions were favourable and the thrombocytopenia/ coagulopathy was corrected. The mean time between the onset of symptoms to maximal weakness was 20.5 hours. But in patients with thrombocytopenia, this was 8hours. The mean interval between the onset of significant symptoms and surgery in our series was 4.7days. Of our seven cases, four had improvement in their Frenkel score and were categorised as a good outcome. At 6 months, all the remaining patients remained in their same preoperative Frenkel score. Those who had thrombocytopenia as risk factor had a poor outcome. Among the patients with thrombocytopenia two patients had fever with thrombocytopenia and for one patient thrombocytopenia was detected on the preoperative blood workup. Also, when the pre-operative functional status was low (Frenkel's A, B, and C) the outcome was poor. The improvement of functional status was significantly dependent on the pre-operative Frenkel's score. We couldn't find any association between the number of segments involved or the time period between the onset of symptoms to surgery with postoperative outcome.

Discussion

SSEDH was first described by Jackson and Bain in the second half of the 19th century while SSSDH was first reported by Schiller (3)(4). SSH is a very rare clinical entity and its presentation can be variable from mild local pain to severe functional impairment in the form of weakness and bowel and bladder involvement. Usually, spinal hematomas are associated with trauma, iatrogenic procedures or spinal surgeries but we studied the patients who had a spontaneous spinal hematoma. The risk factors for SSH include AVMs, coagulation abnormalities,

anticoagulant use, vertebral haemangiomas, hypertension and pregnancy (5). However, in 40-60% of cases demonstrates no identifiable risk factor (6). In two of our patients, we could not identify any risk factors.

Thrombocytopenia was the most common risk factor for SSH in our study which was not reported before. Thrombocytopenia may be associated with a febrile illness which is common in northern Kerala where this study was conducted (7). In our series, two patients with thrombocytopenia had a preceding febrile illness, probably due to viral infection. The most common cause for viral infection with thrombocytopenia is dengue infection which was screened in all patients and was found negative. In a previous study from north Kerala, 26% of cases of thrombocytopenia associated with febrile illness were due to viral infections other than dengue(7). Viral infections causes thrombocytopenia both by decreased production of platelets from bonemarrow, as well as by the increased destruction by antibodies(8).

SSEDH is usually due to bleeding from posterior epidural venous plexus. But Beatty and Winson had postulated an arterial origin for SSEDH particularly in the cervical region since the intrathecal pressure is higher than the venous pressure(9). In all of our cases, we did not find any evidence of vascular malformation with imaging (MR angiography) as well as perioperatively. Bleeding from anterior epidural veins is rarer since they are smaller in caliber and are situated underneath the posterior longitudinal ligament. But anatomical variations are possible where the anterior epidural plexus can have a larger caliber. Among our SSEDHs one was located anterior to the thecal sac. The most common site of SSH in our series was cervicothoracic, probably due to mechanical factors as well as the prominence of epidural veins in the cervical and thoracic regions (6).

The factors associated with poor outcomes were thrombocytopenia and pre-operative functional status. The post-operative recovery depends on the extend of ischemia to the cord which depends on various factors like rate, force, and duration of compression(10). We postulate that in patients with thrombocytopenia as the basic platelet plug formation is not happening to arrest the bleeding there will be a rapid accumulation of blood in the epidural space(11–13). Also, the endothelial supporting function of the platelets is lost which heralds the bleeding in thrombocytopenia causing endothelial gaps for RBC extravasation(12). Here the rate and force of compression may be very high on the cord and may result in neuronal death. All of our patients with thrombocytopenia had rapid deterioration of their motor power (mean-8hours). This shows the rate and force of compression of the spinal cord are high in these patients which resulted in poor postoperative outcomes. After a thorough literature search, this is the only single-institution case series to report thrombocytopenia as a factor predicting poor outcome. From the literature review, various studies have reported different values of platelet count below which there is a significant risk of major bleeding(14,15). We could not find any association between outcome and time took for surgical intervention from the onset of weakness.

Previous studies have shown that the most important factor determining the long-term outcome is the neurological status of the patient before surgical intervention. Other bad prognostic factors are the onset of severe symptoms in a shorter time frame, the involvement of thoracic cord and lack of sensory sparing. The evacuation of the SSEDH within 12 hours has been reported to predict the outcome(16). We found that the preoperative functional status predicted the outcome in our series.

The presence of SSEDH in pregnancy is even more rare and only 27 cases have been reported[16,17]. Several theories are attributed to the occurrence of SSEDH during pregnancy. Usually, these hematomas tend to occur during the third trimester as the pressure in the vertebral venous plexus is normally elevated due to the compression by the gravid uterus(20). When there is a sudden change in pressure, as if when the patient sneezes, coughs, or during voiding there can be rupture of these veins resulting in SSEDH.

One of our cases was an SSSDH, which was due to coagulopathy secondary to necrotising pancreatitis of unknown etiology. The pathophysiology of coagulopathy in severe pancreatitis is due to the activation of platelets and various inflammatory cytokines which will result in consumption coagulopathy(21,22). The SSSDH is produced by the bleeding from subarachnoid vessels as the spinal subdural space is devoid of blood vessels unlike the cranial subdural space. The rupture of subarachnoid vessels may be due to trivial

trauma or sudden fluctuations in pressure due to coughing, sneezing, etc. Recently radiculomedullary veins were also postulated to be involved in spinal subdural bleeds (23).

Conclusions

The most important risk factor which caused SSH in our series was thrombocytopenia. The most common site was cervicothoracic. The outcome was dependent on preoperative functional status. Thrombocytopenia was noted as a bad prognostic factor in our study. The outcome was not dependent on the extent of hematoma or time period between symptom onset and surgery.

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Cervical extradural metastasis from follicular carcinoma thyroid after 14 years post-thyroidectomy with Elsberg phenomenon

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ABSTRACT

Background. Follicular carcinoma thyroid usually metastasises to bone. Common sites of bone metastasis include skull and spine. Spinal metastasis are more common in the cervical region followed by dorsolumbar spine. Cervical extradural lesions present with progressive quadriparesis, sensory loss, dysautonomia, and respiratory distress. Typical Elsberg phenomenon in a cervical extradural lesion is rare. Elsberg phenomenon involves the involvement of ipsilateral upper limb, ipsilateral lower limb followed by contralateral lower limb and contralateral upper limb.

Case presentation. We are reporting a case of 47-year-old lady presented with progressive quadriparesis of 1-month duration. Her weakness started in left upper limb followed by left lower limb, right lower limb and right upper limb weakness. She also had sensory loss below the level of C7. She had undergone near-total thyroidectomy for solitary thyroid nodule 14 years back and was on thyroid supplementation since then. Histopathology at that time was reported as follicular adenoma with Hashimoto thyroiditis. Her right upper limb power was grade 4- Left upper limb grade 1 right lower limb Grade 3, left lower limb grade 2 with hypertonia of both upper and lower limbs. She was evaluated with MRI Spine which showed a dumb bell-shaped extramedullary lesion involving the C5-C6 vertebra with significant cord compression and encasement of the left vertebral artery. USG neck showed left supraclavicular lymph node enlargement and small residual thyroid tissue in the left side of the thyroid. USG guided FNAC from the thyroid tissue and neck nodes were inconclusive. The patient underwent C4 and C5 laminectomy and subtotal excision from the cervical lesion. Histopathology was reported as metastasis from follicular carcinoma thyroid. Postoperatively patient limb power improved to grade 3 left upper and lower limbs and was discharged and later referred for radioiodine ablation

Conclusion. Cervical extradural metastasis from follicular carcinoma thyroid can present with Elsberg syndrome even without any neck swelling even after decades of post thyroidectomy status for a benign aetiology. Laminectomy and decompression may lead to clinical improvement.

Keywords
thyroid,
follicular carcinoma,
cervical extradural,
Elsberg phenomenon

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INTRODUCTION

Carcinoma thyroid is the fifth common malignancy in women and can be broadly classified in to papillary, follicular, medullary and anaplastic.

(1) Papillary carcinoma thyroid is the most common variety, which usually metastasise to neck nodes via lymphatic system. Whereas the follicular carcinoma thyroid spreads hematogenously to lungs and bones.More than 80% of bone metastases from all tumors including DTC are located in the axial skeleton red marrow (vertebrae, ribs and hips) owing to high blood flow. (1)Clinically, they present with bone pains, pathological fractures or signs of cord compression. Progressive Quadriparesis with typical Elsberg phenomenon as the presenting manifestation of follicular carcinoma of thyroid in a post near- total thyroidectomy for a benign etiology after several years of thyroidectomy is quite uncommon in medical literature related to this (2).

CASE PRESENTATION

A 47-year-old lady presented with complaints of neck pain of 4 months duration followed by progressive paraparesis of 1 month duration. Weakness initially started as left upper limb weakness 1 month back followed by weakness of left lower limb, right lower limb and right upper limb. At the time of presentation, she was bed ridden. She also complained of numbness over all the four limbs and chest and abdomen and had urinary retention and constipation. She had underwent near total thyroidectomy for Solitary thyroid nodule 14 years back and histopathology was reported as follicular adenoma with Hashimoto thyroiditis. She was under follow up for next 2 years and was on thyroid hormone replacement. On examination, she was conscious, alert, hemodynamically stable. No signs of hyperthyroidism or hypothyroidism. She had a healed thyroidectomy scar in the neck with Left supraclavicular lymphadenopathy and no other palpable swellings. Her right upper limb power was grade 4- Left upperlimb grade 1 right lower limb Grade 3, left lower limb grade 2 with hypertonia of both upper and lower limbs. She had sensory loss below the C7 level. Triceps jerk, knee jerk and ankle jerk were exaggerated bilaterally and plantar was extensor bilaterally.

Her routine blood investigations were normal. ESR was slightly elevated (42 mm/hr). Mantoux test was negative. She was evaluated with MRI C-spine with screening of whole spine which showed an ill-defined lobulated heterogenous enhancing dumbbell shaped probably extradural soft tissue lesion of size 3.5x3.3x3 cm (TxAPxCC) in the C5 and C6 vertebral level with infiltration in to the body of C6 vertebra. The lesion was extending intraspinally causing severe spinal canal compromise with compression over the spinal cord . The lesion was extending superiorly in to the posterior epidural space from C4 to C7 and was encasing the left vertebral artery at level of C5- C6 vertebra. USG abdomen and chest X ray were normal. Ultrasound neck showed thyroid tissue in the thyroid bed and left supraclavicular lymphadenopathy. FNAC from the left supraclavicular lymphnode and recurrent thyroid were inconclusive.

She underwent C5-C6 laminectomy and subtotal excision of the lesion. The intraoperative findings suggested an extradural lesion at C5-C6 level involving and destroying the C6 vertebra and compressing the spinal cord and encasing left vertebral artery. Histopathology was reported as metastasis from the follicular carcinoma thyroid with TTF-1 positivity. Patient improved clinically postoperatively. At the time of discharge, she had grade 3 power of left upper and lower limbs and grade 4 power of right upper and lower limbs. She underwent radio-iodine scanning followed by radioiodine ablation. She is presently on limb physiotherapy and rehabilitation.

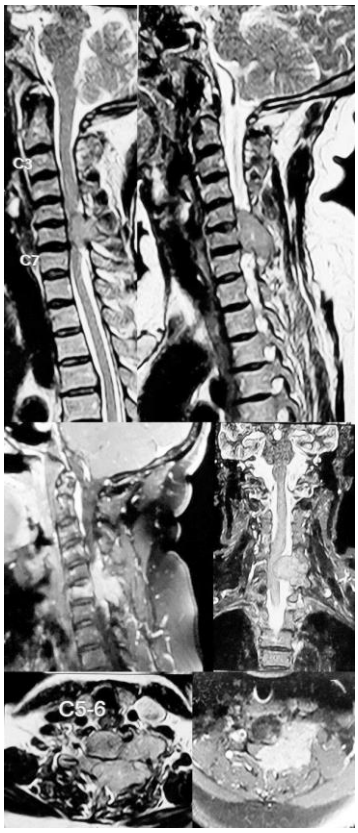

Figure 1. MRI C-spine showing an ill-defined lobulated heterogenous enhancing dumbbell shaped probably extradural soft tissue lesion

Figure 2a. Intraoperative image showing extradural lesion with destruction of C5 and C6 vertebral body with encasement of left vertebral artery.

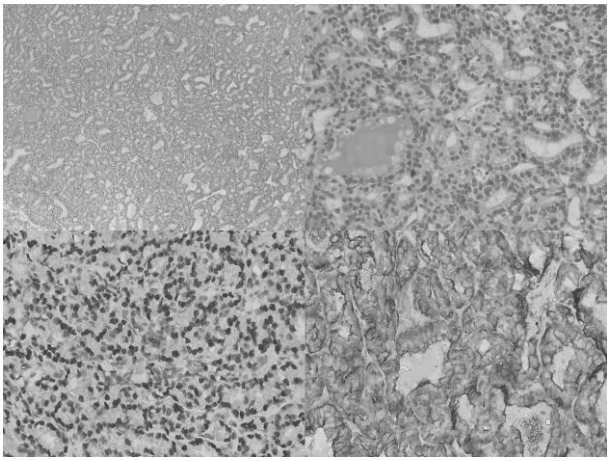

Figure 2b. Histopathology was reported as metastasis from the follicular carcinoma thyroid with TTF-1 positivity.

Discussion

Follicular carcinoma usually forms osteolytic metastasis and are common in the skull and spine. Usual site of spinal metastasis in follicular carcinoma is thoracic > lumbar> cervical. (1) Presentation of follicular carcinoma thyroid spinal metastasis may vary. Patient can present with destruction of the vertebral body, localised tenderness, radiculopathy and with features of myelopathy like quadriparesis or paraparesis, sensory deficits, sphincter disturbances, autonomic dysfunction and respiratory distress. In extradural lesions usually symptoms are progressive as the size of the lesion increases. (3,4)

Elsberg U phenomenon is the progressive quadriparesis with sequential involvement of ipsilateral upper limb, ipsilateral lower limb followed by contralateral lower limb and contralateral upper limb, often described as U-shaped or clockwise involvement of limbs. Elseberg U phenomenon is commonly seen in cervical myelopathy due to cervical extradural lesions or in Foramen magnum pathology and very rarely due to extradural metastasis from follicular carcinoma thyroid.(3,5,6,7)

MRI spine is the investigation of choice for spinal tumours. MRI can help in differentiating the intramedullary tumours from extramedullary and extradural tumours. Bony structure can be properly evaluated by CT spine. (8) Contrast enhanced imaging helps in delineating the relationship of the cervical lesion with vertebral artery as well. If required vertebral artery reconstruction, along with bony reconstruction can help in perioperative planning. Extradural lesions are most commonly tuberculous, myelomatous or metastatic. Hence workup for primary is done routinely. Surgical decompression and biopsy can help in confirmation of diagnosis and clinical improvement

This case is reported in view of the rare clinical presentation of metastatic follicular carcinoma thyroid after 14 years post thyroidectomy without any neck swelling presenting with Elsberg phenomenon. It also suggests the need for more regular followup in cases of follicular adenoma and Hashimoto thyroiditis.

Conclusion

Cervical extradural metastasis from follicular carcinoma thyroid can present with Elsberg syndrome even without any neck swelling even after decades of post thyroidectomy status for a benign etiology. Laminectomy and decompression may lead to clinical improvement. Postoperative radioablation may be required in case of incomplete excision.

Abbreviations

MRI - Magnetic resonance imaging; CT - Computed Tomography; DTC - Differentiated thyroid cancer; FNAC - Fine needle aspiration cytology; ESR - Erythrocyte sedimentation rate.

Declarations

Ethics approval and consent to participate.
Informed written consent for participation obtained from the Patient and her caretakers.
Institutional Ethics committee approval not obtained as the study did not involve any human trials.

Consent for publication
Informed written Consent for publication obtained from the Patient and her caretakers

Availability of data and material
Data and material available in the Department of Neurosurgery, Govt Medical College, Kozhikode, Kerala, India.

Competing interests
Authors declare that there is no competing interests

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Authors' contributions
All authors have contributed to the preparation of manuscript. All authors have read and approved the manuscript, and ensure that this is the case.

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Surgical options for traumatic fractures of the thoracic and lumbar spine. A series of 20 patients

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Keywords
spine, fractures, surgery, fixation, thoracic and lumbar, screw, tarnspedicular, treatment

ABSTRACT

Background context. Thoracolumbar fractures represent a large number of spine injuries in adults. Such fractures are a result of traumatic accidents with high-energy impacts, such as falls from height or following motor vehicle accidents, often resulting in some degree of neurological deficit.

Purpose. To report a total of 20 cases of thoracolumbar fractures in young adults with various neurological manifestations. The majority had indications for transpedicular fixation.

Study Design. Series of 20 cases and review of the literature.

Patient Sample. A series of 20 patients with a history of falling from a height or after motor vehicle accidents (RTA) with complicated fractures at the level of the thoracolumbar vertebrae which present with neurological deficits.

Methods. We report here on a total of 20 patients with a history of falls from height or following RTA. Patients presented to the hospital complaining of back and abdominal pain. Fractures at the thoracolumbar vertebral level were confirmed with imaging studies revealing post-traumatic spinal deformities. All cases were initially considered for conservative medical treatment. However, unstable complicated cases with bone fragment migration as well as spinal canal compression were deemed candidates for surgical intervention via posterior spinal fusion with transpedicular screw fixation.

Written informed consent was gathered from all patients. Detailed history, clinical examination, as well as X-ray, computed tomography and magnetic resonance imaging of the dorsolumbar spine were obtained in all cases. Neurological status was assessed using the Frankel grading for spinal cord injury.

Results. The patients tolerated the operations without complications and remained in stable postoperative condition.

Conclusion. Surgical treatments via transpedicular fixation are extremely efficient for treating unstable and complicated thoracolumbar spinal fractures. Nevertheless, conservative medical treatment is still of high value and should be considered as the first treatment option, especially in stable cases. The patients who underwent surgery showed excellent outcomes and improvement of neurological deficits. The surgical procedure preferred in the present study was the posterior spinal fusion with pedicle screw fixation.

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Introduction

The biomechanical properties of the thoracic spine and thoracolumbar junction directly predispose this anatomically unique region to various types of traumatic injuries. High-energy trauma produced by road traffic accidents (RTA) is the primary cause of injury, followed by falls from a height and sports-related injuries (1). The thoracolumbar vertebrae are associated with a high risk of post-traumatic compression fractures due to the effects of axial loading, which under normal conditions contribute to the natural kyphotic curvature of the thoracic spine (2) (3).

The management of traumatic fractures of the thoracolumbar (T1-L5) spinal column remains controversial. There are a number of publications outlining various treatment strategies aimed at obtaining normal mobilization and stability of spinal fractures. Despite the variety of treatment options presented in medical literature, there has as yet been no definitive consensus with regards to a gold-standard management protocol (4)(5). Nor have there been any reported advantages with respect to patient outcome, despite several operative strategies being currently employed to achieve fracture reduction and fixation. Furthermore, there is a scarcity of supporting evidence in the available literature for choosing conservative versus surgical management or vice versa (6) (7).

While patients with limited vertebral body compression, for example, can benefit from non-operative treatment such as thoracolumbar orthosis, restriction of activities and administration of analgesics (8), surgical management is generally considered of utmost necessity in patients presenting with severe biomechanical spinal instability or acute or chronic neurologic deficit (9). Indications for surgical treatment include unstable injuries associated with neurological deficits, complicated fractures with dislocation or progressive deformations associated with compression of neural structures (10) (11) (12) (13). The primary objectives of surgical treatment of unstable thoracolumbar fractures are optimizing neural decompression, early stabilization, pain relief and adequate nursing care (6) (14).

A number of classification systems have been devised to categorize thoracolumbar fractures. One of the most commonly used classification systems in clinical practice today is the scheme proposed by Francis Denis in 1983, which has aided in the communication and description of thoracolumbar fractures and their respective treatment strategies among medical practitioners [Figure 1] (15). Denis maintained that complete rupture of the posterior ligamentous complex alone would be insufficient to create spinal instability in flexion, extension, rotation and shear, and that spinal instability at least in flexion would develop only in the presence of additional disruption of the posterior longitudinal ligament and posterior annulus fibrosis (15) (16).

In the Denis classification system, the spine is subdivided into three columns as follows: anterior column (anterior longitudinal ligament [ALL] and anterior two-thirds of the vertebral body and annulus), middle column (posterior one-third of the vertebral body and annulus, posterior vertebral wall and posterior longitudinal ligament [PLL]), and posterior column (all posterior structures of the PLL which include: posterior bony arch and posterior ligamentous complex (supraspinous and interspinous ligaments, capsule, and ligamentum flavum).

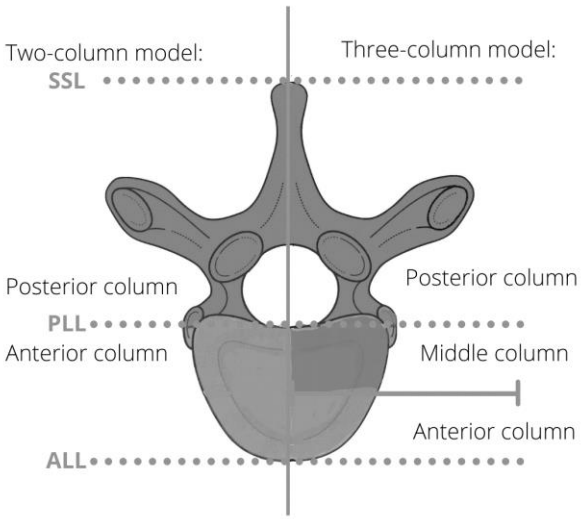


Figure 1. Two-column model compared with three-column model (Denis). In addition to the positions of SSL, PLL and ALL.

The Denis "3-column model" relied on anatomic divisions to guide surgical planning, whereas more modern classification systems such as the Thoracolumbar Injury Classification System (TLICS) emphasize the initial neurologic status and structural integrity of the posterior ligamentous complex as a

guide for surgical decision-making and have demonstrated a high intra- and inter-observer reliability. Other systems, such as the Load-Sharing Classification, also aid as useful tools in planning the extent of instrumentation and fusion (15) (17) (18) (12) (19).

This case study is aimed at presenting our experiences in adult traumatic spinal injury. Radiological findings, treatment strategies, and clinical outcomes were evaluated retrospectively and compared with the available literature.

CASES AND METHODS

Study design

This is a retrospective study conducted at Benha University Hospital, Benha, Egypt, between 2016 and 2020.

We report here a total of 20 patients with thoracolumbar injuries sustained by falling from a height or following RTA, of which 16 had presented with indications for surgical management via transpedicular fixation, i.e., with unstable and complicated fractures associated with neurological deficits. Four cases had no indication for surgical treatment and were treated conservatively.

As per standard procedure for all patients admitted to our clinic, detailed patient histories were gathered, comprehensive physical examinations were performed, and all relevant laboratory investigations were completed for each case. Pre- and postoperative neurological status was assessed using the Frankel Grade classification for spinal cord injury, a functional grading of impairment in activities of daily living, and analysis of gait disturbances (20) (21).

After performing an initial clinical and neurological examination, the diagnosis was confirmed radiologically, i.e., bony structure injury of the thoracolumbar spine was confirmed with computerized tomography (CT), while neural and ligamentous involvement was confirmed with additional magnetic resonance imaging (MRI).

The length of time, from the day of patient admission to the operation, ranged from 3-7 days, depending on the clinical and neurological status of the patient, as well as on trauma severity.

All patients were fully informed with regard to treatment options to manage their injuries, including the aim and scope of the treatment, possible operative and perioperative risks, as well as potential short- and long-term complications. Informed written consent forms were signed and submitted by all patients upon hospital admission.

CASE REPORTS

Surgical procedures

All patients in the present study with surgical indications were treated with pedicle screw fixation, which is generally considered a safe procedure through which adequate reduction and stability can be achieved, and provides patients with early pain relief and mobility (22). Although either anterior or posterior approaches can be used in spinal fusion surgery, posterior approaches are associated with lower postoperative morbidity rates. Less aggressive than the anterior approach, posterior fixation is associated with several advantages, including less intraoperative bleeding and fewer postoperative complications, while still achieving excellent spinal stabilization (23) (24). Preoperative intravenous antibiotic prophylaxis was administered to each patient.

The posterior approach was utilized for each case in the present study. Each patient was placed in a prone position. A midline posterior incision centered over the affected area was performed with the aid of preoperative X-Ray imaging planning. An initial laminotomy was performed on each patient. Using anatomical landmarks such as the facet joints and transverse processes, it was possible to establish insertion points on the pedicles [Figure 2]. For example, an entry point can be identified by drawing a horizontal line through the middle of the transverse processes, or from the intersection of the upper one-third of the transverse process and a vertical line drawn through the prominent ridge on the superior articular facet.

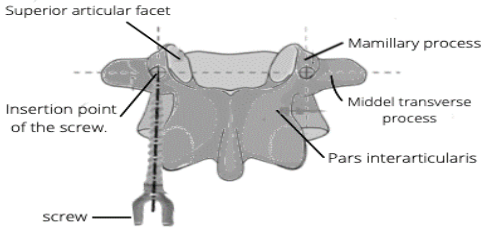


Figure 2. The transpedicular insertion; insertion point of the screw.

Cortical bone was nibbled off at the point of the intersection of these two lines, pilot holes were created using a burr, and a ball handle probe was passed through the cancellous channel in the pedicle and into the vertebral body. Screw angulation and placement were performed using C-arm-guided fluoroscopy.

A transpedicular screw fixation and fusion approach was then employed, with bilateral, two-level pedicle screw placement, followed by bilateral rod placement situated on the fracture level and on at least one adjacent level superiorly or inferiorly, based on the location of the intact endplate. For example, in cases where the inferior endplate was intact and the superior endplate was fractured, screws were inserted caudally to the inferior endplate at an angle of approximately 5°. Transpedicular screw fixation was complemented by placement of adjoining rods with cross-connecting rod reinforcement. Distraction was performed and locking nuts were tightened. The surgical wound was thoroughly irrigated and closed over a suction drain.

Postoperative monitoring and follow-up

Postoperative imaging studies were performed in order to ensure the efficacy of the surgical procedure. Following surgery, patients were transferred to the post-anesthesia care unit for 24 hours**.** Postoperative patient mobilization was initiated on the first day. The average time for suture removal was approximately 12 days. Patients wore a Taylor brace until the 10th–12th postoperative day, or longer in cases with injuries involving all three columns. Regular physiotherapy and assisted mobilization were continued until the patient was discharged from the hospital. A detailed neurological examination was repeated on the day of patient discharge.

All patients with unstable injuries were monitored with regular follow-up visits: at 4–6 weeks post-operation, and bi-monthly afterwards, for an average total period of 24-36 months. Follow-up visits included clinical, neurological and radiological examinations, as well as documentation of any postoperative complications.

Results

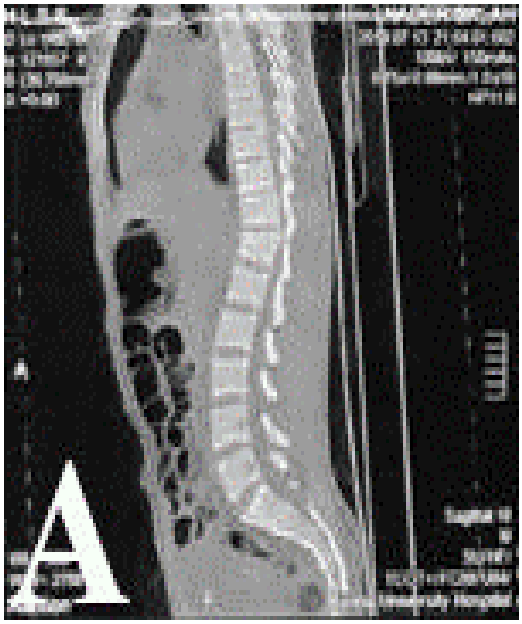
The posterior spinal fixation approach was used in the surgical treatment of 16 cases with unstable thoracolumbar burst fractures. Of the patients treated surgically, 12 had no neurological deficits at the time of hospital presentation. Transient leg numbness, tingling sensation and pain, immediately after the traumatic event, were reported by eight of these 12 patients, with symptoms subsiding by the time of admission into the emergency department. Persistent neurological deficit was reported by four cases in the study.

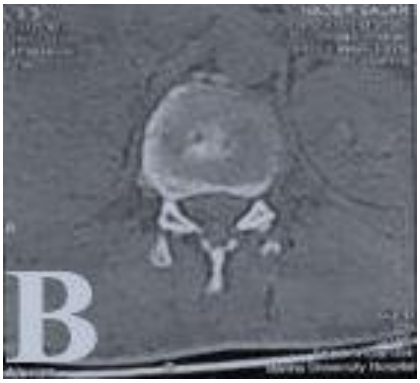
Six cases presented with a T12-level fracture, three cases with a T10-level fracture, one case with T9-level fracture and one case of T11-level fracture. Three cases presented with a fracture at the L3-level, and two cases presented with a fracture at the L2 level. There were no cases of dural tears in the present study.

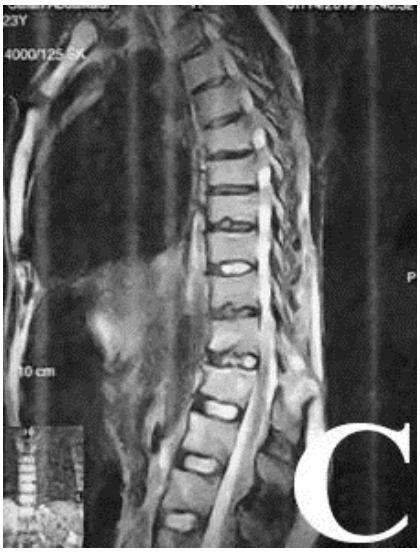
Of the four patients with stable injuries who were managed conservatively, two cases presented with T10-level fractures, one case with a T11-level fracture and one case with a fracture at the L2-level. The mean duration of hospitalization was approximately four weeks.

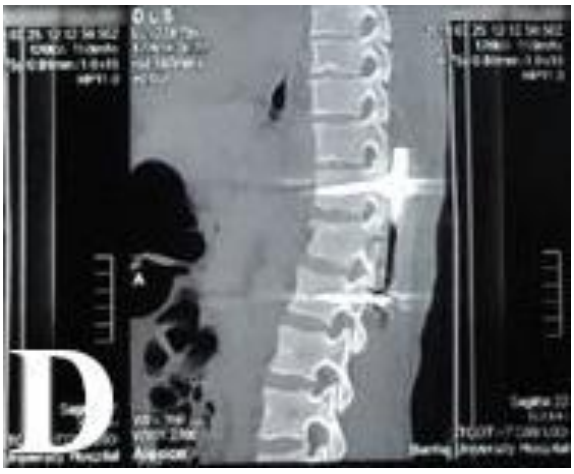
Preoperatively, eight of the patients presented with normal motor function (Frankel grade E). Six patients presented with preserved, functionally useful voluntary motor function (Frankel grade D). Two cases presented with preserved, nonfunctional voluntary motor function (Frankel grade C).

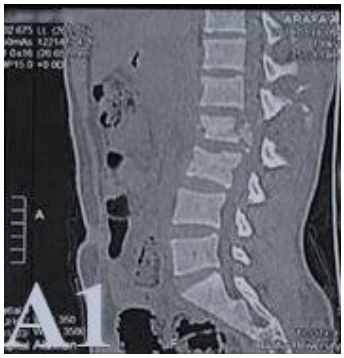
In follow-up visits at 24-36 months postoperatively, the majority of patients had neurological recovery with either Frankel grade of E or D scores, while one patient had a persistent motor deficit, with a Frankel grade of C score.

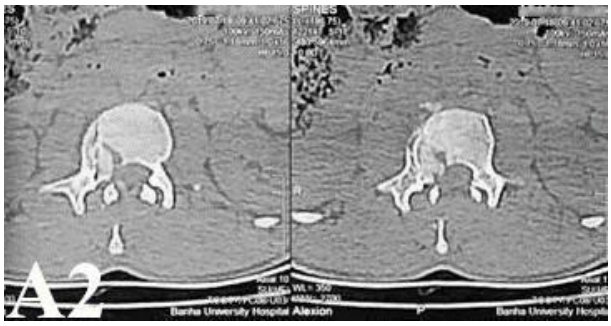


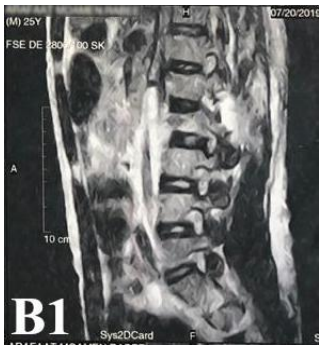


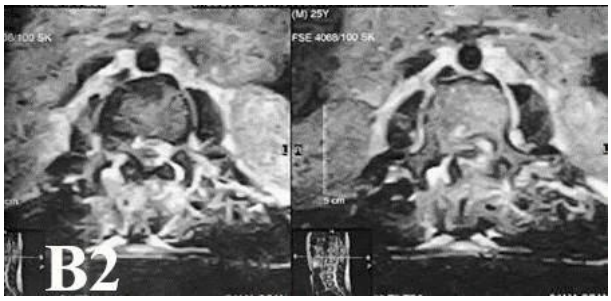












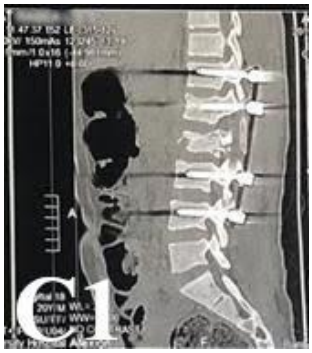
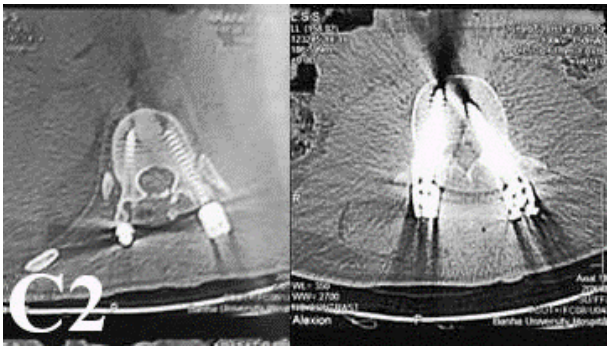


Figure 3. Case 1: A, preoperative sagittal CT of a 26-year-old male patient who sustained a T10 burst fracture without neurological deficit at time of admission (Frankel grade E). B, preoperative axial CT scan image confirming the presence of a fracture at the T10 vertebral level. C, preoperative MRI demonstrating T10-level fracture. D, postoperative sagittal CT imaging taken 24h after the patient underwent a transpedicular fixation procedure. The CT scan demonstrated correct screw placement at two levels (T9 and T11).



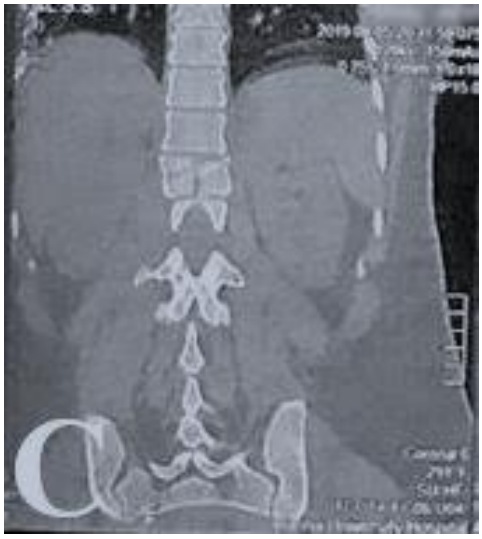
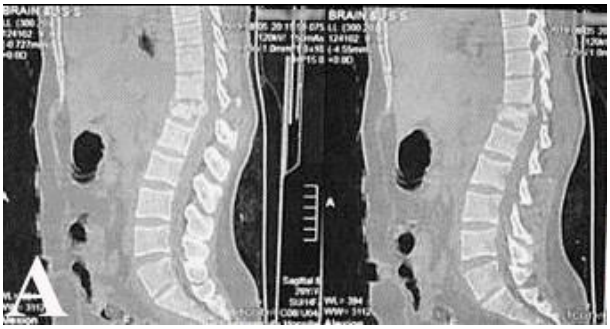
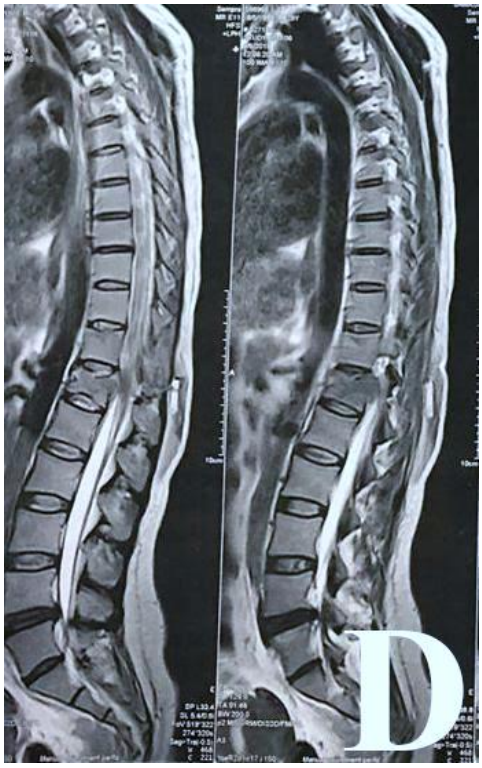
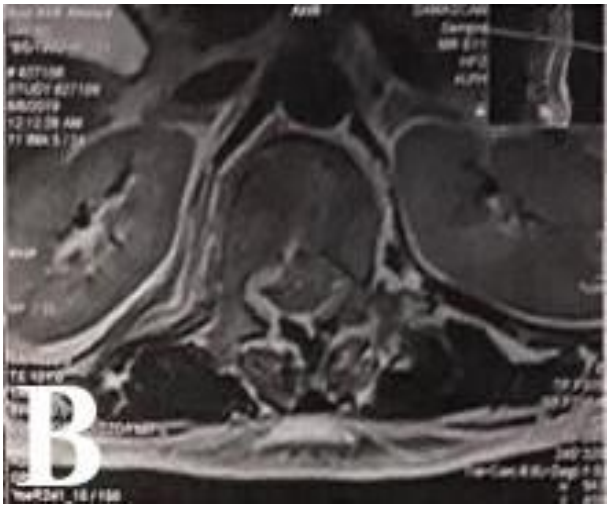
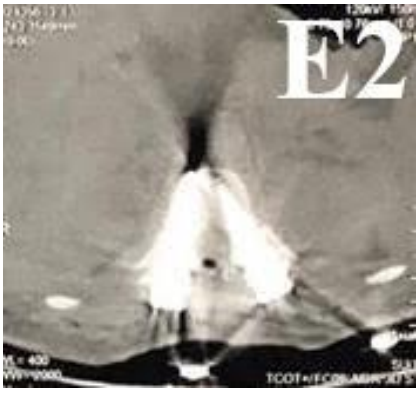


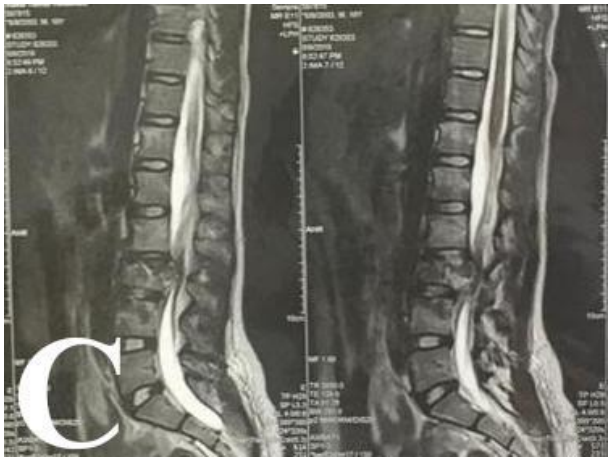
Figure 4. Case 2: A1, preoperative sagittal CT of a 20-year-old male patient who sustained an L2 burst fracture without neurological deficit at time of admission (Frankel grade E). A2, preoperative axial CT image confirming the presence of a fracture at the L2 vertebral level. B1, preoperative sagittal T1-weighted MRI revealing L2 fracture. B2, preoperative axial MRI showing the aspect of the fracture at L2. C1, postoperative sagittal CT scan obtained 24h after the patient underwent a transpedicular fixation procedure. The CT scan demonstrated correct screw placement at two levels superiorly (T12, L1) and two levels inferiorly (L3, L4). There is no significant correction of local post-traumatic kyphosis C2, postoperative axial T1-weighted MRI, 12 months after surgery, at which point the patient had a Frankel grade of E.

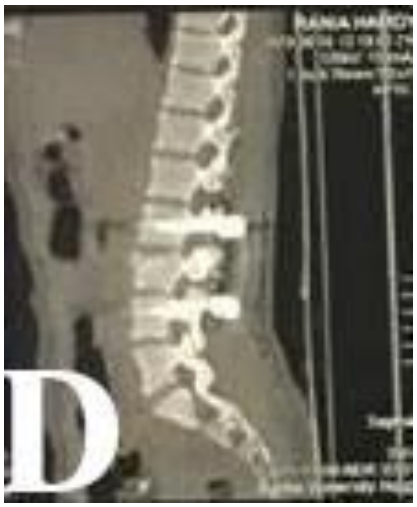


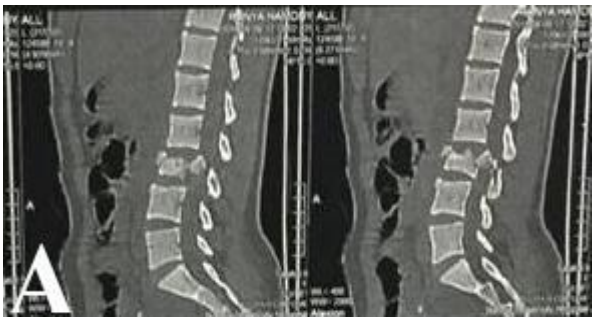












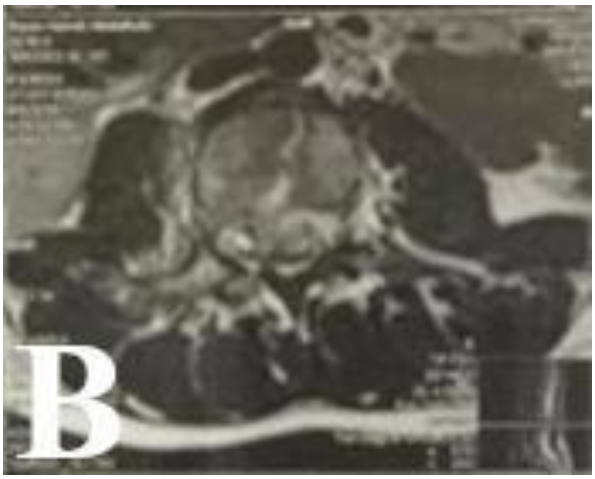


Figure 5. Case 3: A, preoperative sagittal CT of a 29-year-old female patient who suffered a T12 burst fracture without neurological deficit at time of admission (Frankel grade D). B, preoperative axial MRI confirming the presence of a fracture at the T12 vertebra level. C, preoperative coronal CT scan confirming the T12-level fracture. D, preoperative sagittal MRI demonstrating the fracture at T12. E1, postoperative sagittal CT scan acquired 24h after the patient underwent a transpedicular fixation procedure. The CT scan demonstrated correct screw placement at two levels superiorly (T10, T11) and one level inferiorly (L1). E1 and E2, postoperative sagittal and axial T1-weighted MRI revealing correct screw insertion. Serial follow-up CT scans were performed after surgery, with the patient having a Frankel grade of D.

Figure 6. Case 4: A, preoperative sagittal CT of a 17-year-old female patient who was admitted with a burst fracture at the level of L3, with bilateral motor deficit (Frankel grade A). B, preoperative axial MRI confirming spinal cord compression at the L3-level due to the fracture. C, preoperative sagittal MRI demonstrating the presence of the fracture with evidence of spinal cord injury at the L3-level. D, postoperative sagittal CT scan revealing screw insertion at one level superiorly (L2) and at one level inferiorly (L4) relative to lesion. E, postoperative axial T1-weighted MRI revealing correct screw insertion (L2). Serial follow-up CT scans were performed after surgery, with the patient having a Frankel grade of C.

Discussion

The mechanism of injury in the present case series was via fall from a height or road traffic accidents (RTA) (20 cases), resulting in thoracolumbar fractures. Four patients presented with uncomplicated stable fractures, in which conservative management was indicated. The majority of the patients in the study (16 cases) had complicated unstable fractures. The patients were operated using the posterior approach with transpedicular screw fixation within 3-7 days from hospital admission. In our study, the most common site of fracture was located at the T12 vertebral level (6 cases). The surgical interventions proceeded uneventfully with no major intra- or postoperative complications.

All patients who underwent surgery were assessed neurologically pre- and post-operatively at regular intervals. The Frankel Grade classification was used to evaluate neurological function of the patients. Preoperatively, eight cases had Frankel grades of E, six cases had Frankel grades of D and two cases had Frankel grades of C. Following surgical intervention, only one patient had a persistent Frankel grade of C, while the majority of our cases had Frankel grades of D or E, which indicate acceptable results with posterior fixation for unstable thoracolumbar fractures.

Conclusion

The main objectives of surgical treatment of thoracolumbar fractures are to improve neurological deficits as classified by the Frankel scale, to prevent spinal cord injuries, and to achieve stability by screw fixation. Our case study demonstrates that posterior transpedicular screw fixation is an effective and safe surgical method to obtain stabilization of the spine. The approach is associated with good surgical outcomes and minimal complications.

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Intradural migration of bullet in vertebra corpus after meningitis

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ABSTRACT
In a gunshot injury, the spinal cord of the thoracic region is usually the most affected and damaged part of the body. In most cases, the bullet cannot be removed without causing more damage to the injury. Over time, the bullet tends to travel in different areas of the body. Moreover, cases on bullet movements in the spinal canal were reported in the literature. In this study, we reviewed the diagnosis and treatment of a 27-year-old male patient with a bullet detected in his vertebra corpus, which is caused by a gunshot injury. During the follow-up period, an intradural migration of the bullet from the vertebra corpus was observed. Furthermore, we performed surgery to prevent any future neural damage. In this study, we focused on a case with a gunshot injury, presenting an intradural migration of a bullet from the vertebra corpus after meningitis.

Keywords
gunshot injury,
intradural migration,
spinal cord

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INTRODUCTION

Gunshot injuries (GSI) are the third most common cause of spinal cord injuries after traffic accidents and falls from height. Although the incidence of spinal cord injuries caused by GSI changes according to the countries' level of development, the most common causes of it are suicides, accidents and attacks. Moreover, in developed countries, the approximate percentage of spinal cord injuries caused by GSI among all kinds of spinal cord injuries was reported to be 15% [1,2].

Aside from the aforementioned damages on the spinal cord, secondary injuries, such as the degradation of the spinal cord vascularisation, autoregulation deficiency and hypotension, also worsen the neurological presentation due to systemic effects [3].

In the literature, cases of bullets travelling through the intraspinal canal were reported. In our case, the bullet was first stuck in the vertebra corpus, and removing it through manipulation was not feasible during the surgical operation. But in the follow-up period, it was observed that the bullet had left the corpus and travelled through the spinal canal after meningitis.

CASE PRESENTATION

A 27-year-old male patient was admitted to the emergency service following the gunshot injury in the chest area. A chest tube was then inserted as the patient had hemopneumothorax. A hole in the patient's body due to the bullet which entered his thorax from right axillary lower region was observed. Based on the neurological examination, the patient had paraplegia in the lower extremity, and anaesthesia was administered below T10; moreover, an anal sphincter reflex was not observed. The steroid protocol treatment from the NASCIS protocol was performed. A bullet was stuck in the T10 corpus was observed using the spinal tomography (Figure 1). Therefore, an urgent surgery was performed. During the surgery, it was observed that the dura and medulla were partially disintegrated. Two-third of the bullet was in the T10 corpus. However, the bullet could not be removed despite further manipulation. The operation was then ended following duraplasty. As no change in the postoperative neurological examination was observed, the patient was required to undergo physical therapy and rehabilitation and was discharged afterwards.

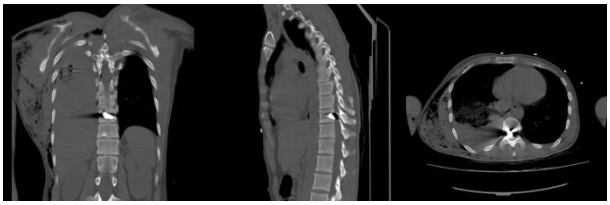

Figure 1. Image of the bullet in the T10 corpus following the gunshot injury.

Due to wound drainage and high fever, the patient was re-admitted a month after the discharge. A meningeal irritation was observed, and the white blood count and C-reactive protein were high. Due to the presence of meningitis, antibiotherapy was started. Moreover, the patient was reoperated since serous wound discharge continued to persist. During the surgery, it was observed that the discharge was coming from an intradural distance. The bullet was stuck in the corpus could not be removed through manipulation. Duraplasty was then performed again, and the wound discharge ended postoperatively. After the antibiotherapy was completed and the wound recovered completely, the patient was discharged and was required to undergo physical therapy and rehabilitation.

Based on the medical imaging performed nearly a year later, it was observed that the bullet in the T10 corpus was dislocated and moved in an intradural distance; it reached the S1 level (Figure 2). Moreover, the neurological deficit of the patient regressed, and the muscle strength of the lower right extremity was evaluated as 4/5 and the lower left extremity 2/5. The patient underwent surgery in order to remove the bullet. During the operation, it was observed that the bullet had reached the L4 level when checked based on the results of the fluoroscopy (Figure 3). L4 total laminectomy was performed after opening the L4 level. When the dura was opened, it was observed that the bullet was in the L3 level. When the patient was in a reverse Trendelenburg position, the bullet moved towards the dural opening and was removed. The dura was closed via primary suturing. Furthermore, no additional deficit was observed in the postoperative neurological examination.

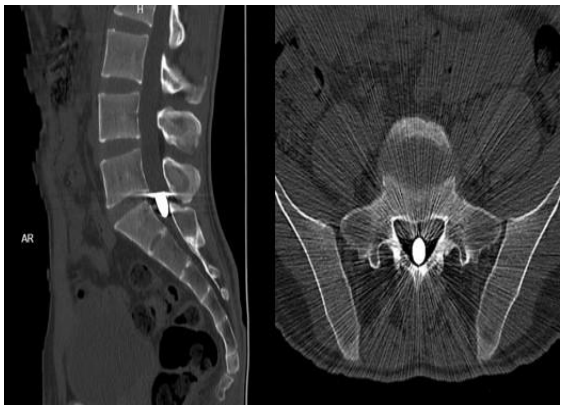

Figure 2. CT image showing the bullet at the S1 level.

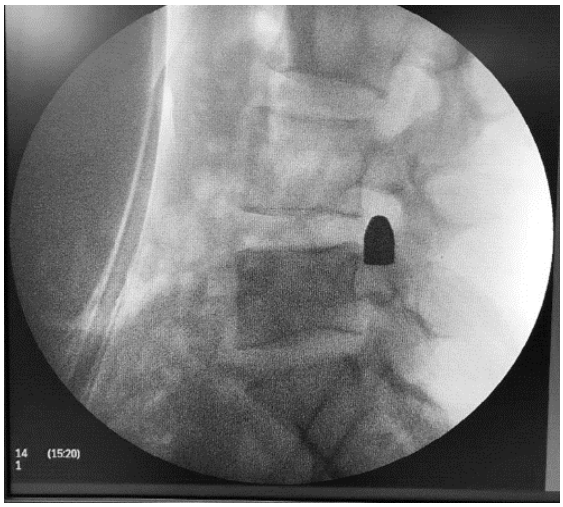

Figure 3. Fluoroscopy image before intraoperative laminectomy

Discussion

Spinal gunshot injuries occur mostly in the thoracic region. Another common place for it to occur is the lumbar region, with the cervical region being the less common [4]. Injuries in the cervical region have a more mortal course. In the thoracic region, the spinal canal/cord ratio is lower and the neural damage is higher compared with that in other levels.

In the literature, studies showing a bullet migration in the intervertebral disc level and in the paraspinal mass tissue into the spinal canal were included. Kuijlen et al. presented a case of bullet migration from the paraspinal muscles to the spinal canal at the L3 level [5]. Conway et al. presented a case showing a cauda equina development after a bullet migration from the L4 to L5 intervertebral disc level [6] . Ceylan et al. presented a case who had back pain caused by a bullet migration anteriorly between the L2 and L3 intervertebral disc levels [7]. In our case, the bullet was stuck in the T10 corpus and migrated through the spinal canal in a span of nearly 1 year since the injury. In our case, in contrast to the other cases, two-third of the bullet was stuck in the vertebra corpus which could not be removed by manipulation during the two surgical operations performed, and the bullet spontaneously migrated to the canal following the patient's meningitis treatment.

In a gunshot injury, leaving the bullet inside the body rarely causes infection, neurological deficit and lead poisoning [8]. In the case of our patient, the infection occurred followed by a to cerebrospinal fluid (CSF) leakage after the first operation. Moreover, gunshot injury treatment is still a disputed and complex subject. Surgery is necessary if CSF leakage, progressive neurological deficit and infection formation co-occur with the infection. Aside from gravity, respiratory movements and CSF fluidity are also factors that affect the bullet movement inside the spinal canal. A neurological deficit may also occur if the bullets move in the spinal canal; in our case, no signs of newly developed neurological deficits were observed. However, a neurological deficit may develop later due to the fibrotic reactions forming in the pia and arachnoid. It was also shown that axon and myelin damage and lead and copper implantation causes induces gliosis in the spinal cord [9,10]. Therefore, we decided to remove the bullet piece although our patient lacked any symptom or additional neurological finding.

Computed and direct tomography are usually the first diagnostic options for gunshot injuries. Kafadar et al. reported that a magnetic resonance imaging (MRI) can be performed since the bullet is covered with non-ferromagnetic metals just like copper in low-speed gunshot injuries [11]. Although MRI is the appropriate option for the evaluation of neurological tissue damage and causes less artefact compared to computed tomography (CT), its use is limited depending on the patient. Since such cases are required to undergo an urgent operation, a ballistic examination cannot be performed for the bullet as MRI is more commonly used. Moreover, the patient did not have an MRI scan since we did not have the sufficient information about the bullet structure. When our patient was positioned on the operation table, the results of the endoscopy showed that the bullet was moving. The bullet which was at the S1 level based on the preoperative CT scan had reached the L4 level, and we determined our incision accordingly. In the case presented by Genç et al., the bullet moved intraoperatively, and its location was determined via ultrasonography [12]. We then performed laminectomy after determining the location of the bullet via endoscopy. However, we did not have to perform a long-level laminectomy and refrained from stabilisation.

Based on the findings of this study, it should be noted that despite being stuck in the bone, most foreign objects can move in later stages. Overall, no neurological deficit following the bullet migration was observed in our patient and necessary measures were taken to prevent any possible neurological deficit. In addition, the individual who caused the injury was also identified by the researchers.

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Global neurosurgery, Bangladesh and COVID-19 era. A perspective from a low-income country

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Keywords
global neurosurgery,
COVID-19,
low-income country

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ABSTRACT

Background. COVID-19 has become an alarming pandemic for our earth. It has created panic not only in China but also in developing countries like Bangladesh. Bangladesh has adequate confinements to constrain the spread of the infection and in this circumstance, overall healthcare workers including neurosurgeons are confronting a ton of difficulties. The purpose of this paper is to depict the proficiency of Global neurosurgery in this COVID-19 time.

Method. Global neurosurgery offers the chance of fusing the best proof-based guidelines of care. This paper demonstrated that, in low to middle-income countries, Global medical procedure has been received to address the issues of residents who lack critical surgical care.

Results. Inappropriate and insufficient asset allotment has been a significant obstacle for the health system for decently giving security to the patients. The fundamental training process has been genuinely hampered in the current circumstance. Worldwide health activities have set to an alternate centre and Global neurosurgery as an assurance is slowed down.

Conclusion. This paper recommended that Global neurosurgical activities need to come forward and increase the workforce to emphasize surgical service.

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COVID-19 pandemic has brought terrible impacts and vigorously affected medicinal services including the neurosurgical field.[2, 3] This pandemic has represented a challenge for all nations. The entire world is confronting this challenge which requires the engagement of all physicians, including neurosurgeons, to manage COVID-19 outcomes.[4, 5] Although neurosurgery constitutes a small portion of this but still, its impact is significant in those requiring intervention. Thus, the concept

of Global Neurosurgery was conceded to address the difference around the world in neurosurgical caregiving. But at present, the world is facing unprecedented effects of COVID-19. Even though pandemics have a worldwide extension, their impacts on the population are unbalanced. [1] The unequal distribution of health care services amongst different countries is the challenging world facing in the 21st century. Surgery has been identified as a major modifiable factor in saving millions of lives. Global surgery was thus introduced to address the issue of people who lack essential surgical care especially in low to middle-income countries (LMIC).

Global Surgery is defined as an area of study, research, practice, and advocacy that aims to improve health outcomes and achieve health equity for all people in need of surgical and anesthetic treatment, with particular emphasis on underserved populations and populations in crisis. [7] In this context Global neurosurgery encompass those who suffer from neurosurgical conditions or those who need neurosurgical care. [8] Global neurosurgery as a new paradigm in care offers the possibility of incorporating the best evidence-based standards of care. Development of research projects and policies. In the Bogota Declaration of Global neurosurgery, 2016 recommendation for amplification of access, alignment of all neurosurgical activity, the advancement of relevant research, assimilation of neurosurgical capacity, and advocacy of universal coverage was made. [9] It has been estimated that 44% of the world's neurosurgeons reside in high-income countries whereas more than 80% of the disease arises in LMICs. [6] To mitigate this a global neurosurgical collaboration is required to increase the workforce and strengthen the surgical service.

There has been less consideration coordinated toward the effect of COVID-19 in LMICs. According to a report, nine-in-ten spine cases are in LMICs, and the spine cases make up 39% of the operative cases in LMICs. [6] Allowing access to surgical procedures to all patients who require them is not a privilege, it is an obligation of the nations. Bangladesh is a country located in Southeast Asia with a population of 164,689,383 people according to UN data. But with around 170 neurosurgeons working in 13 government and few military and private hospitals, it falls way short of providing essential neurosurgical care. Making things worse the current pandemic is making essential neurosurgical care more inaccessible and backlogging of chronic neurosurgical conditions.

During the time of COVID-19 pandemic prioritizing neurosurgical patients has been a major challenge in Bangladesh like many other affected countries of the world. Inappropriate and inadequate resource allocation has been a major obstacle for the health system to function fairly providing safety to the patients. Neurosurgeons are being redeployed to help their colleagues in the hospitals where there was a shortage of personnel. Although this task-sharing and task-shifting are very much necessary in the pandemic situation it resulted in curtailing of neurosurgical service in some instances. [10] There has been an enormous abatement in operative cases which has altogether affected the training of neurosurgical residents as they rely upon elective careful volume to sharpen their clinical and operative skills. [11] One of the key elements of providing standard neurosurgical service worldwide is the training of capable and competent neurosurgeons. The country offers post-graduation in neurosurgery in 4 centers. Also, as a part of the commitment for Global neurosurgery, Bangladesh offers post-graduation to neighboring countries. During recent times many neurosurgeons of Nepal have done their post-graduation from Bangladesh. This systemic and rigorous training process has been seriously hampered in the current situation. Although many international conferences and courses were canceled, these were replaced by numerous webinars arranged by different societies where world-renowned neurosurgeons shared their experience and gave their insight. But these opportunities certainly do not make up for the actual training with the first-hand experience. Like most other LMIC countries Bangladesh lack behind in keeping and managing patient data. In any efficient health system, patient data is the key to efficient management. This lack of centralized record-keeping and patient safety disrupts the accountability of service to the patients. [12] Apart from the cessation of certain academic activities, the current pandemic has also taken its toll on the country's research activities. The absence of local research on local needs impedes evidence-based practice. [7]

It is estimated that approximately 13.8 million new operative cases exist worldwide each year. Of these, nearly 5.2 million cases will require additional 23,300 neurosurgeons from LMICs to address them[6].

As Global health activities have set to a different focus, the Global surgery's niche part Global neurosurgery as a certainty is slowed down. The huge burden on the health care system for the disease as well as the action required to prevent it's spread has significantly affected the neurosurgical service of LMIC like Bangladesh. The already loaded of neurosurgical service in an LMIC like Bangladesh is being overburdened by this pandemic. Like any other low-income country Bangladesh is facing difficult challenges in carrying out evidence-based surgical procedures, insufficient research activity as a part of the residency, the economic crisis affecting the country's health sector leading to an indirect impact on neurosurgical patient's budget allocation in health only 5.15% (Tk 292 billion), health insurance not here, lack of health coverage and difficulty in following up the patients. It is during this time of Global crises the need for Global neurosurgical initiatives to come forward and rise to cause of essential and equal neurosurgical care.

Abbreviations

LMIC: Low to middle-income countries

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The data used in this study are available from the corresponding author on a feasible request.

Competing interests

The authors declare that they have no competing interests.

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Author's contributions

RAK, MMR, AA, EGB and LRMS collected data, wrote and reviewed the manuscript. All authors read and approved the final manuscript.

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Giant dorsal sacral meningocele in a child

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ABSTRACT

Sacral meningoceles are uncommon congenital lesions, usually described in the anterior or lateral position, and they typically are asymptomatic [1,7]. A nine-years male child presented with a progressively increasing swelling over the lumbosacral region since birth.

Keywords
sacral meningocele, lipomyelomeningocele. MRI, meningocele, sacral mass

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Sacral meningoceles are uncommon congenital lesions, usually described in anterior or lateral position and are typically asymptomatic.[1-7] A nine year male child presented with a progressively increasing swelling over lumbo-sacral region since birth. There was no history of any bowel or bladder dysfunctions. Motor and sensory examination was normal. Planters were flexor. Rectal tone was normal. Gait was normal. Results of her sensory, rectal tone and lower limbs motor exams were within normal limits. There were no abnormal skin lesions, skeletal deformities, abnormal sinus or swellings. A physical examination of the patient showed a soft, 4 x 4-cm fluctuant and non-pulsatile mass over sacral region, completely with normal skin without any stigmata. The transillumination test was positive. Routine blood investigations were normal. Magnetic resonance imaging (MRI) of the lumbo-sacral spine showed a large, well-defined cystic over sacrum without any no evidence of internal echoes, solid component or septae (Figure-1 and 2). There was evidence of communication between the cyst and the spinal canal. The patient underwent surgical excision of the swelling and repair of the sac. The large cyst was entered and found to contain clear CSF in a terminal continuation of the spinal subarachnoid space. There was no neural tissue in the sac. And there was no evidence of tethering. Postoperatively, the child had normal neurological and urological function. CT of the brain did not show any evidence of hydrocephalus. He developed CSF leak in post-operative and the defect was repaired with pedicel graft.

A meningocele a developmental defect in the dura resulting in an outpouching of leptomeninges through defect covered with only a layer of skin. [4] Most of the sacral meningoceles are asymptomatic with a soft tissue mass; they produce clinical symptoms depending on their

proximity to the spinal cord and nerve roots (e.g. unexplained radiating or low back pain, or sensory or motor deficits, atypical bowel dysfunction [1-4, 8, 9] The differential diagnosis for the mass lesions in children in sacro-coccygeal area includes meningocele, myelomeningocele, myelocystocele, teratoma, lipoma, hamartoma, lymphangioma, hemangioma, chordoma, and ependymoma. [10-15] MRI is the investigation of choice as it will better delineate the details of the sac and its contents. Also it will help to know the extent of the spinal cord and position of the nerve roots. [3] Radiographs may reveal erosion and widening in the sacral bone, [9] scalloping of the pedicles, laminae and vertebral bodies adjacent to the meningocele resulting in an enlargement of the spinal canal. [16, 17 18]Indications for surgical repair include clinically symptomatic patients [1-3, 8, 19] or if the lesions located in an area where it has greater risk of mechanical trauma or rupture (as in the present case).

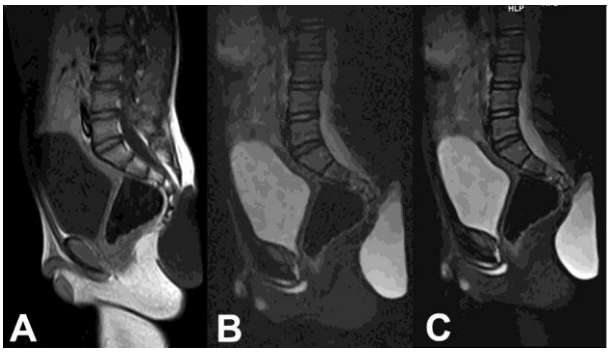

Figure 1. MRI of the lumbo-sacral spine T1W, FLAIR and T2W sagittal images showing large, well-defined cystic lesion over sacrum (signal intensity similar to cerebrospinal fluid) without any no evidence of internal echoes, solid component or septae.

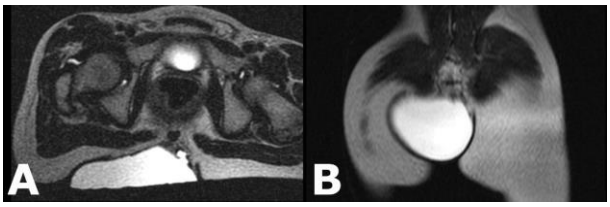

Figure 2. MRI of the lumbo-sacral spine T2W axial images showing large, well-defined cystic lesion over sacrum (signal intensity similar to cerebrospinal fluid).

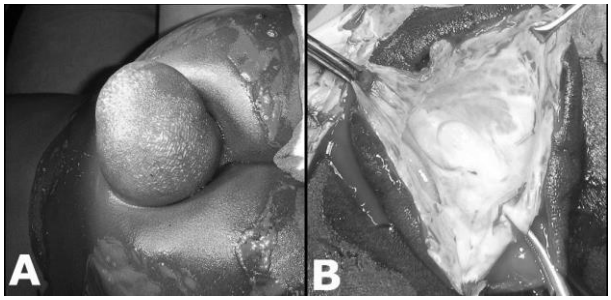

Figure 3. Intraoperative images showing excision and repair of the meningocele.

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