European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 10, Issue 03, 2023

Original Research Article

A study of challenges faced in the management of giant meningiomas

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Abstract

Purpose: Meningiomas are most common tumours of human population, most cases being incidentalomas. Giant meningiomas (>50mm) demand thorough evaluation and planning for management to avoid untoward events. This study was mainly undertaken to understand technical factors and challenges faced in dealing with giant meningiomas.

Methods: The data of the 45 giant meningioma cases, diagnosed and operated on during the study period, was collected from the preoperative, intraoperative and postoperative periods. The data of neurological examination was also collected retrospectively. The data was compiled and analyzed.

Results: Majority of the patients were female and middle aged. Seizures was the most common presentation. The predominant location of the lesion was in parasagittal region and maximum size was upto 90 mm. Neuronavigation was used for precision of craniotomy. Venogram was not routinely performed even in tumors having sinus involvement. More than half of the cases had Simpson grade 1 excision, almost one third had grade two excision. Most of the higher grade excisions were seen in tumors abutting major venous sinuses. Posterior fossa lesions were found to have relatively more complications. Two patients had morbidity and one patient had mortality in this study.

Conclusions: A good pre-operative planning including temporary CSF drainage if required, is essential for good results. The size of the lesion does not necessarily seem to influence the outcome.

Keywords: Meningioma, Simpson grading, craniotomy, pre-operative planning, mortality

1. Introduction

Meningiomas are the most common benign brain tumors in human population [1]. Many times they are only incidentalomas. Because of their benign nature they are slow growing and consequently can reach sizeable dimensions before presenting clinically. Due to the same reason sometimes they can reach very large dimensions. In general, meningiomas larger than 30 mm are called large meningiomas and those bigger than 50 mm are called giant meningiomas [2, 3]. Certain studies classify those bigger than 60 mm as giant meningiomas [4]. Large and giant meningiomas can pose technical challenges in their management which could further be compounded by their location making a thorough evaluation and planning mandatory. Giant meningiomas particularly have associated neurovascular involvement making radical removal technically challenging [2]. Certain publications have reported poorer prognosis for large meningiomas [5]. Many different strategies have been adopted for their management depending on the location and associated clinicoradiological presentations ranging from radical resections [6, 7] to subtotal resections [8, 9, 2]. The author presents a detailed analysis of the technical nuances and challenges faced in the management of giant meningiomas in a single institution by a single surgeon.

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2. Material and Methods

The study was conducted at our institute on patients of giant intracranial meningiomas (without extracranial extension) operated from November, 2016 to September, 2019 by the same surgeon. The ethical committee approval was obtained from the same institute before the start of the study.

The retrospective study included 45 cases of giant meningiomas that were operated on by a single surgeon (one of the authors), during the study period. The data was collected from the preoperative, intraoperative and postoperative periods, including details of the thorough neurological examination done on a daily basis throughout the inpatient course. A contrast MRI of the brain was done for establishing the diagnosis and to make an operative plan. The largest dimension of the three axes of a lesion on the MRI is taken as the size of the tumor. For this study, meningiomas greater than 50 mm are considered as giant meningiomas. When required by the location, a CT angiogram and/or venogram was also done. Neuronavigation guidance was used for planning supratentorial craniotomy and to avoid adjacent vital structures. Posterior fossa lesions were approached in the prone or park bench position. Supratentorial lesions were operated in the supine position with head turned as required. No additional intraoperative monitoring was adopted. Depending on the location, the approaches used were parasagittal craniotomies extending across the sinus for parasagittal meningiomas, supraorbital bifrontal approach for olfactory groove meningiomas, pterional approach for sphenoid wing meningioma, suboccipital approach for convexity and infratentorial falcotentorial meningiomas, retromastoid approach for transverse and sigmoid sinus meningiomas, retromastoid transpetrosal approach for a petroclival meningioma. During surgery the patient vitals were monitored and any need for transfusion assessed and was given an intraoperative transfusion if the blood loss was more than 15% of the body mass. Intraoperative events like, arachnoid breach, injury to the adjacent normal brain, significant vascular injuries (arterial and venous), the degree of surgical resection (Simpson grade) were assessed in each patient. The patients were monitored for a postoperative period varying from 3 days to one week. The end result was determined as discharge or death at the end of one week.

3. Results

3.1. Presentation

The presenting features of the 45 patients is represented in Table 1.

3.2. Location

Most of the giant meningiomas were noticed in the supratentorial space, parasagittal location (17) being the most common and that too, the left side (10:7). Two of the patients had a parafalcine location. Next common location was the sphenoid wing (seven in total) again more on the left side than the right (six on the left side). Amongst the seven sphenoid wing meningiomas six of the giant meningiomas were from the lateral one third. The next most common location observed was the olfactory groove with seven of the lesions noted in this location. Six patients along the convexity (three on the right and three on the left), two in the orbital roof region and one in the tubercular sella region were noted.

Amongst the total of four posterior fossa lesions there was one each case of petroclival meningioma, petrosigmoid meningioma, tentorial meningioma abutting the torcula, and a petrous meningioma. Except for the petroclival meningioma all were seen in females and the predominant presenting complaint was imbalance in walking with ataxia on examination. The patient with a petrous meningioma had vertigo also as a presenting complaint and none of these three meningiomas had any cranial nerve involvement. The patient with petroclival meningioma had brainstem compression with sensorimotor involvement and lower cranial

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nerve involvement.

3.3. Size of the lesion

Summarized in Table 2.

3.4. Additional imaging

The tentorial meningioma extending to torcula was evaluated by a CT venogram to assess the dominance of the sinus and relevant surgical anatomy. Also an MR venogram was done for the meningioma as it was seen abutting the sigmoid sinus. Venogram was not done routinely for parasagittal meningiomas.

3.5. Surgical procedure

For most of the cases preoperative planning was executed during surgery. Neuronavigation was used for precision of craniotomy for supratentorial lesions. The petroclival lesion was initially approached through retromastoid, retrolabyrinthine presigmoid approach and a redo surgery was attempted with a routine retrosigmoid approach in the second sitting. One case of medial one third sphenoid wing meningioma and a case of olfactory groove meningioma had to be reoperated as adequate retraction could not be achieved due to edema during the initial procedure. One patient with left convexity meningioma was operated in some other center and was reoperated with an extension of the preexisting left frontal craniotomy.
Nine patients needed transfusions. One patient with parasagittal meningioma was transfused preoperatively due to anemic status and six others with parasagittal meningiomas needed transfusion during surgery due to bleeding. Two of the four posterior fossa lesions needed transfusion, one with the tentorial lesion abutting the torcula as there was bleeding from torcular area towards the final reaches. The patient with petroclival meningioma had to be transfused and reoperated.

3.6. Extent of excision

Twenty seven of the total patients had a Simpson grade 1 excision, fourteen had a grade 2 excision, three had a grade 3 excision and one patient had a grade 4 excision. All the olfactory groove meningiomas had a grade 1 resection and also the tuberculum sella meningioma, falcine lesions and petrous meningioma. Most of the grade 2 excisions were seen in parasagittal meningiomas or in other words parasagittal meningiomas had the maximum grade 2 excisions (12 out of the 17 attributed to sinus abutment). Two of the convexity meningiomas had a grade 2 excision, one was a cystic meningioma with improper delineation of planes once cyst ruptured and the other was a redo surgery with improper planes in close proximity to the motor speech area with adhesions. Three patients had grade 3 excision, one was a patient of sphenoid wing meningioma, the largest meningioma of the study with MCA peripheral branch involvement while rest of the sphenoid wing meningiomas had a grade 1 resection. The second was the petrosigmoid meningioma with the sigmoid part left out due to bleeding during resection attempts and the third was the tentorial meningioma reaching the torcula. Handling of the sigmoid attachment was met with sigmoid sinus bleed compromising total excision in the petrosigmoid meningioma and torcular bleed compromised excision of tentorial meningioma. The patient with petroclival meningioma was the only patient in the study who had a grade 4 excision.

3.7. Morbidity and mortality

Parasagittal meningiomas had the least morbidity in this study as only one patient had a partial foot drop (due to surgery). One of the 6 olfactory groove meningiomas had a

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postoperative smell loss (three had at presentation). One patient with a lateral sphenoid wing meningioma had hemiparesis. Recurrent convexity meningioma patient had a mild exaggeration of motor aphasia post-surgery. There were no mortalities in supratentorial lesions.

There was one mortality among the four patients of posterior fossa meningiomas. Torcular region meningioma patient succumbed to pansinus block.

4. Discussion

Meningiomas are seen more commonly in females than males[6], as is in our observation, where females had them twice more commonly than males (69% vs 31%). Giant meningiomas are usually challenging because of their sheer size and also because of the pattern of their growth in that they usually involve adjacent important neurovascular structures[2]. The ideal goal of total excision might be quite challenging many times in giant meningiomas.

4.1. Presentation

Presentation depends on the location of the lesions. In our series' most of the lesions were supratentorial (91%), the commonest presentation was seizures (64%). Except for olfactory groove meningiomas which predominantly presented with olfaction loss, neurological manifestations with giant meningiomas were seen less commonly relatively to their size and were seen only as a presentation of mass effect rather than any deficits due to primary brain involvement including the two cases where brain was seen to be involved (a case of convexity meningioma which turned out to be atypical meningioma and one sphenoid wing meningioma which had significant perivascular involvement both of which didn't have any significant deficits preoperatively). Few of the parasagittal meningiomas arising from the posterior aspect of the sinus had contralateral hemiparesis which resolved after surgery. Lesions particularly from the sphenoid wing region had language function abnormalities owing to close proximity to the language centers. Only the petroclival meningioma was the case in the series with significant preoperative deficits including sensorimotor and cranial nerve palsies. All of the tumors being giant meningiomas, presentation with either headache or altered sensorium was relatively less indicating slow growing nature of the lesions and the plasticity of the brain.

4.2. Location

Most of the giant meningiomas in the study were parasagittal in location, followed by sphenoid wing, olfactory groove and convexity in that order. There were only globular sphenoid wing meningiomas in the study. The maximum dimensions of the tumors were seen in sphenoid wing more so the lateral sphenoid wing, convexity and the parasagittal location in that order possibly because they were towards the surface or they were away from temporal lobe leading to delayed presentation Considering the more accessible nature of these locations, total or near total excision of the lesions was not difficult to achieve. Major complications noticed in this study were related to posterior fossa tumors.

4.3. Size

There is no exact definition of giant meningioma in the literature. Different authors and studies have considered meningiomas of varying sizes as giant meningioma. As in many of the publications, tumors >50 mm are usually identified as giant meningiomas and similarly in our study tumor diameter of 50 mm was considered as the lower limit.

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4.4. Surgery

4.4.1. Extent of excision

The ideal goal of any tumor surgery would be a total excision. But this might be quite challenging many times in giant meningiomas. In our study we achieved Simpson's grade1 excision in 27 patients, grade 2 in 14 patients, grade 3 in 3 patients and grade 4 in 1 patient. Three of the 4 patients with higher Simpson grade resection were in the posterior fossa.

There are certain recent documentations of en block removal of even large meningiomas[8], though it can be undertaken for smaller meningiomas particularly the convexity lesions. En block removal of larger lesions was wrought with serious postoperative complications in the past hence the concept of internal tumoral decompression has been proposed. The principle of internal tumoral decompression was followed in all cases in our series.

The Simpson paper and many other articles had highlighted the importance of radical surgical excision of meningiomas, but it might not always be feasible with larger meningiomas. Now a days there is a trend towards a less radical approach particularly towards skull base meningiomas for a better quality of life but age again plays a greater role in the decision. Younger patients should preferably be offered a more radical excision to avoid early recurrences [7].

4.4.2. Technical difficulties and Complications

Among the 4 tumors in the posterior fossa that were operated, only two patients had an uneventful course and were discharged in a reasonable time frame. The one patient with a tentorial meningioma had the tumor attached to dominant transverse sinus on the right side and was operated by a subtotal resection of the tumor due to torrential bleeding from the sinus compromising further surgery. Hemostasis was secured during surgery by hemostatic agents and postoperative scans revealed no hemorrhage in the postoperative bed but the patient's GCS remained low. A postoperative venogram demonstrated a block in all the sinuses except the left transverse sinus which showed a partial flow and finally patient could not be salvaged. This was possibly consequent to the blockade of flow in the dominant transverse sinus leading to pan sinus block. Similar occurrence with torcular and tectorial large meningiomas has been reported by Carlos Eduardo da selva *et al*. in their paper [7].

One patient had a huge petrosal meningioma filling more than 40% of posterior fossa. The retraction of cerebellum was quite difficult and multiple careful attempts were made to evacuate CSF (Cerebro spinal Fluid) from cistern magna and with difficult retraction the tumor was removed in to. In retrospective review of the MRI and literature, the realization was that CSF could have been released in a better way by opening the dura below the level of tonsillar herniation that occurred due to the mass effect of the lesion.

The one case of left sphenoid wing meningioma involving the medial one third also had similar issues. Considering the large size of the lesion a bigger craniotomy was done and dura was opened widely despite which the tumor could not be accessed easily in the first attempt and retraction induced venous congestion compelled closure in the first attempt. After controlling the edema, tumor was re-approached in a different sitting with good CSF release enabling complete excision of the lesion without any deficits.

Another similar incidence was noted with a giant olfactory groove meningioma about 70 mm in maximum dimension, which could not be operated in the first attempt in the initial phase of the study and had to be re-operated at week later, with a good CSF release.

In any case excision of giant lesions would pose technical challenges but things could be eased out by a good CSF release. In view of giant lesions with significant mass effect and sometimes midline shift lumbar drains sounds dangerous but controlled lumbar drain insertion by closing it immediately after insertion and gradually releasing sounds more practical as practiced by Farooq *et al*. in their paper on large olfactory groove meningiomas [11].

Preoperative steroids have been shown to be very useful in controlling edema but also better

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surgical tolerance of the brain, lesser surgical trauma and hence better postoperative recovery [12].

One of the left sided sphenoid wing meningioma (lateral one third) was very large (almost 90 mm) making it difficult to identify the planes due to multiple pial breaches. The patient landed up with right hemiparesis postoperatively owing to inadvertent injury to one of the peripheral branches of the middle cerebral artery. Involvement of vascular structures in sphenocavernous meningiomas is a well reported entity [2, 7]. Consequently conservative surgical resections have been proposed for sphenoid region meningiomas with vascular invasion frore better functional outcomes [13, 14].

A case of giant petroclival meningioma with multiple cranial nerve palsies and motor deficits in the form of quadriparesis in a 7 year old kid, was approached through a combined left sided retrosigmoid and presigmoid transpetrosal route with a subtotal excision of the tumor as the surgical duration was quite prolonged compounded by bleeding from the lesion. In a different setting the patient was reexplored through the retrosigmoid route with near total excise of the lesion. Postoperatively the condition of the patient wasn't much different. In a retrospective analysis of the case it was felt that possibly only retrosigmoid route alone would have sufficed in the case avoiding the time and risk of a presigmoid traspetrosal route risking the semicircular canal. Giant clival and petroclival meningiomas may have to be accessed in more than one stages for radical excision as observed by Laligam.N.Shekar *et al.* [15], usually complicated by their consistency, vascularity and encasement of cranial nerves as was observed in our case. In a study by da silva CE *et al.* [7] petroclival meningiomas were the most challenging tumors because of their neurovascular involvements. In their study also, this was the only topography with major motor impairments.

Other cases were sigmoid sinus meningioma and two falcotentorial meningiomas all of which were excised near totally to Simpson grade 2. The attachment to the sinus was left in all the cases and was coagulated well.

Parasagittal meningiomas though larger than their posterior fossa counterparts, were surgically less bothersome. One of the cases in the initial part of the study period was a right parasagittal meningioma with left foot drop. It was operated by a frontoparietal craniotomy. The tumor turned out to be an atypical meningioma requiring postoperative radiotherapy. There was difficulty in accessing the falcine part of the tumor. Then onwards all the craniotomies for giant parasagittal meningiomas were done beyond the sinus for adequate access and ease of excision. In two cases the draining veins were seen crossing over the tumors and had to be carefully dissected making the excision difficult with prolonged surgical time. Most of the cases of parasagittal meningiomas had a grade 2 resection leaving behind the part attached to sinus which was coagulated thoroughly. In a study be Ricci A *et al.* [6] a total of 75 patients underwent grade 1 and grade 2 resections. According to Moon-Soo Han *et al*. the safest strategy to tackle lesions involving the sinus would be to do the maximum safe resection and manage the residue with different modes of radiation. According to them grade1 or 2 resection with removal of sinus or its wall did not significantly alter recurrences[8]. In our study parasagittal meningiomas were among the subgroup with least morbidity. On the contrary Hirofumi Oyama reported that parasagittal meningiomas had unusually bad results[5]. Pial damage was seen in most cases of parasagittal meningiomas in our series but no resultant deficits were noted.

There was only one patient among parasagittal meningiomas who developed mild foot drop postoperatively, which recovered within the first week. This was quite less compared to tumors reaching a maximum size of up to 80 mm.

The olfactory groove meningiomas were accessed by a basifrontal approach and were relatively easier in terms of excision. One of the tumors was approached by cutting the attachment of falx and the other was operated by working around the falx. All the cases were approached only by bicoronal subfrontal approach. In a study by Farooq G *et al.* [11], which included 19 patients of olfactory groove meningioma, authors recommend a bicoronal sub frontal approach and they achieved grade 1 excision in 18 of the 19 patients. None of the cases had a CSF leak in the current series. Considering the one patient who had a resurgery it

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seems beneficial to have a lumbar drain preoperatively for easier surgery.

Among the convexity meningiomas in the series, one was a left perisylvian recurrent meningioma. There were pial breaches reaching the tumor and also during tumor dissection and in an attempt to avoid significant injuries grade 2 excision was done. Patient had a mild exaggeration of motor speech defect that was there at presentation.

The cystic meningioma was a tough tumor. As the tumor dissection begun, the cyst ruptured releasing the fluid and subsequently making the surgery very difficult as the tumor plane was lost at many places. As the sylvian area vessels and insula were at risk due to improper planes, grade 2 resection only was attempted. Ideally cystic meningiomas need a grade 1 resection just like any other meningioma [16]. This case was actually approached as an intraaxial lesion as the diagnosis was not clear before surgery on the imaging. Owing to difficult dissection considering the morphology and location only grade 2 resection could be achieved.

The duration of the surgeries was almost 6-8 hours in most of the cases. Most of the cases had a pial breach during surgery though all the attempts were made to avoid the same.

There was only one mortality in the series which was a direct consequence of the surgical procedure. Four other patients had a notable postoperative deficit and one patient with the petroclival meningioma continued to have the preoperative clinical status.

Mario Nazerino noted few important factors influencing patient outcome like grade of brain atrophy, grade of brain edema adjacent to the lesion, location of the tumor, extent of neurovascular entrapment and intravascular fluid management during surgery [17]. Hence a good anesthesia backup is one of the essential factors other than the surgical skill.

Large and giant meningiomas are technically challenging, but with the current surgical techniques and technology, gross total resection can be achieved with minimal morbidity and mortality with improvement in symptomatology after surgery even in a single stage surgery [17, 18].

5. Conclusions

Giant meningiomas pose a great challenge for surgeon due to technical difficulties in terms of size and difficulty of dissection. A good preoperative planning including considering temporary CSF drainage is essential for good results. Size does not necessarily seem to influence outcome as much as the location particularly considering the posterior fossa lesions. A grade 1 resection of large and giant meningiomas may not always be feasible nor may need to be attempted for better clinical outcomes. A preoperative pial damage may not necessarily lead to poorer outcomes. Though giant meningiomas may take a longer surgical time final results, when all the above factors are carefully considered, it could be gratifying.

Ethical Statement

All human and animal studies have been approved by the institute ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Conflict of interest

The authors declare that they have no conflict of interest

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