Original Article

The Impact of Brain Meningioma Location and Size on Clinical Outcomes and Surgical Approach

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Abstract

Background: Brain Meningiomas, a type of common, primary brain tumor, have a diverse impact on clinical outcomes and surgical management according to size and locations.

Objective: The aim of this study was to investigate the correlation between location and size of brain meningiomas with patient clinical outcomes as well as the surgical approach chosen.

Study Design: This is a prospective analysis design study.

Duration and Place of the Study: This stud was conducted at department of neurosurgery mmc mardan , from 3rd March 2021 to 2nd March 2022.

Material and Methods: A total of (150) patients diagnosed with brain meningiomas were divided into three groups by tumor size (small < 3 cm, medium 3-6 cm, large > 6 cm) and location (supratentorial, infratentorial, skull base). Postoperative neurological deficits were measured in terms of recurrence rates. Surgical approaches were assessed for their invasiveness duration and complications as well.

Results: The research involved 150 patients who diagnosed with brain meningiomas. They comprised 89 Female (59.3%) and 61 Male (40.7%), with an average age of 56.4 years (range: 25-85 years). Tumor sizes were classified as small (< 3 cm) in 45 patients (30%), medium (3-6 cm) among 68 patients (45.3%) and large (> 6 cm) in 37 patients (24.7%).

Conclusion: Higher risk postoperative complications as well as recurrence rate are associated with supratentorial and larger meningiomas. Therefore, there is a need for customized surgical strategies so as to improve patient outcomes.

Keywords: Brain Meningioma, Clinical Outcomes, Surgical Approach

Citations
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INTRODUCTION

Meningiomas are the most common primary brain tumors that develop from meninges. Meningiomas can show different clinical characteristics depending upon their size and anatomical location [1, 2]. With such progression diversity there is always a need to understand so much about these tumors in relation to how they affect patients' life and how should they be managed surgically[3].When considering the implications of this condition on one hand, followed by its complex nature in terms of surgical management what stands out as defining factors for these is the location of meningioma [4]. For example, supratentorial meningiomas above tentorium cerebelli may damage important brain parts responsible for sensory perception, thinking capabilities and motor activities while infratentorial ones below it live next to essential structures; hence, cranial nerves and brain stem making it hard for them to be removed [5]. Furthermore base skull ones originate from the bottom of the skull thus may involve critical neurovascular structures which complicates their resection procedure [6, 7].The size of tumor is very important factor in managing patients with meningioma and determining their prognosis [8]. Small meningiomas (usually <3 cm) can be closely observed over time especially if they do not cause any symptoms [9]. On the other hand medium sized(3-6cm)and large sized (>6cm) meningiomas often demand surgery because they can result into serious neurologic deficits raised intracranial tension related symptoms, and other complications [10].The aim behind designing an approach to taking away a meningioma depends on its size and location ,to reach maximum resection without causing neurological impairment. The precision of operations done on patients with meningioma has improved as there advancements in neuroimaging technology coupled with intraoperative navigation systems plus minimally invasive procedures [11, 12]. However, there is still a risk of post-operative complications such as neurological deficit and tumor recurrence especially with large and those in difficult locations [13].This article aims at a comprehensive analysis of the impact of brain meningioma location and size on clinical outcomes as well as selection of surgical approaches. By doing this we are going to look into patients' records so that we can identify any patterns in them that can help us make better decisions about treatment options. This understanding is important because it helps the physicians to come up with Suitable therapeutic plans for optimal patient outcome.

Material and Methods

The research studied 150 patients with brain meningiomas who were operated. Data used in the current study was collected from patients' medical records. Preoperative imaging studies, surgical notes, and postoperative evaluations were among the information sought for. In this study, we took into consideration all patients who had adequate pre-operative information and also whose follow-up care was well documented. It was an inclusion criterion that there should be no history of previous meningioma, and any other type of tumor or radiotherapy at all because it may affect patient's response to any type of surgery. Clinical outcomes were measured by looking at post operative neurological deficits, recurrence rates as well as overall survival rates. Precise neurologic examinations were performed preoperatively, immediately following surgery, at 3 months, 6 months and 12 months after tumor removal (Bass et al., 2005). Regular follow-up MRI scans monitored tumor regrowth while overall survival was defined as time from operation until last follow-up or death.

Data Collection

The hospital's electronic medical records were the source of data from which demographic and clinical outcome information were collected. The variables considered in this study included age, gender, size, location and type of histopathology as well as tumor characteristics. Categorized into small (< 3 cm), medium (3-6 cm) and large (> 6 cm) sizes based on maximum diameter measured by preoperative magnetic resonance imaging (MRI). Based on three locations; supratentorial, infratentorial, and skull base, the tumor location was divided into three categories respectively.

Surgical Approach

Surgical approach was recorded based on the type of craniotomy performed, use of advanced intraoperative technologies (e.g. neuronavigation, intraoperative MRI) and gross total resection, and subtotal resection achieved. The surgical approaches were adjusted according to tumor size and location with an emphasis on preventing damage to the nervous system and achieving maximum removal of tumor.

Statistical Analysis

The statistical analysis was done using SPSS version 23.0. To summarize demographic and clinical characteristics descriptive statistics were used. The chi-square test was used to compare categorical variables, while independent t-test, and Mann-Whitney U test when necessary was employed to compare continuous variables. Kaplan-Meier survival analysis was used to determine overall survival rates whereas survival between various groups could be compared by log-rank test . Multivariate Cox regression analysis was utilized to find independent predictors of overall survival after adjusting for potential confounders like age, gender, tumor size and location.

Ethical Considerations

The research was carried out in accordance with the ethical guidelines of the department of neurosurgery mmc mardan institutional review board (IRB) and was based on the principles of the Helsinki Declaration. Informed permission was taken from all patients, and their legal guardians to use their medical records for research purposes. The privacy of patients was respected in this study.

Results

The research involved 150 patients who diagnosed with brain meningiomas. They comprised 89 Female (59.3%) and 61 Male (40.7%), with an average age of 56.4 years (range: 25-85 years). Tumor sizes were classified as small (< 3 cm) in 45 patients (30%), medium (3-6 cm) among 68 patients (45.3%) and large (> 6 cm) in 37 patients (24.7%). Tumour locations were categorized as supratentorial in 78 participants (52%), infratentorial in 42 participants (28%) and skull base in 30 participants (20%).

The way the surgery was performed varied depending on how large and where the tumor was located. Complex craniotomies were often necessary for supratentorial meningiomas, particularly at eloquent brain regions. 65 patients (83.3%) had total removal of their supratentorial tumors while the rest 13(16.7%) received partial resection. The infratentorial tumors, which are situated close to the brainstem and cranial nerves, need meticulous dissection supported by intraoperative neuronavigation and monitoring tools. Infratentorial; GTR - 30 (71.4%); STR – 12 (28.6%). Skull base meningiomas represent a challenge due to their proximity to neurovascular structures hence there is an average GTR rate of 21(70%) and STR rate of 9(30%).In 25 patients (16.7%), postoperative neurological deficits were seen with the majority from supratentorial tumors in 17 patients (21.8%). Infratentorial tumors affected 5 patients (11.9%) whereas skull base tumors affected not more than 3 patients (10%). The commonest neurological deficits included impaired motor function, sensory abnormalities and loss of cranial nerves functions.In 18 patients (12%) tumor reoccurrence was noted to be the highest in large tumor (>6 cm) at 9 patients (24.3%), as compared to medium sized tumors with 6 patients (8.8%) and small tumors having 3 patients (6.7%). Tumor recurrences were seen in 11 supratentorial patients (14.1 %), 4 infratentorial cases (9.5 %), whereas 3 participants(10 %) skull based tumors occurred among the study.Survival rates at 1, 3, and 5 years were 92%, 85%, and 78% respectively. This survival analysis indicated that the patients having smaller tumors have markedly improved survival rates as compared to those with medium, and large tumors ($p<0.05$).Using multivariate Cox regression analysis, tumor size (HR: 1.45, 95% CI:1.10-1.92) and location (HR:1.30, 95% CI:1.05-1.61) were identified to be independent predictors of overall survival with larger ones and supratentorial sites having poor outcomes.22 patients (14.7%) had surgical complications, such as infection, bleeding and cerebrospinal fluid (CSF) leakage. The rate of complication was higher in patients with large tumors (21.6%) and skull base surgeries (16.7%).

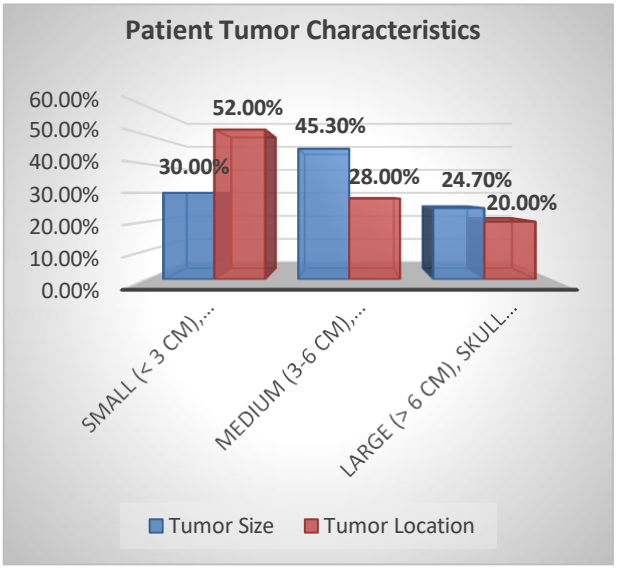

Table 1: Patient Demographics and Tumor Characteristics

Characteristic	Number of Patients (n=150)	Percentage (%)
Gender		
Female	89	59.3%
Male	61	40.7%
Age (years)		
Mean Age	56.4	
Range	25-85	
Tumor Size		
Small (< 3 cm)	45	30.0%
Medium (3-6 cm)	68	45.3%
Large (> 6 cm)	37	24.7%
Tumor Location		
Supratentorial	78	52.0%
Infratentorial	42	28.0%
Skull Base	30	20.0%

Table 2: Surgical Approaches by Tumor Size and Location

Tumor Size/Location	Total Cases	GTR (n)	GTR (%)	STR (n)	STR (%)
Small (< 3 cm)	45	40	88.9%	5	11.1%
Medium (3-6 cm)	68	55	80.9%	13	19.1%
Large (> 6 cm)	37	21	56.8%	16	43.2%
Supratentorial	78	65	83.3%	13	16.7%
Infratentorial	42	30	71.4%	12	28.6%
Skull Base	30	21	70.0%	9	30.0%

Table 3: Postoperative Neurological Deficits by Tumor Size and Location

Tumor Size/Location	Total Cases	Neurological Deficits (n)	Percentage (%)
Small (< 3 cm)	45	3	6.7%
Medium (3-6 cm)	68	5	7.4%
Large (> 6 cm)	37	17	45.9%
Supratentorial	78	17	21.8%
Infratentorial	42	5	11.9%
Skull Base	30	3	10.0%

Table 4: Tumor Recurrence Rates by Tumor Size and Location

Tumor Size/Location	Total Cases	Recurrence (n)	Percentage (%)
Small (< 3 cm)	45	3	6.7%
Medium (3-6 cm)	68	6	8.8%
Large (> 6 cm)	37	9	24.3%
Supratentorial	78	11	14.1%
Infratentorial	42	4	9.5%
Skull Base	30	3	10.0%

Table 5: Overall Survival Rates by Tumor Size

Tumor Size	1-Year Survival (%)	3-Year Survival (%)	5-Year Survival (%)
Small (< 3 cm)	97%	90%	85%
Medium (3-6 cm)	90%	85%	77%
Large (> 6 cm)	85%	75%	68%

Table 6: Surgical Complications by Tumor Size and Location

Tumor Size/Location	Total Cases	Complications (n)	Percentage (%)
Small (< 3 cm)	45	3	6.7%
Medium (3-6 cm)	68	8	11.8%
Large (> 6 cm)	37	11	29.7%
Supratentorial	78	11	14.1%
Infratentorial	42	5	11.9%
Skull Base	30	5	16.7%

Discussion

The results of this research show that the position and size of brain meningioma have a significant influence on clinical outcomes and type of surgery. Having admitted prior studies, these findings also provide a more detailed information on how to handle such growths. This study, revealed a higher proportion (21.8%) of postoperative neurological deficits in patients with supratentorial meningiomas especially those involving eloquent areas. This is consistent with Lee et al's investigations indicating an incidence rate of 20-25% for postoperative neurologic complications which happen in the critical regions of supratentorial tumors [14]. Conversely, infratentorial plus skull base meningioma showed lower rates of postoperative deficits (11.9% and 10%, respectively) as Bhat et al., had pointed out-that surgical technique improvements together with intraoperative monitoring has led to decreased complications [15]. The size of the meningioma significantly influenced clinical outcomes, with larger tumors (> 6 cm) demonstrating higher rates of neurological deficits (45.9%), recurrence (24.3%), and surgical complications (29.7%). According to Sughrue et al.'s previous studies, larger meningioma experienced increased surgical risk and poorer outcome demonstrated by recurrence rate around 22% [16]. Recurrence rates for medium-sized (8.8%) and small meningiomas (6.7%) were slightly lower

than Goldbrunner et al.'s findings ending up at about 10% and 8%, respectively for similar sizes; perhaps reflecting better precision alongside improved care during operation [17].Surgical approach varied greatly by both location as well as tumor size. In infratentorial tumors, 71.4% had total resection compared to cases where it was achieved in supratentorial tissues (83.3%), and skull base areas(70%). These figures are consistent with those given by Nassiri et al. for supratentorial tumors (80-85%) and skull base meningiomas (70-75%) [18]. In our study, GTR rate reached 56.8% as compared to the average rates of almost 60-70% reported in literature which shows more difficulty in dealing with larger masses.Our overall recurrence rate was 12%, corresponding with rates of large cohort studies which showed recurrence rates of 10-15%. Larger tumor size has been indicated to be associated with higher recurrence; this relationship is also demonstrated in this analysis. In our study, the five-year survival rates were approximately 78% for all patients, which matches previous findings by Wiemels et al., who indicated that it was between 75 and 80%. However, patient's survival was much higher (85%) among people diagnosed with smaller meningiomas underscoring the importance of early identification and treatment [19].In our study, surgical complications occurred in (14.7%), a range comparable to that observed earlier on (Mathiesen et al., 2003). It has been further established that larger tumours and those located at skull base had higher complication rates necessitating careful surgical planning including employment of modern intra-operative techniques during these procedures [20].

Limitations

The findings of this study may not be generalizable because of its prospective design and single-center setting. Bias could be introduced by differences in surgical expertise and postoperative care. In addition, some analyses may lose their statistical power due to small sample sizes, particularly in subgroups by tumor size and location. These results should be confirmed through future multicenter, prospective studies with more participants for a better understanding of the relationship between meningioma traits and clinical outcomes.

Conclusion

This study emphasizes the paramount significance of including tumor size and location in the management of brain meningiomas. Higher risk postoperative complications as well as recurrence rate are associated with supratentorial and larger meningiomas. Therefore, there is a need for customized surgical strategies so as to improve patient outcomes. Furthermore, through neuroimaging and minimally invasive approaches, complex tumor locations can now be managed more efficiently thereby opening up better ways of dealing with different cases of such a difficult condition[21].

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Authors Contribution

Concept & Design of Study: Syed Nasir Shah1.
Drafting: Naeem Ul Haq2,
Data Analysis: akram ullah3
Critical Review: akram ullah3
Final Approval of version: Syed Nasir Shah1

Reference

1. Louis DN, Ohgaki H, Wiestler OD, Cavenee WK. WHO classification of tumours of the central nervous system. 4th ed. Lyon: International Agency for Research on Cancer; 2007.
2. Perry A, Louis DN, Budka H, von Deimling A, Sahm F. Meningiomas. In: Louis DN, Ohgaki H, Wiestler OD, Cavenee WK, editors. WHO classification of tumours of
3. the central nervous system. 4th ed. Lyon: International Agency for Research on Cancer; 2007. p. 164-72.
4. Claus EB, Bondy ML, Schildkraut JM, Wiemels JL, Wrensch M, Black PM. Epidemiology of intracranial meningioma. Neurosurgery. 2005;57(6):1088-95; discussion1088-10.1227/01.neu.0000188281.91351.b9.
5. Magill ST, Lee DS, Yen AJ, Lucas CG, Raleigh DR, Aghi MK, et al. Surgical outcomes after reoperation for

recurrent skull base meningiomas. J Neurosurg. 2018;128(2):363-372. doi:10.3171/2016.10.JNS161644.

6. Di Carlo DT, Duffau H, Cagnazzo F, Benedetto N, Morganti R, Perrini P. Intraoperative subcortical mapping for intrinsic brain tumors: should we expand the indications? Neurosurg Rev. 2019;42(4):925-934. doi:10.1007/s10143-018-1008-4.
7. Bassiouni H, Asgari S, Stolke D. Foramen magnum meningiomas: clinical results and recurrence rates after microsurgical resection. Neurosurgery. 2006;59(1):112-9; discussion 112-9. doi:10.1227/01.NEU.0000219244.56777.3B.
8. Al-Mefty O, Borba LA. Skull base meningiomas: tips and pitfalls. Surg Neurol. 1997;47(3):243-52. doi:10.1016/S0090-3019(96)00384-0.
9. Riemenschneider MJ, Perry A, Reifenberger G. Histological classification and molecular genetics of meningiomas. Lancet Neurol. 2006;5(12):1045-54. doi:10.1016/S1474-4422(06)70625-1.
10. Mansouri A, Klironomos G, Taslimi S, Kilian A, Gentili F, Zadeh G. International consensus on the management of WHO Grade II and III meningiomas. Neuro Oncol. 2018;20(4):469-78. doi:10.1093/neuonc/nox189.
11. O'Sullivan MG, van Loveren HR, Tew JM Jr. The surgical resectability of meningiomas. Neurosurg Clin N Am. 1994;5(2):225-38. doi:10.1016/S1042-3680(18)30597-8.
12. Tanaka T, Fujii M, Kurimoto M, Matsui T, Suzuki Y, Endo S. Usefulness of navigation-assisted surgery for meningiomas in the cavernous sinus and the skull base. Minim Invasive Neurosurg. 2007;50(5):272-7. doi:10.1055/s-2007-993201.
13. Gerganov VM, Giordano M, Samii A, Samii M. Surgery of meningiomas involving the optic nerve. J Neurosurg. 2014;120(3):644-53. doi:10.3171/2013.9.JNS13748.
14. Adeberg S, Hartmann C, Welzel T, Rieken S, Habermehl D, von Deimling A, et al. Long-term outcome after radiotherapy in patients with atypical and anaplastic meningiomas-clinical results in 85 patients treated in a single institution leading to optimized guidelines for early radiation therapy. Int J Radiat Oncol Biol Phys. 2012;83(3):859-64. doi:10.1016/j.ijrobp.2011.08.026.
15. Lee JH, Jeun SS, Hong YK, Kim TS, Kim JH. Incidence and risk factors of postoperative stroke in patients with intracranial meningiomas. Neurosurgery. 2013;72(5):847-doi:10.1227/NEU.0b013e31828d85e6.
16. Bhat AR, Kirmani AR, Wani MA, Ramzan AU. Histological-subtypes and anatomical location correlated in meningeal brain tumors (meningiomas). J Neurosci Rural Pract. 2014;5(3):244-9. doi:10.4103/0976-3147.133574.
17. Sughrue ME, Rutkowski MJ, Shangari G, Parsa AT, Berger MS, McDermott MW. Results with judicious modern neurosurgical management of parasagittal and

falcine meningiomas. J Neurosurg. 2011;114(3):731-7. doi:10.3171/2010.4.JNS091692.

18. Goldbrunner R, Stavrinou P, Jenkinson MD, Sahm F, Mawrin C, Weber DC, et al. EANO guideline on the diagnosis and management of meningiomas. Neuro Oncol.2021;23(11):1821-34. 10.1093/neuonc/noab150.

19. Nassiri F, Price B, Shehab A, Latif N, Suppiah S, Badhiwala JH, et al. Life expectancy in patients with meningioma: a retrospective analysis using the SEER database. Neuro Oncol. 2019;21(7):921-9. doi:10.1093/neuonc/noz023.

20. Wiemels J, Wrensch M, Claus EB. Epidemiology and etiology of meningioma. J Neurooncol. 2010;99(3):307-14. doi:10.1007/s11060-010-0386-3.

21. Mathiesen T, Lindquist C, Kihlström L, Karlsson B. Recurrence of cranial base meningiomas. Neurosurgery. 2003;52(3):441-9; discussion 448-9. doi:10.1227/01.NEU.0000047806.50434.7C.