[Downloaded free from http://www.mmjonweb.org on Wednesday, December 15, 2021, IP: 10.232.74.23]

Original Article

Differentiation of Typical and Atypical Meningiomas Using Magnetic Resonance Imaging

Imran Nazir[1], Suhail Rafiq[2], Mohammad Naseed[1], Musaib Ahmad Dar[2], Feroze Shaheen[1]

[1]Department of Radiodiagnosis and Imaging, SKIMS Srinagar, Srinagar, Jammu and Kashmir, [2]Department of Radiodiagnosis and Imaging, GMC Srinagar, Srinagar, Jammu and Kashmir, India

Abstract

Background: Meningiomas are the most common intracranial neoplasms. They are usually homogeneously enhancing extraaxial masses. However, 10% of meningiomas are atypical with different imaging appearance. Distinguishing typical from atypical meningiomas on imaging is highly important in surgical and treatment planning. **Materials and Methods:** Our study was a retrospective one comprising twenty cases each of pathologically proven typical and atypical meningiomas excluding enplaque lesions. Magnetic resonance images were reviewed with each of the lesions showed as dural-based enhancing mass. Individual features analyzed were age, gender, maximum size, location, signal characteristics on T1, T2 weighted, susceptibility weighted imaging , diffusion-weighted, apparent diffusion coefficient, contrast-enhanced T1, interface with adjacent brain tissue, signal changes in adjacent brain tissue, and changes in overlying bone. **Aim:** The aim of the study is to retrospectively assess the magnetic resonance imaging (MRI) features of pathologically proven typical and atypical meningiomas. **Results:** Magnetic resonance features such as diffusion restriction, bony changes in form of destruction, indistinct interface with brain parenchyma, heterogeneous postcontrast enhancement, and edematous changes >6 mm thick in adjacent brain parenchyma were in favor of atypical meningioma. **Conclusion:** MRI has the ability to differentiate typical and atypical meningiomas based on imaging appearance which is important in surgical and treatment planning.

Keywords: Magnetic resonance imaging, meningioma, Magnetic resonance spectroscopy

Introduction

Meningiomas represent approximately 15% of all symptomatic and roughly one-third of all incidental (asymptomatic) intracranial neoplasms,[1,2] with a higher incidence of up to 35.2% among Asians and Africans.[3] Their typical appearance is that of a homogeneous, extraaxial mass, that enhances strongly with contrast, usually located in the cerebral convexity, parasagittal region, or in the planum sphenoidale. Up to 10% of meningiomas are, however, atypical or malignant[4] and may present with unusual imaging findings. Some of them may even mimic other neoplastic and nonneoplastic central nervous system lesions.

Most meningiomas are benign and classified as Grade I according to the World Health Organization standards,[4] these lack histologic evidence of atypia. On histology, these feature atypia and increased mitotic activity. These tend to be more aggressive, with shorter postoperative recurrence-free intervals and increased recurrence rate. The distinction between benign and atypical or malignant meningioma represents important surgical information because surgical and treatment planning as well as prognostication will depend on those pathologic types.

Aim

The aim of the study is to retrospectively assess the magnetic resonance imaging (MRI) features of pathologically proven typical and atypical meningiomas.

Materials and Methods

The study comprises retrospective analysis of twenty cases each of pathologically proven typical and atypical

Access this article online

Quick Response Code:

Website: http://www.mmjonweb.org

DOI: 10.4103/MJ.MJ_36_20

Address for correspondence: Dr. Mohammad Naseed, Department of Radiodiagnosis and Imaging, SKIMS Srinagar, Srinagar, Jammu and Kashmir, India.
E-mail: mnaseed@gmail.com

Submitted: 15-Oct-2020 **Revised:** 20-Oct-2020 **Accepted:** 24-Nov-2020 **Published:** 13-Apr-2021

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Nazir I, Rafiq S, Naseed M, Dar MA, Shaheen F. Differentiation of typical and atypical meningiomas using magnetic resonance imaging. Mustansiriya Med J 2021;20:17-20.

[Downloaded free from http://www.mmjonweb.org on Wednesday, December 15, 2021, IP: 10.232.74.23]

meningiomas excluding en-plaque lesions. MRI images were reviewed with each of the lesions showed as dural based enhancing mass.

Individual features analyzed were age, gender, maximum size, location, signal characteristics on T1, T2 weighted, susceptibility weighted imaging (SWI), diffusion weighted, apparent diffusion coefficient (ADC), contrast-enhanced T1,

Table 1: Age distribution of patients

Age group percentage (years)	Typical	Atypical
<20	0	0
20-40	3	1
40-60	12	7
>60	5	12
Total	20	20

χ^2=5.19, *P*=0.074

Table 2: Gender distribution of patients

Gender	Typical	Atypical
Male	7	9
Female	13	11
Total	20	20

χ^2=0.41, *P*=0.51

Table 3: Size distribution of lesions

Size (max. diameter) (cm)	Typical	Atypical
<2	0	0
2-4	5	2
>4	15	18
Total	20	20

χ^2=0.21, *P*=0.40

Table 4: Location of meningiomas

Location	Typical	Atypical
Falx and parasagittal	5	3
Convexity	7	5
Sphenoid dura	3	6
Suprasellar	3	3
Posterior fossa	2	3
Total	20	20

χ^2=2.03, *P*=0.73

Table 5: Predominant signal intensity on T1 lobe number of patients

Signal	Typical	Atypical
Predominantly hypointense	8	6
Isointense	8	9
Predominantly hyperintense	0	0
Heterogenous	4	5
Total	20	20

χ^2=0.45, *P*=0.79

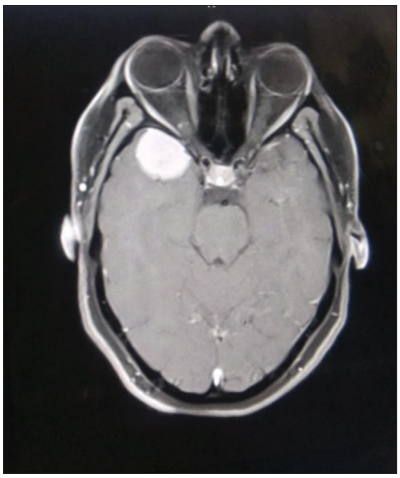

Figure 1: Axial post contrast magnetic resonance image showing homogeneously enhancing dural based mass lesion

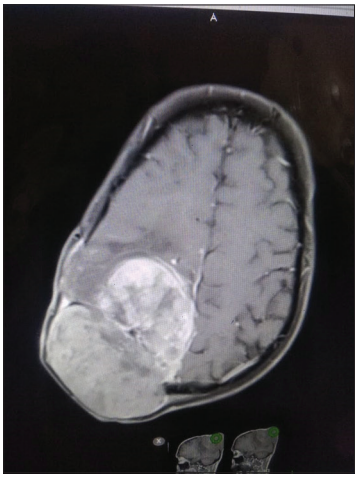

Figure 2: Axial postcontrast magnetic resonance image showing heterogeneously enhancing mushroom-shaped dural based mass lesion with bony destruction and underlying brain edema in the right parietooccipetal region

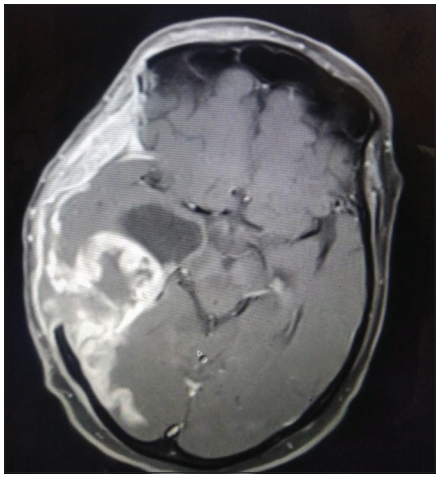

Figure 3: Axial postcontrast magnetic resonance image showing heterogeneously enhancing tentorial cerebellum based mass lesion with nonenhancing cystic component and edematous component within the underlying brain

[Downloaded free from http://www.mmjonweb.org on Wednesday, December 15, 2021, IP: 10.232.74.23]

Table 6: Predominant signal intensity on T2

Signal	Typical	Atypical
Predominantly hypointense	4	3
Isointense	9	10
Predominantly hyperintense	5	4
Heterogenous	2	3
Total	20	20

χ^2=0.94, *P*=0.81

Table 7: Blooming signal on susceptibility-weighted imaging

Blooming on SWI	Typical	Atypical
Present	8	3
Absent	12	17
Total	20	20

χ^2=3.13 *P*=0.07. SWI: Susceptibility-weighted imaging

Table 8: Signal on diffusion-weighted imaging

Diffusion restriction versus normal brain	Typical	Atypical
Restricted	0	13
Similar	6	6
Facilitated	14	1
Total	20	20

χ^2=24.26, *P*<0.0001

Table 9: Overlying bone changes the number of patients percentage

Lesion side	Typical	Atypical
No change perceptible	12	5
Hyperostosis	08	8
Destruction	00	7
Total	20	20

χ^2=9.8, *P*=0.007

Table 10: Contrast enhancement

Lesion side	Typical	Atypical
Homogenous	18	6
Heterogenous with necrotic areas	2	14
Total	20	20

χ^2=15.0, *P*=<0.0001

Table 11: Interface with adjacent brain parenchyma

Interface with adjacent brain tissue	Typical	Atypical
Well defined	19	4
Indistinct	1	16
Total	20	20

χ^2=23.01, *P*=<0.0001

interface with adjacent brain tissue, signal changes in adjacent brain tissue, and changes in overlying bone [Figures 1-4].

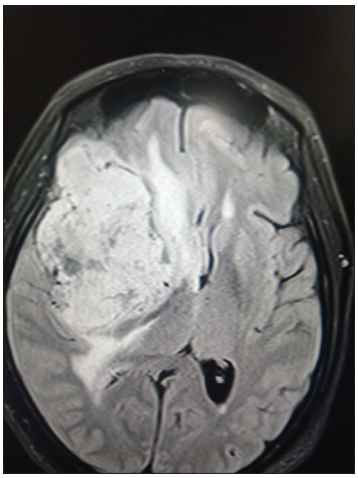

Figure 4: Axial fluid-attenuated inversion recovery magnetic resonance image showing heterogeneously hyperintense extraaxial mass lesion with associated edematous changes in the underlying brain with subfalcine herniation

Statistical analysis

Categorical variables were described in terms of frequency and percentage. The value of $P < 0.05$ indicated a statistical significant difference in the Chi-square test.

Results

Results are described in Tables 1-12.

Discussion

In our study, most patients with meningioma aged 40 years or more. Typical meningiomas were mostly seen in the age group of 40–60 (60%), while most atypical meningiomas were > 60 years of age (60%). This is in accordance with the study by Brokinkel *et al*.,[5] who found that the median age of patients with operated meningiomas was between 51 and 71 years of age. Most patients with meningiomas were females, both in typical (65%) and atypical (55%) variants. However, there was increased incidence of atypical meningiomas in males (45%) as compared to typical meningiomas (35%). This is in agreement with the study of Surov *et al*.[6] who found that male sex is associated with high proliferative potential of meningiomas. Varlotto *et al*.[7] in their study found that, most patients with meningiomas were female (68%) and that the median presenting age was 59.16 years (range 2–86). Data from the central brain tumor registry of the United States demonstrates a > two-fold higher incidence among females (age-adjusted incidence rate [per 100,000 person years] of 8.36 and 3.61 for females and males, respectively).[8]

Most meningiomas were more than 4 cms in size in both typical and atypical variants. In a study by Hale *et al*.,[9] there was a significant difference in bulk of the tumor in typical and atypical lesions, however, in our study, no significant size difference was noted between them, most meningiomas were seen along the convexity and parasagittal region in both typical

[Downloaded free from http://www.mmjonweb.org on Wednesday, December 15, 2021, IP: 10.232.74.23]

Table 12: Changes in adjacent brain parenchyma

Edema such as signal changes in adjacent brain parenchyma more than 6 mm in thickness	Typical	Atypical
Present	3	13
Absent	17	7
Total	20	20

χ^2=10.41, *P*=0.001

and atypical lesions. No statically significant difference was noted between the two. Most typical and atypical meningiomas were hypo to isointense on T1-weighted images and iso to hyperintense on T2 weighted images. Blooming foci on SWI representing calcification were noted in 40% of typical meningiomas and in 15% of atypical meningiomas. Surov *et al*.[6] also concluded that the absence of calcification is an independent risk factor for high-grade meningioma.

In our study, most atypical meningiomas (65%) show restricted diffusion on diffusion-weighted imaging (DWI), whereas 30% show similar and 5% show facilitated diffusion. This was in contrast to typical meningioma which either shows similar (30%) or facilitated (70%) diffusion. The results were found to be statistically significant ($P < 0.05$). These findings are in agreement with the findings of Surov *et al*.[6] who concluded there are different DWI findings and histopathological parameters. Grade II/III tumors had statistically significant lower ADC mean values than Grade I meningiomas.

In our study, bony changes in form of destruction were seen in 35% of cases of atypical meningiomas and none of the typical meningiomas. The results were found to be statistically significant ($P < 0.05$).

In our study, typical meningiomas show mostly homogenous enhancement (90%), whereas as heterogeneous enhancement was noted in 70% of atypical meningiomas. Furthermore, in our study, 95% of typical meningiomas were having clear interface with adjacent brain parenchyma while 80% of atypical meningiomas were having indistinct interface with adjacent brain parenchyma. The results were found to be statistically significant ($P < 0.05$). In a study by Kawahara *et al*.,[10] unclear tissue-brain interface and heterogeneous enhancement were independent predictive factors for high-grade meningioma. In meningiomas with an unclear tissue-brain interface and heterogeneous enhancement, the probability of high-grade meningioma was 98%.

Interface with adjacent brain parenchyma was indistinct in 80% of atypical meningiomas, whereas clear distinction was noted in 95% of typical meningiomas. The results were found to be statistically significant ($P < 0.05$). This is in agreement with the study done by Kawahara *et al*. who found that 65% of high-grade meningiomas and 2.6% of benign meningiomas showed unclear interface with surrounding brain parenchyma.

Significant brain edema (>6 mm of thickness) was noted in 65% of atypical meningiomas, while as only 15% of typical meningiomas showed the same findings. The results were found to be statistically significant ($P < 0.05$). This is in contradiction to the study done by Toh *et al*.[11] who found that peritumoral edema was present in 75% of classic meningiomas and 66.6% of atypical meningiomas.

Conclusion

MRI has the ability to differentiate typical and atypical meningiomas based on imaging appearance.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Russell DS, Rubinstein LJ. Pathology of tumors of the nervous system. 5th edition: Williams and Wilkins Co.; 1989. p. 449-83.
2. Wood MW, White RJ, Kernohan JW. One hundred intracranial meningiomas found incidentally at necropsy. J Neuropathol Exp Neurol 1957;16:337-40.
3. Das A, Tang WY, Smith DR. Meningiomas in Singapore: Demographic and biological characteristics. J Neurooncol 2000;47:153-60.
4. Louis DN, Scheithauer BW, Budka H. Meningiomas. In: Kleihues P, Cavenee WK, editors. WHO Pathology and Genetics of Tumours of the Nervous System. Lyon, France: IARC Press; 2000. p. 176-84.
5. Brokinkel B, Holling M, Spille DC, Heß K, Sauerland C, Bleimüller C, *et al*. Surgery for meningioma in the elderly and long-term survival: Comparison with an age- and sex-matched general population and with younger patients. J Neurosurg 2017;126:1201-11.
6. Surov A, Gottschling S, Mawrin C, Prell J, Spielmann RP, Wienke A, *et al*. Diffusion-weighted imaging in meningioma: Prediction of tumor grade and association with histopathological parameters. Transl Oncol 2015;8:517-23.
7. Varlotto J, Flickinger J, Pavelic MT, Specht CS, Sheehan JM, Timek DT, *et al*. Distinguishing grade I meningioma from higher grade meningiomas without biopsy. Oncotarget 2015;6:38421-8.
8. Yee G, Rycroft R, Phillips C, English C, Carson S, Schwenn M. 2010 CBTRUS statistical report: Primary brain and central nervous system tumors diagnosed in eighteen states in 2002–2006. Hinsdale, IL: Central Brain Tumor Registry of the United States; 2009.
9. Hale AT, Wang L, Strother MK, Chambless LB. Differentiating meningioma grade by imaging features on magnetic resonance imaging. J Clin Neurosci 2018;48:71-5.
10. Kawahara Y, Nakada M, Hayashi Y, Kai Y, Hayashi Y, Uchiyama N, *et al*. Prediction of high-grade meningioma by preoperative MRI assessment. J Neurooncol 2012;108:147-52.
11. Toh CH, Castillo M, Wong AM, Wei KC, Wong HF, Ng SH, *et al*. Differentiation between classic and atypical meningiomas with use of diffusion tensor imaging. AJNR Am J Neuroradiol 2008;29:1630-5.