Descriptive epidemiological analysis, MRI signals intensity and histopathological correlations of meningiomas

Azmy M. Hadidy, *MD, FRCR,* ***Mustafa M. Nadi,*** *MD, HSNS,* ***Tahani M. Ahmad,*** *MD, HSRad,* ***Maysa A. Al-Hussaini,*** *MD, MRCPath,* ***Abdelkarim A. Al-Abaddi,*** *MD, FACHARZT,* ***Awni F. Musharbash,*** *MD, FRCS,* ***Walid S. Maani,*** *MD, FRCS.*

ABSTRACT

الأهداف: عرض الوصف الإحصائي لحالات الأورام السحائية فيما يخص نسبة الانتشار والموقع التشريحي، والأعراض، و العلامات بالإضافة إلى إمكانية إيجاد علاقة بين إشارات الرنين المغناطيسي MRI و نتيجة الفحص النسيجي وذلك بهدف محاولة وضع أسس للتشخيص النسيجي من خلال الرنين المغناطيسي.

الطريقة: تمت مراجعة 120 حالة ورم سحائي من الذين تمت معالجتهم جراحيا في مستشفى الجامعة الأردنية (JUH) – عمان – الأردن خلال الفترة ما بين يناير 1997 حتى يناير 2007. تم إدراج 90 حالة منها في الدراسة وقمنا بدراسة السجلات الطبية و الصور الشعاعية والتقارير النسيجية.

النتائج: تبين أن الأورام السحائية أكثر شيوعاً في الإناث منها في الذكور وبنسبة (2.2:1). وأن الأورام المجاورة للجيب الوريدي السهمي الأعلى هي الأكثر انتشاراً 23.3%. وكانت 4.4% من الحالات أورام سحائية متعددة. أما من ناحية نسيجية فمعظمها كانت من النوع الحميد، وأظهرت إشارة رنين مغناطيسي مقاربة لإشارة المادة الرمادية في صور T1 و T2، بالإضافة إلى الاصطباغ بالمادة الملونة بشدة.

خاتمة: كانت نسب انتشار الأورام السحائية وتوزيعها بين الإناث والذكور ومواقعها التشريحية كما وجد في حالات مستشفى الجامعة الأردنية JUH مقاربة للنسب والتوزيع المتفق عليه في المراجع العلمية عالميا. وقد تبين أنه لا توجد علاقة واضحة بين إشارات الرنين المغناطيسي والتصنيف النسيجي للورم السحائي كما تمت مشاهدته في T1WI، و T2WI، و سلسلة FLAIR.

Objectives: To present our experience in operated meningioma cases regarding their prevalence, anatomical location, multiplicity, presenting signs and symptoms, and the possible correlation between MRI signal intensity and histological grades to set criteria for radio-pathological diagnosis.

Methods: In this retrospective study, 120 operated meningioma cases in the Department of Neurosurgery, Jordan University Hospital (JUH), Amman, Jordan between January 1997 and January 2007 were reviewed. Our study included 90 cases, and their medical records, histopathological reports, and neuroimages were analyzed thoroughly.

Results: Meningioma was more common in females than males with a ratio of 2.2:1. Para-sagittal meningiomas were the most common (23.3%). Multiple intracranial meningiomas were found in 4.4% of the cases. Most cases were of benign histopathology and exhibited iso-intense signals on T1 and T2, and appeared with hyper-intense signals on FLAIR with vivid enhancement.

Conclusion: The prevalence of meningioma among genders and its anatomical location at JUH corresponds to the published medical literature worldwide. There was no correlation between signal intensities (as seen on T1WI, T2WI, and FLAIR sequences), enhancement pattern on one side, and histological grades on the other side.

Neurosciences 2010; Vol. 15 (1): 11-14

From the Departments of Radiology (Hadidy, Ahmad), Neurosurgery (Nadi, Musharbash, Maani), Pathology (Al-Hussaini), and Anesthesia (Al-Abaddi), Faculty of Medicine, Jordan University Hospital, Amman, Jordan.

Received 9th June 2009. Accepted 29th September 2009.

Address correspondence and reprint request to: Dr. Azmy Hadidy, Consultant of Neuroradiology, Department of Radiology, Faculty of Medicine, Jordan University Hospital, PO Box 340621, Amman 11134, Jordan. Tel. +962 788707000. Fax. +962 (6) 5353388. E-mail: amshadidy@yahoo.com

Meningioma is the most common benign intracranial tumor, accounting for 15-30% of all primary intracranial neoplasms,[1-4] with an annual incidence of 2.3-5.5 per 100,000 populations[5,6] that increases significantly with age being mostly diagnosed at 40-60 years. It is twice more common in females,

Disclosure. No funding for this work was received from any organization or foundation.

except for the malignant type in which a male to female ratio of 3:1 is reported.[1] When discussing the epidemiology of meningioma, a distinction should be made between studies dealing with a limited population (hospital-based), those dealing with the population of a large series involving operated cases (as in this article), and those including autopsies.[5,7] Pathologically, meningiomas are divided into 3 groups: benign (90%), atypical (5-7%), and malignant/anaplastic (3-5%).[8] Magnetic resonance images are now the most reliable imaging technique, and considered the investigation of choice.[9-13] The characteristic MRI findings involve cortical buckling, cerebrospinal fluid clefts (identifiable in 80% of cases), broad base contact against the dural surface, pseudocapsule of displaced vessels of subarachnoid space, secondary intraaxial vasogenic edema, and dural tail sign.[1] On T1-weighted images, 60% of meningiomas are iso-intense, and 30% are mildly hypo-intense, compared with gray matter. On T2-weighted images, the tumors are iso-intense 50%, or mildly to moderately hyper-intense to gray matter 40%.[13] A few studies in medical literature correlated the histopathological diagnosis with MRI signals, but yet there is no reliable criterion for a histological diagnosis using MRI signals. Our objective in this study was to present our experience of operated meningiomas, and to compare the epidemiology data with worldwide figures.

Methods. Medical records of 120 patients with meningiomas who underwent surgery between January 1997 and January 2007 at Jordan University Hospital (JUH), Amman, Jordan were reviewed regarding clinical presentation, neuroimages (MRI), and histopathological results. Neither institutional ethics committee approval nor informed consent was required for reviewing patient records and images. Their presenting symptoms and signs were analyzed according to what was found in their medical records, which initially were evaluated by Neurosurgery specialists. Twenty-three cases were excluded, as their post-operative histopathological findings were not available. Of the remaining 97 cases, 90 were included in our retrospective study as their clinical data were complete and accurately documented. Of those, 46 cases had their postoperative specimen examined by a neuropathologist, and re-classified according to the World Health Organization (WHO) 2007 classification system.[8] Only 33 cases had well documented clinical notes and histopathological diagnoses, and their MRI scans were reviewed by one specialized neuroradiologist; these were included in our analysis and studied retrospectively in a blind manner. The MRI was performed using Siemens 1.5 tesla system (Siemens vision plus 1996, Erlangen, Germany). Axial and sagittal (T1WI: TR 700ms; TE 14 ms; T2WI: TR 3600ms; TE 90ms) sequences were initially obtained followed by coronal (FLAIR TR 8000; TE 110, TI 2500) sequence then T1WI sequences after intravenous gadolinium (0.2 ml/kg) injection. Slice thickness was 3mm with a 3mm gap. The field of view (FOV) ranged from 21-23cm. The signal intensity was graded as hyper-intense, hypo-intense, or iso-intense, relative to gray matter on T1, T2, and FLAIR images. Tissue blocks were obtained from each tumor. Sections were stained with hematoxylin and eosin. A neuropathologist who was blinded to the radiological findings reviewed all cases. We classified our cases into 3 histopathological groups: benign, atypical, and malignant meningiomas, according to the classification scheme of WHO 2007.[8] A two-way blinded study comparing histopathological features and MRI signals (T1WI, T2WI, FLAIR, and post gadolinium T1 sequences) was performed.

The statistical analysis was carried out using the Statistical Package for Social Sciences version 16.0 (SPSS Inc., Chicago, IL) Data were analyzed using Fisher exact test with $p<0.05$ considered statistically significant.

Results. *Clinical presentation and anatomic locations.* Of the 120 cases of intracranial meningiomas, 82 cases (68%) were females with an age range of 23-65 years, and a mean age of 47 years and 6 months, and 38 cases (31.7%) were males with age range of 34-70 years, and mean age of 47 years and one month. Four cases had multiple intracranial meningiomas. Para-

Table 1 - Anatomical location of operated meningioma cases in 90 patients.

Anatomical location	n (%)	Right	Left
Olfactory groove	9 (10.0)		
Sella and supra sella	3 (3.3)		
Tuberculum sellae	1 (1.1)		
Planum sphenoidale	1 (1.1)		
Intraventricular	1 (1.1)		
Sphenoid wing	17 (18.8)	7	10
Convexity	18 (20.0)	9	9
Para-sagittal	21 (23.3)	6	15
Falx	2 (2.2)	2	-
Posterior fossa, tentorium	4 (4.4)	-	4
Tentorial, supratentorial	1 (1.1)	1	-
Petroclival	6 (6.6)	4	2
Posterior fossa convexity	1 (1.1)	-	1
Petrous	1 (1.1)	1	-
Multiple intracranial*	4 (4.4)	*	*
Total number	**90**	**30**	**41**
Percentage (%)		(33.3)	(45.5)

*Four cases of multiple meningiomas were not classified into right and left subgroups, as this will falsely increase the number of the included cases

Table 2 - Presenting symptoms in 90 patients.

Symptoms	Pathology		
	Benign (n=71)	Atypical (n=16)	Malignant (n=3)
Headache	39	8	1
Speech problem	4	-	-
Loss of smell	1	-	-
Behavioral changes	1	-	-
Seizure	18	3	1
Vertigo	1	-	-
Dizziness	1	-	1
Vomiting	3	1	-
Blurring of vision	17	4	-
Decreased hearing	3	-	-
Dysphagia	1	1	-
Sensory problem	1	-	-

Table 3 - Physical signs at presentation (N=90).

Signs	Pathology			Total
	Benign (n=71)	Atypical (n=16)	Malignant (n=3)	
	n (%)			
Cranial nerves	3 (4.2)	1 (6.3)	- -	4 (4.4)
Hydrocephalus	1 (1.4)	- -	- -	1 (1.1)
Optic atrophy	2 (2.8)	- -	- -	2 (2.2)
Exaggerated reflexes	2 (2.8)	- -	- -	2 (2.2)
Focal deficit upper and lower limbs	17 (23.9)	6 (37.5)	1 (33.3)	24 (26.7)
Papilledema	3 (4.2)	- -	-	3 (3.3)
Cerebellar signs	1 (1.4)	- -	-	1 (1.1)

Table 4 - Correlation between histopathological groups and MRI signal; total number of cases 32.

MRI signal	Atypical (n=8)		Benign (n=24)	
	n (%)			
TI				
Iso	4	(50.0)	17	(70.8)
Hypo	4	(50.0)	7	(29.2)
Hyper	-	-	-	
T2				
Iso	3	(37.5)	12	(50.0)
Hypo	-		3	(12.5)
Hyper	5	(62.5)	9	(37.5)
Flair				
Iso	3	(37.5)	10	(41.7)
Hypo	-		3	(12.5)
Hyper	5	(62.5)	11	(45.8)
Enhancement				
Mild	1	(12.5)	2	(8.3)
Moderate	1	(12.5)	5	(20.8)
Vivid	6	(75.0)	17	(70.8)

Iso - iso intense to grey matter, Hypo - hypo intense to grey matter, Hyper - hyperintense to grey matter

sagittal location was the most common site, with left side predominance followed by convexity meningiomas (**Table 1**). On clinical presentation, the most common complaint was headache with 55% of the benign tumors presenting with headache (**Table 2**). Focal neurological deficit was found in 26.7% of patients (**Table 3**).

MRI signal intensities and histopathological correlation. Thirty-two cases out of 90 were analyzed regarding MRI signal intensities and histopathological correlation. Malignant meningioma was found in 3 cases (3.3%); the MRI was reviewed for only one case (33.3%), which showed iso-intense signal on T1, T2, and FLAIR with mild enhancement, but as this is a very limited sample we did not include malignant meningioma in the statistical analysis. Sixteen cases (17.7%) were atypical meningiomas, and MRI was reviewed for 8 cases (50%). Most of them exhibited iso or hypo-intense signal on T1 and hyper-intense signal on T2 and FLAIR with vivid enhancement. Benign meningiomas were found in 71 cases (79%), and 24 cases had their MRI reviewed. Seventeen cases (70.8%) showed iso-intense signal on T1, 9 cases (37.5%) appeared hyper-intense on T2, and 11 (45.8%) on FLAIR, with 17 cases vividly enhanced (**Table 4**). No correlation was found between MRI signal intensity and histopathological grouping on T1WI (p=0.598, not significant), T2WI (p=0.54 not significant), FLAIR (p=0.689 not significant), and enhancement (p=0.279 not significant).

Discussion. Descriptive epidemiological studies are important subjects as they show variations in brain tumor incidence, morbidity, and mortality by age, gender, histological type, anatomical location, geographic region, and ethnicity.[14] The Connecticut Cancer Registry is the oldest in the United States, dating back to 1935.[14] The registry in our department is considered one of the oldest at our locality in the Middle East, dating back to 1979. The Jordan National Cancer Registry started in 1998. It collects pathological diagnoses from all public, military, and private sector laboratories in Jordan. This study considered 90 operated cases in detailed analysis, and 120 operated cases regarding gender and age analysis as there was no doubt in their clinical documentation; however, those cases that received other modalities of treatment were not included. Expansion of sample size was difficult as some diagnosed cases were not operated at our hospital, others lost follow up, and accordingly their exact histopathological diagnosis was not available, in addition to limited accessibility of a few images that were not saved in our archive. Attempts to predict the histological characteristics of meningiomas on the basis of CT characteristics have only been successful with malignant meningiomas.[15] There are literature

studied correlations between MRI signal intensities and histopathological subtypes of meningiomas (such as meningothelial, fibroblastic, angioblastic),[16] but not the grading of the tumor (benign, atypical, and malignant), which may be easier to memorize and may influence surgical plans and approaches.

In conclusion, the prevalence of meningioma regarding age, gender, symptoms, clinical signs, intracranial location, and histological grades as seen in our department corresponded to published medical references worldwide. There was no correlation between histological grades of meningiomas and MRI signal intensities. For this, a surgeon cannot depend on the MRI technique to predict which pathology he may face intraoperatively, and no neuroradiologist can tell. It is hoped that other imaging techniques will be expected to yield more information and can predict the grade of meningioma before the operation, which will expedite management plans and the extent of surgery.

References

1. Louis DN, Scheithauer BW, Budka H, von Deimling A, Kepes JJ. Meningiomas. In: Kleihues P, Cavenee WK, editors. Pathology and Genetics of Tumors the Nervous System: World Health Organization classification of tumors. Lyon (FR): IARC Press; 2000. p. 176-184.
2. Rachlin JR, Rosenblum ML. Etiology and biology of meningiomas. In: Al-Mefty O, editor. Meningiomas. New York (NY): Raven Press; 1991. p. 27-35.
3. DeMonte F, Al-Mefty O. Meningiomas. In: Kaye AH, Laws ER Jr, editors. Brain Tumors. New York (NY): Churchill Livingstone; 1995. p. 675-704.
4. Longstreth WT Jr, Dennis LK, McGuire VM, Drangsholt MT, Koepsell TD. Epidemiology of intracranial meningioma. ***Cancer*** 1993; 72: 639-648.
5. Haddad G, Al-Mefty O. Meningiomas: an overview. In: Wilkins RH, Rengachary SS, editors. Neurosurgery. New York (NY): McGraw-Hill; 1996. p. 833-841.
6. Kurland LT, Schoenberg BS, Annegers JF, Okazaki H, Molgaard CA. The incidence of primary intracranial neoplasms in Rochester, Minnesota, 1935-1977. ***Ann N Y Acad Sci*** 1982; 381: 6-16.
7. Nakasu S, Hirano A, Shimura T, Llena JF. Incidental meningiomas in autopsy study. ***Surg Neurol*** 1987; 27: 319-322.
8. Louis DN, Ohgaki H, Wiestler OD, Cavenee WK, Burger PC, Jouvet A, et al. The 2007 WHO classification of tumours of the central nervous system. ***Acta Neuropathol*** 2007; 114: 97-109.
9. Bydder GM, Kingsley DP, Brown J, Niendorf HP, Young IR. MR imaging of meningiomas including studies with and without gadolinium-DTPA. ***J Comput Assist Tomogr*** 1985; 9: 690-697.
10. Haughton VM, Rimm AA, Czervionke LF, Breger RK, Fisher ME, Papke RA, et al. Sensitivity of Gd-DTPA-enhanced MR imaging of benign extraaxial tumors. ***Radiology*** 1988; 166: 829-833.
11. Watabe T, Azuma T. T1 and T2 measurements of meningiomas and neuromas before and after Gd-DTPA. ***AJNR Am J Neuroradiol*** 1989; 10: 463-470.
12. Zimmerman RD, Fleming CA, Saint-Louis LA, Lee BCP, Manning JJ, Deck MDF. Magnetic resonance imaging of meningiomas. ***AJNR Am J Neuroradiol*** 1985; 6: 149-157.
13. Zimmerman RD. MRI of intracranial meningiomas. In: Al-Mefty O, editor. Meningiomas. New York (NY): Raven Press; 1991. p. 107-116.
14. Wrensch MR, Minn Y, Bondy M. Epidemiology. In: Bernstein M, Berger M, editors. Neuro-Oncology, The Essentials. New York (NY): Thieme Medical Publishers; 2000. p. 2-17.
15. Vassilouthis J, Ambrose J. Computerized tomography scanning appearances of intracranial meningiomas. An attempt to predict the histological features. ***J Neurosurg*** 1979; 50: 320-327.
16. Paek SH, Kim SH, Chang KH, Park CK, Kim JE, Kim DG, et al. Microcystic meningiomas: radiological characteristics of 16 cases. ***Acta Neurochir (Wien)*** 2005; 147: 965-972.

ETHICAL CONSENT

All manuscripts reporting the results of experimental investigations involving human subjects should include a statement confirming that informed consent was obtained from each subject or subject's guardian, after receiving approval of the experimental protocol by a local human ethics committee, or institutional review board. When reporting experiments on animals, authors should indicate whether the institutional and national guide for the care and use of laboratory animals was followed. Research papers not involving human or animal studies should also include a statement that approval/no objection for the study protocol was obtained from the institutional review board, or research ethics committee.