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RESEARCH ARTICLE

OUTCOME DETERMINANT FACTORS FOR PATIENTS TREATED SURGICALLY FOR INTRACRANIAL AND SPINAL MENINGIOMAS

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The overall recurrence rate was higher among patients who underwent Simpson resection grade III and IV than those who underwent grade I and II.

ABSTRACT

Background: Meningiomas are a diverse set of tumors arising from the meninges (1). They account for one third of primary central nervous system tumors occurring primarily in older individuals with a female predominance (2). The etiology of meningiomas is not known in most cases (3). They can arise anywhere from the dura (4). Related Symptoms are determined by its location and by the time course over which the tumor develops (5,6).
In this study, we will classify our patients in different groups each one related to the surgical procedure used then classified into different subgroups to study survival among patients treated surgically for meningiomas.
Results: This was a retrospective cohort analysis done in two different medical centers on patients treated surgically for meningioma. Out of the 36 patients, pathologic studies revealed that 44% were transitional type, 31% meningothelial type, 8% atypical, 8% fibrous, 3% psammomatous, 3% anaplastic and one hemangiopericytoma grade 2/3. Regarding sex predilection, 67% of patients were female and 33% were male.
Concerning the Simpson grading system, it has been noted that the more aggressive in excising the tumor the less chance we have for tumor recurrence. The overall recurrence rate was higher among patients who underwent Simpson resection grade III and IV than those who underwent grade I and II.
Conclusion: Our study proves that anaplastic/atypical meningiomas carry out the highest risk of mortality and recurrence among other histological types and surgical treatment with extensive resection is the best treatment option in most of cases.
Moreover, our results showed that 86% of meningiomas are WHO grade I, 8% are grade II, and 3 % are grade III which is concordant also with the general statistics.

INTRODUCTION

Meningiomas are the most frequent primary brain tumors. Although most meningiomas are benign, mortality and morbidity can be related to the location and mass effect.
Moreover, sex is an important factor studied in our review in order to find a match with the international registries that show a higher frequency of the tumor among females possibly related to either some genetic predispositions or hormonal imbalance according to Harvey Cushing and collaborators (1).
Furthermore, the benefit of surgical resection of meningioma among other therapies illustrated by Joseph Wiemel and collaborators (2) is studied in our review by evaluating patients operated surgically for meningiomas by a single neurosurgeon in two different medical centers in Lebanon and following up them looking at the surgical morbidity and mortality rate, survival rate and the rate of tumor recurrence according to the tumor location and its histopathologic features.
We will try to find an association between elderly population and the degree of the tumor appearance as confirmed by different reviews that state an increasing of meningioma diagnosis among elderly population (especially after 65 years old).

In this review, we will classify our patients between different groups each one related to the surgical procedure used (depending in tumor location) than in each group we will

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classify patients within different subgroups (A: Histopathologic features, B: morbidities …).
Preoperative and postoperative data will be analyzed and pathology reports will be also reviewed and analyzed.
Due to the lack of such registry in Lebanon, the primary objective of our study is to follow up patients who underwent surgical resection of meningioma.

Review of Literature

Epidemiology

According to the Central Brain Tumor Registry in the United States (CBTRUS), there were 129,841 new cases of meningioma diagnosed from 2008 to 2012. The estimated number of new cases per year in the United States is nearly 26,000. The incidence rate varies by race, with blacks having a 1.2-fold higher incidence than whites (7). The incidence of meningioma increases progressively with age, with a median age at diagnosis of 65 years. Meningiomas are rare in children, except in those who have had radiation therapy before or a hereditary syndrome such as neurofibromatosis type 2 (NF2).
Long-term follow-up of epidemiologic studies on irradiated patients has observed that the incidence of meningiomas continues to rise even after several decades, and that risk may be highest among patients treated at a young age (8-10). In a cohort of over 4,000 childhood cancer survivors exposed to cranial radiation, the cumulative risk of meningioma was 5.6 percent by age 40 years (11). Cumulative incidence was highest among patients younger than five years at initial cancer diagnosis (10 percent); additional risk factors included female sex and increasing dose of radiation.

Hormonal predisposition

A genetic predisposition to meningioma is noticed in patients with neurofibromatosis type 2 (NF2) and schwannomatosis. Patients with multiple endocrine neoplasia type 1 (MEN1) also have an increased risk of meningioma, although at lower rates compared with neurofibromatosis (12).

Multiple observational studies have explored a possible relationship between either hormone replacement therapy or oral contraceptive use and the risk of meningioma, with mixed results (13,14-20). A meta-analysis of six prospective case-control studies that included over 1600 meningioma cases found that ever-use of hormone therapy was associated with a small but significant increase in the risk of meningioma (relative risk [RR] 1.35, 95% CI 1.2-1.5) (20). In studies that distinguished between estrogen-only versus combined estrogen-progestin hormone therapy, estrogen, but not combined therapy, was associated with increased risk (RR 1.31). This is equivalent to an approximate absolute excess risk of 2 per 10,000 users over five years.

Some, but not all, studies have also suggested a protective effect of smoking and an increased risk with higher body mass index (BMI), both of which could potentially be mediated through their effects on endogenous estrogen levels (13,17-19). Inhibition of estrogen or progesterone receptors has not been shown to alter the natural history of recurrent meningiomas.

Some studies show that breast cancer is also a risk factor for meningioma occurrence but we do not have till this moment clear data that confirm this result because of overlapping hormonal imbalance in breast cancer.

Obesity and meningioma

A positive association between BMI and meningioma has been reported in several large observational studies, with odds ratios ranging from 1.4 to 2.1 (13,17). This relationship might be related to endogenous hormonal factors, since obesity is associated with higher levels of estrogens and other growth factors, add that obesity is an established risk factor for a variety of tumors such as endometrial cancer, colon cancer, and breast cancer.

Head trauma has been studied as a potential cause for brain tumors, but results have not been satisfying because recall of the history by the patient was not obvious in many patients.

Cell phones and meningioma

Some studies looked at a possible link between cell phone usage and the subsequent development of brain tumors but till present, there is no conclusive evidence supporting a causal relationship. However, the prolonged latency period seen with ionizing radiation suggests that longer follow-up is required.

Classification

Meningiomas frequently are extremely slow growing and often are asymptomatic. The probability of a tumor recurring or growing after surgery is dependent on the tumor's WHO (World Health Organization) grade and on the extent of surgical resection using Simpson Scale. According to the World Health Organization (WHO) scheme, which is based upon morphologic criteria (21,22), classification system divides meningiomas into three groups. WHO grade 1 are benign and generally have a favorable prognosis, while atypical grade II and malignant grade III meningiomas are substantially more likely to recur (23).

The table 1 represents the distribution of meningioma according to WHO classification system.

Table 1 WHO classification of meningiomas (24).

	WHO grade I	WHO grade II	WHO grade III
Frequency	About 90%	5-7%	1-3%
Architectural pattern	Meningothelial, psammomatous, secretory, fibroblastic, angiomatous, lymphoplasmacyte-rich, transitional, microcystic, metaplastic	Clear-cell, chordoid, atypical	Papillary, rhabdoid, anaplastic
Histological	No signs of atypical or malignant growth	≥4 mitotic figures per 1.6 mm^2 or ≥3 of the following features: increased cellularity, small cells with a high ratio of nucleus to cytoplasm, prominent nucleoli; sheet-like growth pattern; geographic necrosis	≥20 mitotic figures per 1.6 mm^2, obvious malignant cytology
Biological behaviour	Can infiltrate in dura, venous sinuses, bone, orbit, soft tissue and skin	Can infiltrate in brain tissue.	Infiltrates in brain tissue

The WHO grading system correlates with outcome and thus has a major impact on treatment planning. Patients with WHO grade II or grade III meningiomas are significantly more likely to have invasive disease, a local recurrence following the initial treatment, and ultimately to have a shorter overall survival compared with patients with a WHO grade I meningioma.
The Simpson scale remains the most practical method to predict the risk of meningioma recurrence following resection. For instance, rates of recurrence for patients with grade I, II, and III

meningiomas are 7 to 25, 30 to 50, and 50 to 94%, respectively, in various series as shown in table 2.

Table 2 Recurrence rate of meningioma according to Simpson Scale (25).

Simpson Grade	Completeness of Resection	10-year Recurrence
Grade I	complete removal including resection of underlying bone and associated dura	9%
Grade II	complete removal + coagulation of dural attachment	19%
Grade III	complete removal w/o resection of dura or coagulation	29%
Grade IV	subtotal resection	40%
Grade V	Simple biopsy	3%

Although WHO grade III meningiomas are considered malignant, distant metastasis is rare and the primary issue is local recurrence, which necessitates additional treatment beyond surgery and ultimately can cause death (26). Whereas the 10-year recurrence is estimated at 9% for patients with Simpson grade I and 40% for patients with Simpson grade IV.

Genetics and Meningioma

Furthermore, efforts have identified several oncogenic mutations in a small subset of non-*NF2* mutant meningiomas that have potential therapeutic implications. In two separate studies, mutations in Smoothened (*SMO*), an activator of the Hedgehog pathway that is mutated in many basal cell carcinomas, were found in approximately 5 percent of tumors, and mutations in v-akt murine thymoma viral oncogene homolog 1 (*AKT1*), an activator of the phosphatidylinositol 3-kinase (PI3K) pathway, were found in up to 13 percent of tumors (27-29). Mutations in *TRAF7*, a proapoptotic ubiquitin ligase, were identified in approximately one-quarter of tumors in one study (28). However, the role of these mutations in the pathogenesis of meningiomas remains uncertain. Another study found oncogenic mutations in *PI3KA* in approximately 7 percent of meningiomas (29). Activation of the mammalian target of rapamycin complex 1 (mTORC1) pathway also appears to be a common alteration in meningioma that has potential therapeutic implications (30).

Diagnosis

Meningiomas are frequently extremely slow growing and often are asymptomatic or minimally symptomatic discovered incidentally on a neuroimaging study or at autopsy.

In a systematic review and meta-analysis of incidental findings on brain MRI in nearly 20,000 children and adults, meningioma was the most common incidental tumor, identified on 0.29 percent of MRIs (31). The prevalence of incidental findings, including meningioma, increased with age. A subsequent prospective, population-based study of brain MRI in 5000 healthy adults (mean age 65 years) identified meningioma in 2.5 percent of participants (32). The most common locations were convexity (62 percent) and falx cerebri (15 percent).

A definitive diagnosis of meningioma and classification as benign, atypical, or malignant (World Health Organization [WHO] grades I, II, and III, respectively) requires histologic confirmation (figure 1). However, imaging studies often provide a tentative diagnosis and may be sufficient for empiric treatment when obtaining tissue for pathologic confirmation entails too high a risk of causing further neurologic deficits.

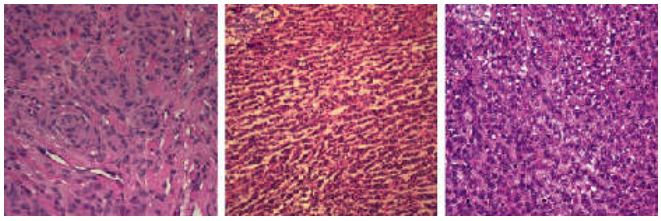

Figure 1- Histologic appearance of meningioma, WHO grades I-III. Left panel: transitional meningioma (grade I) showing characteristic cellular whorls; intranuclear pseudo-inclusions are visible in some cells. Middle panel: Chordoid meningioma (grade II) with cohesive epithelial-like cords of cells; small foci of more typical arachnoidal differentiation are found in most of these tumors. Right panel: anaplastic meningioma (grade III) consisting of pleiomorphic arachnoidal cells with a high mitotic rate; foci of necrosis are widely distributed throughout most anaplastic meningiomas (33).

Management

Surgical resection

Multiple advances in neurosurgery, including microsurgery, improved preoperative imaging, and intraoperative image-guided approaches, have extended the neurosurgeon's ability to resect lesions that were previously considered only partially resectable or unresectable, while minimizing damage to normal brain. Advances in endoscopic endonasal surgery have made anterior cranial base and clival tumors in particular more resectable as well (34).

The management of patients with meningioma requires a balance between definitive treatment of the tumor and avoidance of neurologic damage from the treatment. Patient-specific factors (presence or absence of symptoms, age, comorbidities) and the location of the meningioma in relation to critical brain structures and regions are all important factors in determining the optimal treatment. Depending upon these characteristics, initial management may consist of surgery, surgery plus radiation therapy, or radiation therapy alone. In addition, some patients with small, asymptomatic, or minimally symptomatic lesions may simply be monitored for evidence of tumor growth, with initial treatment deferred.

Our approach to the management of small, asymptomatic meningiomas is to reassess the patient with MRI or CT after three to six months. If the patient remains asymptomatic and there is no evidence of tumor growth, the patient can then be monitored with neuroimaging on an annual basis for three to five years, then every two to three years for as long as they remain a candidate for intervention.

Symptomatic meningiomas and asymptomatic tumors that are large, expanding, infiltrating, or associated with surrounding edema should be surgically resected if feasible. Complete surgical resection is preferred when a meningioma is in an accessible location, since complete resection of the tumor and its dural attachment can be curative and associated with significantly improved local control and progression-free survival compared with partial resection, independent of meningioma grade and other prognostic factors (34-37).
The Simpson grading system has been used to describe the extent of surgical resection.

Radiotherapy

Surgery is often combined with radiation therapy (RT) in the initial management of atypical and malignant meningiomas (WHO grades II and III) because the risk of recurrence is high and negative surgical margins cannot be assured.

Studies demonstrating an overall survival advantage from complete resection of benign meningiomas generally antedate the adjuvant use of RT with contemporary conformal techniques for patients with residual disease which appears to yield results comparable to more aggressive surgery and can minimize treatment-related neurologic deficits.

In contemporary practice, the goal of surgery is to achieve as extensive a resection as possible while minimizing neurologic deficits. The extent of resection varies depending upon the location of the tumor (table 3), whether there is imaging evidence of invasion, and the presurgical status of the patient (eg, neurologic deficits, comorbidities).

Table 3 WHO grade of histopathological variants; common sites of origin and operative mortality in intracranial meningiomas (37).

WHO-grade type	Number of patients (%)	Operative mortality (%)	Most common sites of origin (no. of patients)
Benign	89.30 (651/729)	4.30 (28/651)	Parasagittal, anterior parafalcine, Sphenoid Ridge, Convexity, Olfactory Groove, Intraventricular, Tentorium, Tuberculum Sellae, Cerebellopontine Angle, and so on
Meningothelial	57.75 (421)		
Fibroblastic	11.11 (81)		
Transitional	10.43 (76)		
Psammomatous	3.84 (28)		
Secretory	1.51 (11)		
Angiomatous	1.65 (12)		
Lymphoplasmacyte	1.10 (8)		
Metaplastic	1.65 (12)		
Microcystic	0.27 (2)		
Atypical	5.90 (43/729)	16.28 (7/43)	Convexity (8 patients), Tentorial (5), Sphenoid Ridge (4), Olfactory Groove (4), Jugular Foramen (2), and so on
Atypical	3.43 (25)		
Chordoid	1.37 (10)		Parasagittal (6), Tentorium (2), and so on
Clear Cell	1.10 (8)		Convexity (5), and so on
Malignant	4.80 (35/729)	25.71 (9/35)	Posterior parafalcine (5), tentorium (4), cerebellopontine angle (2), peritorcular (2), and so on
Rhabdoid	2.33 (17)		
Anaplastic	1.37 (10)		Sphenoid ridge (4), Cerebellopontine angle (3), and so on
Papillary	1.10 (8)		Intraventricular (4), tuberculum sellae (4)
Total	100 (729)	6.04 (44/729)	

Posterior parafalcine = Posterior 1/4 of falx cerebri

Complications

Postoperative neurologic deficits can be a direct complication of surgery. The reported incidence of such neurologic deficits ranges from 2 to 30 percent depending upon the location of the tumor and the extent of the resection. Cortical brain injury may occur if the arachnoid and pia are adherent to the tumor and there is disruption of the pial vasculature with subsequent cortical microinfarction. Cranial nerve deficits are a risk in surgery for skull base meningiomas, and intraoperative cranial nerve monitoring should be used for tumors located near the cranial nerves.

The reported overall surgical mortality has varied widely, reflecting differences in patient selection criteria as well as changes in surgical care. Factors associated with an increased mortality included poor preoperative clinical condition, brain compression from tumor, advanced age, incomplete tumor removal, and intracranial hematoma requiring evacuation.

Older series indicated that the mortality was higher in older adults (39,40). More recent series, using contemporary neurosurgical techniques, have shown that surgery is feasible in carefully selected older adults (40,41). As an example, there was no perioperative mortality in a carefully selected series of 74 patients aged ≥80 years, and the incidence of postoperative complications was only 9 percent (42).

Objectives

The primary objective of our study is to follow up patients who underwent surgical resection of meningioma.

Furthermore, we will evaluate our patients according to other parameters such as age, sex predilection and the degree of tumor recurrence according to the surgical extent and its histopathologic type. We will identify also the benefit of radiotherapy in some rare cases.

Study Design and Population

This is a retrospective study conducted on 36 patients who underwent consecutive operations for intracranial and spinal canal meningioma between 1994 and 2014 at two different medical centers in Lebanon, Sacre-Coeur Hospital and Clemenceau Medical Center. The patients were followed up for a duration between 12 and 336 months after surgery.

Most of the operations were performed using a microsurgical technique and when necessary, more sophisticated surgical tools (neuronavigation, cranial nerve monitoring, neuroendoscopy…) were also applied.

The data encompassed all surgically-treated cases, according to the following criteria:

Inclusion Criteria

- Patients that underwent surgical meningioma resection under general anesthesia.
- Patients of all ages
- Sex : males and females
- Neuroradiologic diagnoses of the tumors were made by magnetic resonance imaging (MRI)

Exclusion Criteria

- Meningiomas not treated surgically.

Data Collection

The data was collected from patients' files at the clinic of Dr. Ibrahim Saikali and the medical record departments of the 2 hospitals included in the study, and from interviews of the patients either personally or over the phone.

Then we plotted our data on an excel sheet according to the following parameters (tumor location, histopathologic features, hospital stay, need for ICU, tumor recurrence, age, sex, clinical presentation and Simpson Grade).

Preoperative and postoperative data and therapy were also analyzed and pathology reports were also reviewed.

Statistical Analysis

The majority was complete in term of data. Data were plotted into the excel sheet then survival rate was calculated and postop morbidities detected according to different parameters (histopathologic features, extent of the tumor, tumor recurrence, age, sex, clinical presentation and Simpson Grade).

Overall survival was defined as the duration between the date of initial diagnosis and death due to any cause or the date of the last follow-up. Progression-free survival was calculated as the duration from the date of initial diagnosis until the date of

recurrence or disease progression. All retrieved and consolidated data were then statistically analyzed according to the simple rule of proportion (number of cases 36).

The study population was 36 patients with complete data.

Patients age ranged between a minimum of 16 years and a maximum of 83 years, with a mean of 60 years (n=36).

There were 12 males (33%) and 24 females (67%). Among females, 71% of cases were above 50 years old.

Table 4 Sex predilection in patients operated for meningioma in our study

Male	**12**	**33%**
Female	24	67%
Total	36	100%

Out of the 36 meningiomas, 1 was psammomatous type (3%), 16 were transitional type (44%), 11 were meningothelial (31%), 3 were fibrous type (8%), 3 were atypical (8%) 1 anaplastic type with bone invasion (3%) and one hemangiopericytoma grade 2/3.

Table 5 Different Histological types of meningioma according to our study

Transitional type	**16 (44%)**
Meningothelial type	11 (31%)
Fibrous type	3 (8%)
Atypical	3 (8%)
Psammomatous type	1 (3%)
Anaplastic type	1 (3%)
Hemangiopericytoma	1 (3%)

Table 6 WHO classification of meningiomas according to our study

WHO grading system	**I**	**II**	**III**
Frequency (%)	86	8	3

The extent of the tumor resection at the first operation was Simpson Grade I in 33 patients, Grade II in 2, Grade III in 1.

Table 7 Simpson Grade of meningioma resection among patients enrolled in our study

Simpson Grade	**Percentage**
Grade 1	33 (92%)
Grade 2	2 (5%)
Grade 3	1 (3%)
Grade 4	0%
Grade 5	0%

According to medical records, four of our patients presented with motor deficit. Dysphasia was the predominant presenting symptom in half of them, while the others had visual disturbances. On the other hand, hemiparesis was the predominant sensory symptom in two of our patients who presented with sensory deficit. The remaining 30 patients presented to the doctor's office with headache and seizures (table 8).

Table 8 Presenting symptoms of patients enrolled in our study

Presenting Symptoms	**Percentage**
Motor deficit	4(11%)
Sensory deficit	2(6%)
Headache	23(64%)
Seizures	7(19%)

Bladder and sphincter disturbances were not mentioned in any of the patients. The mean duration of the development of symptoms prior to surgery was 6 months. Surgical resection led to significant alleviation of pre-operative symptoms. Surgical results showed improvement in all our patients (either directly postop or after following up patients at the doctor clinic) but deterioration occurred in two cases due to HAP and bedsore bleed postop (table 9).

Table 9 Complications encountered after surgical resection

Complications	**Percentage**
HAP	1(3%)
Bedsore bleed	1(3%)
None	34(94%)

There was no radiographic evidence of tumor recurrence in patients with an extent of resection of Simpson grade I, II, or III. We experienced three recurrences. Two were WHO type 2 (atypical meningothelial and fibroblastic) (Figure 2). One was reoperated by another neurosurgeon and the other is under monitoring by another neurosurgeon. One case was initially misdiagnosed as meningothelial meningioma however it was later redefined as hemangiopericytoma when reoperated for a late recurrence after 9 years. This tumor vertebral metastasis was also resected. Adjuvant radiation therapy was administered to the cranial recurrence and vertebral metastasis. The mean time to recurrence was 174 months (range 12 to 336 months) after surgery.

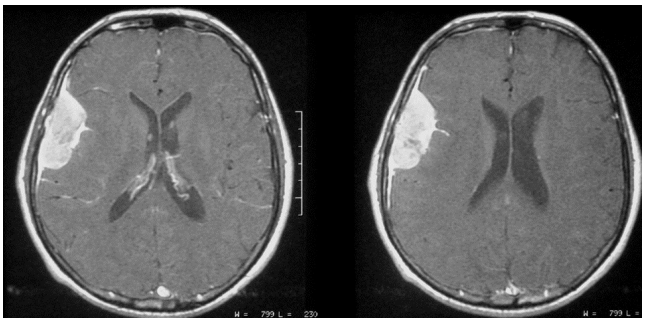

Figure 2 Atypical convexity meningioma, WHO grade II

There was one case of postoperative major neurological deficit (aphasia and hemiparesis related to a postoperative arterial branch infarct). No immediate postoperative death occurred in the present series. Three patients died of progression of secondary medical disorder (2 cases of heart failure and one case of HAP who died respectively 1 month, 2 months, and 4 years postop), and a fourth patient died after an unknown insult.

We lost contact with 8 patients because they either changed their contact information or they travelled abroad.

Although most meningiomas are encapsulated and benign tumors with limited numbers of genetic aberrations, lethal consequences can occur sometimes according to their location. They are the most frequently diagnosed primary brain tumor accounting for 33.8% of all primary brain and central nervous system tumors reported in the United States according to the NPCR-CSS which includes non-malignant brain and other CNS tumors (21,22). The challenges to meningioma research are several: (i) as a relatively rare disease, large or multicenter studies are necessary for sufficient numbers; (43); (ii) the prevalence of subclinical disease in up to 2.8% of the population, as suggested by autopsy studies which indicates that the pool of susceptible persons are much larger than those with clinically confirmed diagnoses; and (iii) the problem of

detection bias because an important number of meningiomas are discovered incidentally after performing MRI for other purposes (headache for example) (44,45).

Many investigators have reported a higher proportion of women in their series (46) and the ages of the people who were diagnosed ranged mostly from 40 to 70 years.

In our study, the female-to-male ratio is 2 to 1 so it has been suggested that meningioma occurs more frequently in women which has been shown in variable series (46).

Headache is the most common symptom in the recent studies (5,6) as found in our population from two different medical centers in Lebanon (23 out of 36 patients presented with headache as initial symptom).

MRI has been determined to be the best noninvasive neuroimaging technique in achieving exact diagnosis and some findings make it possible to distinguish benign from malignant tumors such as tumor outline, invasive behavior, and edematous reactions. It can demonstrate also tumor vascularity, arterial encasement, venous sinus invasion, and the relationship between the tumor and surrounding structures (31). That is why MRI was our imaging modality for evaluating meningiomas.

In most cases, meningioma growth is slow and well-distinguished from the spinal cord, enabling easy removal of the tumor. Total resection of the tumor was achieved in most of the cases in our study (90%). The rate of total tumor resection was reported to be 82% by Allen Levy and collaborators, 92.6% by Francois Roux and collaborators, and 97% by Carlo Solero and collaborators (47). Tumors carry a favorable prognosis if completely resected. However, morbidity may result following radical excision particularly for anteriorly located and en plaque meningiomas for tumors located in the thoracic spine (4%) due to the blood irrigation and calcifications found inside the tumor.

Furthermore, many factors influence on the postoperative results including preoperative neurological status, the nature and location of the tumor, and the type of surgical resection (so the extent of resection is thought to be the main prognostic factor in the treatment of benign tumors). In previous studies, recurrence of spinal meningiomas often results in higher morbidity compared to intracranial cases (47).

No immediate postoperative death occurred in our study.

Concerning its histologic features, we have several well recognized types : meningothelial, fibroblastic, transitional, psammomatous, atypical, anaplastic and angiomatous tumors.
The recurrence rate of intracranial meningioma is approximately 10-20%, depending on the length of follow-up (Figure 3) (WHO Grade 2 and 3 respectively atypical and anaplastic type are associated with a higher recurrence rate than WHO Grade 1 benign type). Metastases are rarely seen, add that the late recurrence rate of spinal meningiomas published only in a few long-term studies was 4% (43,46).

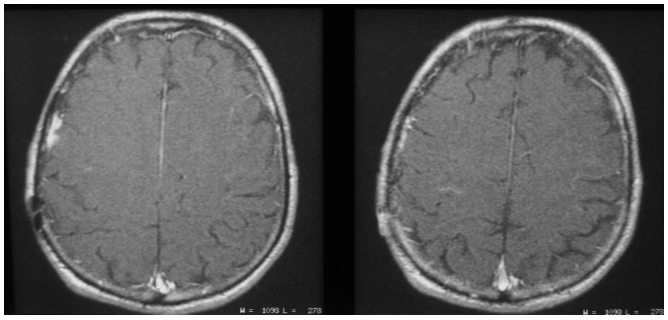

Figure 3 A 1 year follow up imagery after atypical meningioma resection

After a total resection, the recurrence-free rates at 5, 10, and 15 years, were 93%, 80% and 68%, respectively, whereas, after a subtotal resection, the progression-free rates were only 63%, 45% and 9%, respectively, during the same periods according to Allen Levi and collaborators, Francois Roux and collaborators (47). In this study, we experienced 3 recurrences (after 1, 6, and 9 years respectively) (Figure 4). Two of our recurrent cases involved tumors that were categorized pathologically as atypical (WHO grade 2) meningiomas with the third being an anaplastic hemangiopericytoma (WHO grade 3); those results match the international standards (43,45) confirming the highest rate of tumor recurrence among WHO grade 2 and 3. We do believe, like other authors in different studies, that spinal meningiomas have such a low rate of recurrence because of both their poor tendencies for growth (they are mostly psammomatous calcified tumors) and their prevalence in an aged population in whom the follow-up period is relatively short (47).

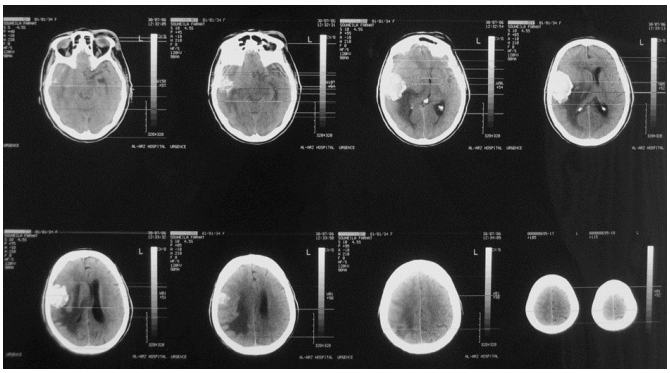

Figure 4 Right sphenoid wing meningioma before and after surgical resection

Although surgical removal is the best accepted treatment for meningiomas, radiotherapy can also control unexcised or recurrent meningioma according to Rene-Olivier Mirimanoff and collaborators (49) who suggested that radiotherapy should be considered as an adjunct treatment after subtotal excision. We had one patient (hemangiopericytoma) irradiated after

resection of the local recurrence at 9 years along with the distant spinal metastases. So one of our patients was treated by radiotherapy to prevent or delay another potential recurrence of its aggressive tumor (anaplastic hemangiopericytoma) and his last MRI done few months ago was negative for tumor recurrence.

Radiotherapy RT alone can be effective in treating meningiomas that are not amenable to a subtotal resection providing a temporary tumor control and avoiding the risks of surgery (50) or even used as an adjunct to surgery to prevent or

delay a potential tumor recurrence (mostly applicable in pathologically aggressive tumors or subtotally resected tumors) as shown in our hemangiopericytoma case misdiagnosed initially as a meningothelial meningioma (51).

Limitations and Perspectives

The main limitation is that our study was conducted in only two medical centers in Lebanon (Sacre Coeur hospital and Clemenceau medical center), which renders the generalization of the results to the Lebanese population rather difficult. But this makes the results more reliable in terms of demonstration of the surgical advantages for disease control in patients with meningioma and identification of morbidities that may accompany surgical meningioma resection.

Furthermore, patients' information were taken from the EMF from both hospitals and from the patient himself (either by visit or phone call) which reduces the likelihood of the results being biased.

Moreover, surgeries and patients follow up were performed by a single neurosurgeon which lead to a homogenous medical and surgical outcome after specific therapy.

At the end, one of our concerns since we have initiated our study was to initiate a nucleus in the Lebanese society of neurological surgery in association with the Lebanese society of oncology so that we can estimate the prevalence of meningioma in our society either to interfere earlier in the disease process or to work on some researches for the future.

Meanwhile, as proven by our study and by international registries regarding meningioma treatment, surgery with a gross total resection once feasible is the best option for patient's recuperation.

In this report, the surgical outcome of 36 cases of spinal canal and intracranial meningiomas have been reviewed. Symptoms and signs were reduced after operation which highlights on the benefit of surgical resection of the tumor once possible. Recently, advances in microneurosurgery and neuroimaging techniques have resulted in decreases in mortality and morbidity rates of meningioma treatment.

Moreover, early detection and complete resection of spinal canal and intracranial meningiomas once indicated seem to produce a good clinical outcome. It is well-known that the recurrence rate of intracranial meningiomas is correlated with the extent of resection (Simpson grade 3 and 4 more likely to recur than grade 1 and 2), and the histologic type of the tumor (atypical and anaplastic with the highest rate of mortality and recurrence). So this proves that radical tumor excision is the most effective treatment, as it determines the patient outcome, and it should always be applied. In cases of subtotal resection, radiotherapy could be applied, as it seems to delay tumor's reappearance.

Our patients experienced no recurrence of intraspinal meningiomas once gross total resectioning was achieved, regardless of the control of the dural origin.

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