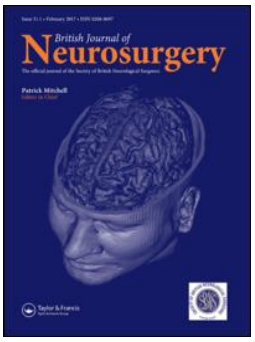

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ORIGINAL ARTICLE

Neurosurgery for intracranial meningioma in patients aged more than 80 years: benefits and rationale

Christophe Joubert[a], Aurore Sellier[a], Pauline Sahuc[b], Nathan Beucler[a], Nicolas Desse[a], Cedric Bernard[a], Pierre-Julien Cungi[c] and Arnaud Dagain[a,d]

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ABSTRACT

Background: Elderly patients with symptomatic benign intracranial tumours such as meningioma pose particular problems in decision making. We report on the outcome, morbidity and mortality in patients aged over 80 years after undergoing cranial surgery for meningiomas.

Methods: In this retrospective study, 37 patients aged more than 80 years underwent surgery at our neurosurgery department. The Karnofsky Performance Scale (KPS) was used to assess functional status. The American Society of Anesthesiologists (ASA) classification system, the Geriatric Scoring System, the Clinical-Radiological Grading System and the Sex, Karnofsky, ASA, Location and Edema score were used to define clinical status and tumour characteristics. The Charlson Comorbidity Index and Clavien–Dindo classification scores reflected therapeutic morbidity.

Results: Preoperative KPS scores were generally higher than 60 ($n = 32$). Of the 37 patients, 24 (64.8%) were in ASA class I or II, and 27 (73.0%) had one or more comorbidities. The median length of follow-up was 80.0 months (range: 1–96 months). The 1-year mortality rate was 2.7% ($n = 1$). Tumour control was achieved in 33 patients. At discharge, KPS scores were improved in 21 patients (with an average gain of $+18.1 \pm 8.7$), stable in 10 patients and poorer in 6 patients. KPS scores improved or were stable in patients with shorter lengths of hospital stay (15.5 ± 17.9 days vs 51.4 ± 25.4 days; $p < 0.01$), those with Clavien–Dindo scores lower than 2 ($p < 0.01$) and those with less favourable preoperative KPS scores (69.4 ± 10.9 vs 82.0 ± 11.0; $p = 0.04$).

Conclusion: Historically, surgery for intracranial meningiomas in patients aged >80 years has been feasible; this series demonstrated decreasing rates of postoperative mortality. Functional benefit should be the main goal of surgery. Perioperative morbidity should be better assessed and predicted because it significantly influences functional outcomes.

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Intracranial meningioma; older patients; functional outcome; morbidity; surgery

Introduction

Because people are living longer than ever before[1], surgeons have had to tackle new challenges in elderly patients with tumours who require surgery. This is particularly relevant in cases of intracranial meningioma as they occur in many elderly patients[2] and are the most encountered intracranial tumour[3].

Surgery for meningiomas in very old patients has been performed previously[4–10], and preoperative scoring systems are used routinely to predict postoperative morbidity and mortality. Despite these precautions, the benefits of surgery remain uncertain after the age of 80 years.

In this study, we assessed functional and morbidity outcomes in a consecutive series of patients aged ≥80 years with intracranial meningiomas and report our experience. We also discuss similar and previous studies with regard to clinical trends and describe the rationale for surgery in this specific population.

Patients and methods

Patients aged ≥80 years at the time of the surgery were retrospectively included. Data from January 2009 to December 2018 were extracted from our hospital database. The institutional ethics board of our hospital approved the study (No. 2018/004).

Data were acquired for all patients who underwent neurosurgery to treat intracranial meningiomas. Surgical decisions were based on clinical symptoms caused by either the intracranial meningioma ($n = 35$) or a rapidly growing lesion ($n = 2$). Patients who had undergone previous surgery for the same lesion before 80 years of age were excluded.

Clinical data were collected from the informatics database of our hospital. A neurosurgeon and a radiologist reviewed imaging data at the time of the analysis. The Karnofsky Performance Scale (KPS) was used to assess functional status before surgery[11], at discharge and at the time of the patient's last contact with the hospital. The Simpson grading system was used to evaluate quality of tumour resection[12]. We used previously validated scoring systems such as the American Society of Anesthesiologists' (ASA's) Physical Status Classification System, Geriatric Scoring System (GSS)[13], Clinical-Radiological Grading System (CRGS) and Sex, Karnofsky, ASA, Location and Edema (SKALE) score[10] to define the clinical status and tumour characteristics and the Charlson Comorbidity Index (CCI)[14] and Clavien–Dindo Classification scores for therapeutic morbidity[15]. The Response

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Assessment in Neuro-Oncology criteria were used to define oncologic status during the follow-up period[16].

Continuous variables were expressed as means (± standard deviations) or as medians (with range of minimum to maximum), and quantitative data were expressed as numbers and percentages. We used the Mann–Whitney *U* test to compare quantitative data. Fisher's exact test was used for to assess qualitative data. Survival data were studied using the Kaplan–Meier method. For patients alive at the time of analysis, a censored survival point was entered as the last date of available clinical data. Because the cohort size was reduced based on the selection criteria described, we did not plan or perform any multivariable analysis. A p value of <0.05 indicated statistical significance. Data in Microsoft Excel files were analysed using the Analyse-it® Method Validation edition (Microsoft Corporation, Redmond, WA, USA).

Table 1. Baseline characteristics of the patients ($N = 37$).

Characteristics	Number of patients	Percentage
Age		
Median: 81.9y [80.0–93.1]		
<85	30	81.1
≥85	7	18.9
Sex		
Female	20	54.1
Male	17	45.9
Clinical symptoms		
Motor deficit	17	45.9
Epilepsy	15	40.5
Cognitive dysfunction	13	35.1
Dysphasia	7	18.9
Sensitive deficit	4	10.8
Headache	4	10.8
Asymptomatic	2	5.4
Visual dysfunction	1	2.7
Pre-operative KPS		
>70	15	40.5
60–70	17	45.9
<60	5	13.6
ASA		
I	8	21.6
II	16	33.2
III	13	35.1
Charlson comorbidity index		
≤2	22	59.5
>2	15	40.5
SKALE		
≤8	9	24.3
>8	28	75.7
Geriatric scoring system		
≤18	19	51.3
>18	18	48.7
Clinical-radiological grading system		
>10	27	73.0
≤10	10	27.0

Results

Baseline characteristics

From January 2009 to December 2018, 352 patients were diagnosed with intracranial meningioma. Of the 56 patients aged ≥80 years, 19 patients did not undergo surgery because either the tumours were asymptomatic ($n = 14$) or their general status was poor ($n = 5$). The remaining 37 patients were retrospectively included in the study (Table 1). Thirty-five patients exhibited symptoms and two had fast-growing lesions. Motor dysfunction and epilepsy were the clinical signs that were most often reported. Clinical signs of high intracranial pressure were absent, except for 'headache', which was infrequently reported (10.8%). A combination of clinical symptoms was observed in 21 cases (56.8%).

In our cohort, the preoperative KPS scores of 32 patients were above 60 ($n = 32$), and those of 17 patients were between 60 and 70; thus, this cohort was in general neurologically impaired but did not require occasional assistance and were able to care for most of their personal needs.

Twenty-four patients (64.8%) were in ASA class I or II, 27 (73.0%) had one or more comorbidities, 9 (24.3%) had a second concomitant neoplasm, and 13 (35.1%) had undergone anticoagulant or antiplatelet treatment for vascular comorbidities (stroke, coronaropathy or dysrhythmic cardiopathy). Fifteen patients (40.5%) had CCI scores of ≥3.

To assess patient comorbidities, three items from GSS and one item from KPS yielded scores of ≥14 for the entire cohort (median$n = 19$, range = 15–26). This 'favourable' grading despite comorbidities was in line with SKALE scores, the median of which was 10 (range = 6–14), and with CRGS scores, the median of which was 12 (range = 7–15).

Tumour characteristics and surgical data

As detailed in Table 2, there was a predominance ($n = 25$ [67.6%]) of convexity tumours and parasagittal locations that matched the clinical findings at the time of diagnosis. Venous sinuses were rarely involved ($n = 3$ [8.1%]). Oedema was peritumoural in 33 patients (89.2%) but lobar in 8 (21.6%); the latter led to focal deficit in 7 cases and clinical epilepsy as the first symptom in 3 cases. The diameter of the tumours was 3–6 cm in general ($n = 25$ [67.6%]). World Health Organization (WHO) grade I meningioma was the most common type of tumour ($n = 32$ [86.5%]).

Total tumour excision was performed in 34 patients (91.9%). The other three patients underwent partial excision (Simpson grade 4); two were located at the skull base (one in the olfactory groove and one in the middle of the sphenoid wing, adherent to

Table 2. Tumour characteristics and surgical data of the patients according to location.

		Main diameter (cm), Number (%)			Edema, Number (%)			WHO Grading, Number (%)		Quality of resection (Simpson), Number (%)		Tumor control (last contact), Number (%)
Location	Number (%)	<3	3–6	>6	Absent	Moderate	Severe	I	II – III	I–II–III	>III	
Convexity	16 (2.43)	1 (2.7)	8 (6.21)	7 (9.18)	2 (4.5)	9 (3.24)	5 (5.13)	15 (5.40)	1 (2.7)	16 (2.43)	– –	14 (8.37)
Sagittal/parasagittal	9 (3.24)	2 (4.5)	6 (2.16)	1 (2.7)	2 (4.5)	5 (5.13)	2 (4.5)	6 (2.16)	3 (1.8)	8 (6.21)	1 (2.7)	7 (9.18)
Middle skull base	6 (2.16)	1 (2.7)	5 (5.13)	– –	– –	6 (2.16)	– –	6 (2.16)	– –	5 (5.13)	1 (2.7)	6 (2.16)
Anterior skull base	4 (8.10)	– –	4 (8.10)	– –	– –	3 (1.8)	1 (2.7)	4 (8.10)	– –	3 (1.8)	1 (2.7)	4 (8.10)
Posterior fossa	2 (4.5)	– –	2 (4.5)	– –	– –	2 (4.5)	– –	1 (2.7)	1 (2.7)	2 (4.5)	– –	2 (4.5)
Total	37 (100.0)	4 (8.10)	25 (67.6)	8 (6.21)	4 (8.10)	25 (67.6)	8 (6.21)	32 (86.5)	5 (5.13)	34 (91.9)	3 (1.8)	33 (89.2)

Venous sinuses invasion: sagittal (2), transverse (1).
Edema: severe e.g. lobar, moderate: peri tumoral.

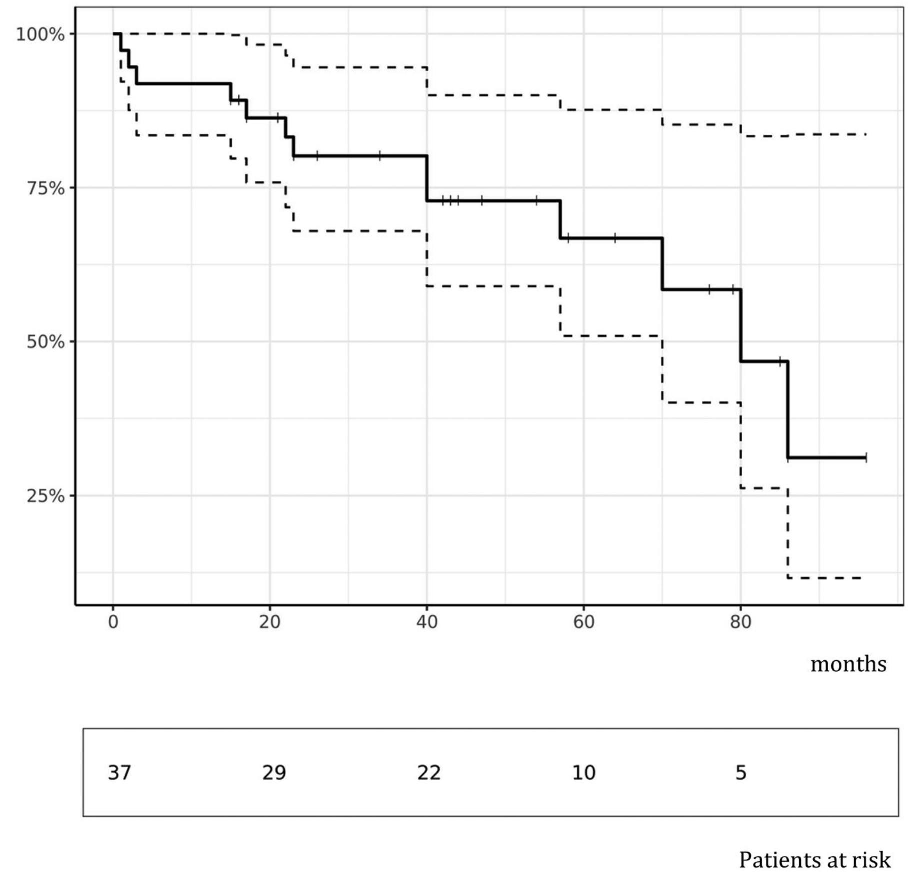

Figure 1. Kaplan–Meier curve showing patient mortality after undergoing surgery ($N = 37$).

the supraclinoid portion of the carotid artery), and one involved the posterior third of the sagittal sinus. Because of these locations, resection could not be completely performed, and the remaining portions of these tumours were coagulated.

The average duration of surgery was 190 min (median, 180 min; range, 90–442 min) for meningiomas in convexity and parasagittal locations and 289 min (median, 181 min; range, 109–541 min) for skull base meningiomas. These differences were not statistically significant.

Global outcome

The median duration of follow-up was 80.0 months (range, 1–96), with a mortality rate of 31.2% by December 2018 (95% confidence interval, 11.6–83.7; Figure 1). The 1-year mortality rate was 2.7% ($n = 1$). After hospitalisation at the department of neurosurgery, 17 patients (46%) were admitted to rehabilitation centres and 17 (46%) returned home. Of the other surviving patients, one was admitted to the neurological ward and one to the cardiovascular ward, in both cases for complications.

The average length of hospital stay was 20.6 days (median, 10.0 days; range, 4–102). Patients with Clavien–Dindo scores of less than 2 had statistically shorter mean stays in the hospital (9.88 ± 4.27 days) and in the intensive care unit (0.16 ± 0.374 days) than those with higher Clavien–Dindo scores ($42.8\text{d} \pm 27.8$ days and 8.17 ± 8.23 days, respectively; $p < 0.001$ for both).

After surgery, nine patients had Clavien–Dindo scores of ≥ 2; of these patients, four exhibited increasing oedema, one had status epilepticus and four experienced postoperative haematoma, which in one case (2.7%) necessitated surgical revision. One of these nine patients died of pneumonia on day 23 after surgery.

Table 3. Global outcome regarding significant factors influencing patients' mean survival ($N = 37$, loss to follow-up or considered deceased as of December 2018; univariable analysis).

	Average (SD)	Median [Q25–75]	Min	Max	n	*p* Value*
Clavien-Dindo score						
<2	50.8 (±27.5)	54.0 [23.0–76.0]	3.00	96.0	25	0.02
≥ 2	28.2 (±15.9)	34.0 [16.8–42.0]	1.00	44.0	12	–
Post-operative evolution of KPS						
Improved	47.4 (±26.0)	43.0 [23.0–67.0]	3.00	96.0	31	0.048
Worsened	23.2 (±19.5)	25.0 [5.50–40.0]	1.00	44.0	6	–

	Correlation coefficient (CI95%)	n	*p* Value**
Hospital length of stay	−0.330 (−0.591; −0.006)	37	0.046
Post-operative evolution of KPS	0.332 (0.009; 0.592)	37	0.045

*Mann Whitney test.
**Pearson's correlation test.

Of the patients with postoperative haematoma, all had preoperative hypertension. We observed concomitant medical complications in seven of these nine patients: urinary tract infection in three, pulmonary infection in three and deep venous thrombosis in three.

Of the entire cohort, 11 patients had died by December 2018: 4 because of neoplasm, 4 because of cardiovascular disease and 2 (including the patient who died postoperatively) because of pulmonary infection; 2 additional patients were lost to follow-up. Univariable analysis revealed statistically significant differences in survival according to Clavien–Dindo scores and postoperative

Table 4. Functional outcome regarding quantitative changes in KPS scores of patients at discharge ($n = 36$; 30 had improved or stable scores, and 6 had poorer scores; univariable analysis).

	Average (SD)	Median [Q25–75]	Min	Max	n	p Value*
Charlson Comorbidity index						
≤2	4.09 (±12.6)	5.00 [0.0–10.0]	−30.0	20.0	22	0.048
>2	13.6 (±18.6)	20.0 [2.5–27.5]	−30.0	40.0	14	–
Clavien-Dindo score						
<2	12.8 (±11.4)	10.0 [0.0–20.0]	0	40.0	25	0.01
≥2	−3.64 (±18.6)	0 [−15.0–10.0]	−30.0	30.0	11	–
Gss						
>16	5.94 (±15.4)	10.0 [0.0–20.0]	−30.0	40.0	32	0.03
≤16	22.5 (±9.6)	25.0 [17.5–30.0]	10.0	30.0	4	–
SKALE						
>8	4.29 (±14.8)	5.00 [0.0–12.5]	−30.0	30.0	28	0.014
≤8	20.0 (±13.1)	20.0 [10.0–30.0]	0	40.0	8	–

	Correlation coefficient (CI95%)	n	p Value**
Surgery duration	−0.122 (−0.433; 0.215)	36	0.48
Hospital stay duration	−0.428 (−0.663; −0.116)	36	<0.01
ICU stay duration	−0.404 (−0.647; −0.087)	36	0.014
Pre operative KPS	−0.626 (−0.792; −0.375)	36	<0.001

*Fisher's test.
**Pearson's correlation test.

changes in KPS scores (Table 3). We observed significant quantitative correlations between the length of hospital stay and survival and between the length of hospital stay and improvement in KPS score (Tables3 and 4).

Tumour control was achieved in 33 patients by December 2018. Tumour progression was noted in two patients who died of other causes. Of the four patients who received adjuvant radiation therapy, two achieved tumour control. In univariable analysis of our cohort, a Simpson grade of <3 was significantly associated with tumour control by December 2018 ($p < 0.01$), whereas WHO grade was not ($p = 0.051$).

Functional outcome

At discharge, KPS scores were improved in 21 patients, with an average increase of 18.1 ± 8.7; they were stable in 10 and poorer in 5; and the patient who died postoperatively showed worsening of the KPS score. Among the 21 patients whose KPS scores improved postoperatively, the median length of overall survival was 42 months (range, 15–80); 1 was lost to follow-up, 7 died by December 2018 and KPS scores remained improved in the remaining 13, with a final average increase of 24.6 ± 11.9. Among the 10 patients with stable KPS scores postoperatively, the median length of overall survival was 57 months (range = 17–86); of these, three died by 2018, and four of the other seven showed improved KPS scores, with an average increase of 15 ± 5.77, and 4 patients continued having stable scores. Of the six patients whose KPS scores worsened postoperatively, one was lost of follow-up, one died within the first month, and one showed improved KPS scores subsequently, with an increase of +10.

Of the 25 survivors by December 2018, 2 were lost to follow-up. KPS scores improved in 17, with an average increase of 22.4 ± 11.4; were stable in 5; and worsened in 3, with an average decrease of 13.3 ± 9.5. Considering the qualitative postoperative changes in KPS scores, we observed that the scores improved or were stable in patients with shorter lengths of hospital stay (15.5 ± 17.9 days vs 51.4 ± 25.4 days; $p < 0.01$), in those with Clavien–Dindo scores of <2 ($p < 0.01$), and in those with less favourable preoperative KPS scores (69.4 ± 10.9 vs 82.0 ± 11.0; $p = 0.04$). To better determine the factors influencing the quantitative postoperative changes in KPS scores, we performed univariable analysis, the results of which are reported in Table 4 .

Discussion

Elderly patients and the role of age

There is limited surgical information on elderly patients despite the fact that an increasing number of elderly patients undergo surgery. We found only six studies that reported the neurosurgical outcomes in very old patients (>80 years of age) with meningioma. The main results of those reports are listed in Table 5 [6,10,17–20]. Because of increasing life expectancy, a cut-off age of 65 years for defining 'elderly' is not relevant in actual practice; we define 'very old' as more than 80 years of age, and clinicians should focus on screening such patients with regard to surgery[1,21].

In a study in which age was the main selection criterion, age also remained a major prognostic factor with regard to overall survival[7,14]. Steinberger *et al.*[22] reported that an age of >80 years was an independent risk factor for any complication, for death within 30 days of surgery, and for length of hospital stay exceeding 5 days after craniotomy for resection of meningioma. These findings were in line with those of Grossman *et al.*[14]. Moreover, if 'geriatric' criteria are used to determine which patients undergo intracranial surgery, the cohorts are too small to perform multivariable analysis, and only purpose trends could be analysed. Previous works have focused mostly on patients aged <80 but >65 years[13,23] or on comparisons between older and younger patients[14,22,23]; few have focused exclusively on patients aged >80 years[6,10,17–20].

Mortality

Life expectancy in patients aged ≥80 years limits the results in regard to length of follow-up and overall survival. Brokinkel *et al.*[5] compared survival rates in patients who underwent surgery after the age of 65 years with those of the general population who underwent surgery and found that the older group apparently had a higher mortality rate 3 months after surgery but found no statistically significant difference in overall survival between the two groups (hazard ratio, 1.03; 95% confidence interval, 0.70–1.50; $p = 0.886$). In similar studies (Table 5), rates of perioperative mortality (or at least mortality during the postoperative hospital stay) and 1-year mortality ranged from 2.7% to 13.5%. Major differences in the duration of the follow-up period prevented further comparisons.

Interestingly, these six studies confirmed that meningioma was not the direct cause of death. Postoperative mortality rates were low in the studies after 2005[10,17,18], ranging from 0% to 3.9%, as opposed to 13.5%–29.4% in two earlier series[6,19]. This improvement is probably attributable to better selection criteria for surgery[10,13] and to advances in medical support. Furthermore, in these studies, mortality was the main endpoint, and prognostic scoring systems were selected accordingly[8,9,13,14,24].

Morbidity

With regard to morbidity, comparisons among studies were limited because complications were defined differently among studies. The distinction between medical and surgical complications

Table 5. Synthesis of studies in the literature of patients aged ≥80 years who underwent surgery for intracranial meningiomas.

Author Year of publication	Number of patients	Age (median)	Peri-operative morbidity	Surgical revision	Peri-operative mortality	1-year Mortality	Median follow-up	Overall mortality*	Recurrence rate
Mastronardi et al. 1995	17	82 [80–86]	5.8% (n = 1)	35.3% (n = 6)	23.5% (n = 4)	23.5% (n = 4)	? [6–96]	35.3% (n = 6)	5.9% (n = 1)
D'Andrea et al. 2005	37	82 [80–86]	16.2% (n = 6)	2.7% (n = 1)	13.5% (n = 5)	13.5% (n = 5)	? [6–96]	18.9% (n = 7)	2.7% (n = 1)
Riffaud et al. 2007	11	82 [81–87]	9.1% (n = 1)	–	–	9.1% (n = 1)	34.5** [11–65]	90.9% (n = 1)	9.1% (n = 1)
Sacko et al. 2007	74	82 [80–90]	9.4% (n = 7)	2.7% (n = 2)	1.4% (n = 1)	9.4% (n = 7)	92 [1–147]	27% (n = 20)	5.4% (n = 4)
Koglund et al. 2013	51	83.4** [80–90]	?	13.7% (n = 7)	3.9% (n = 2)	15.7% (n = 8)	?	?	?
Dobran et al. 2018	25	81.5** [80–87]	12.0% (n = 3)	–	8% (n = 2)	?	? [12–48]	?	12.0% (n = 3)
Present study 2020	37	82 [80–93]	32.4% (n = 12)	2.7% (n = 1)	2.7% (n = 1)	2.7% (n = 1)	80 [1–96]	29.7% (n = 11)	8.1% (n = 3)

*At the time of the last contact; **average, median not available; '?' not available.

was unclear. Mastronardi *et al.* reported only morbidity that led to surgery[19]. Sacko *et al.*[10], D'Andrea *et al.*[6] and Dobran *et al.*[17] accurately detailed morbidity but did not mention any medical complications. In contrast, Konglund *et al.*[18] mentioned both, as did we in this report. This is probably why morbidity rates appeared higher in more recent series than in earlier series[22], even in younger patients[7] and those without symptoms[25].

We used the Clavien–Dindo score, which was based on the severity of the postoperative complications, without distinction. Of interest in our study was that the Clavien–Dindo score was statistically associated with the length of hospital stay ($p < 0.001$), overall survival ($p = 0.019$) and qualitative and quantitative differences in KPS scores at discharge (Table 4). Thus, the Clavien–Dindo score may be useful for predicting postoperative morbidity. Despite differences in the Clavien–Dindo scores according to CCI scores (cut-off = ≤2), no statistically significant difference was observed in our cohort. Nevertheless, as emphasised in a literature review by Poon *et al.*, CCI remains the only score that can help predict morbidity in patients undergoing meningioma resection[8].

Functional outcome

With regard to life expectancy at the time of diagnosis, incidence of low-grade meningiomas, and various causes of death (mostly comorbidities), we focused on changes in KPS scores, prognostic factors in these changes and morbidity and its predictive factors rather than overall survival. There was a correlation between change in KPS scores after surgery and overall survival (Table 3).

Although the functional benefit of surgery is important to both patients and surgeons, it has not been studied in patients with symptoms. We found that qualitative and quantitative changes in KPS score were influenced by perioperative morbidity (Table 4). Even if our single-centre, retrospective study of a small cohort cannot lead to definitive conclusions, this study has yielded original results. With regard to the quantitative changes in KPS scores, we found that the improvement in KPS scores was significantly greater in patients with less favourable CCI, SKALE and GSS scores and less favourable preoperative KPS scores. Because of the limitations of our study, these results should be interpreted with caution. It appears reasonable that surgery provides better benefits to patients with more severe symptoms. This significant trend should be confirmed in a study with a large cohort. The findings would help neurosurgeons determine whether patients aged ≥80 years should undergo surgery.

Surgery and meningioma

Surgical duration was not statistically associated with morbidity ($p = 0.38$), overall survival ($p = 0.63$), or change in KPS scores after discharge ($p = 0.48$) in our series. These results were in line with those of previous studies; however, Dobran *et al.* reported significantly higher rates of mortality in patients for whom surgery lasted more than 240 min[17] and better neurological outcomes in those for whom surgery was shorter ($p = 0.002$). Nevertheless, many factors affect surgical duration, including tumour size and location as well as surgeons' experience, which cannot be compared statistically in small cohorts.

In view of our results, the aim of surgery should be total (Simpson grade 1 or 2) or near-total resection (Simpson grade 3) to enable significant functional improvement and an acceptable rate of tumour control.

Limitations

Because of the selective inclusion criteria, our cohort was small and statistical trends were limited. We retrospectively included patients who underwent surgery; thus, the cohort was homogeneous in that regard, and this probably led to selection bias. Such bias might have reduced the significance of previously validated scoring systems such CRGS, SKALE and GSS or CCI, but these scoring systems are useful in routine practice to make surgical decisions. On the other hand, the use of these different scores may have confounded our results; however, this may not be relevant, especially as KPS is part of CRGS, GSS and SKALE and thus remains the lowest but significant common denominator.

Therefore, it would be relevant to plan early rehabilitation after surgery in patients aged ≥80 years, as previously described for spine surgery[26]. Furthermore, such planning could reduce the length of hospital stay of patients with symptomatic tumours who are admitted to the hospital; observation for 7–10 days may be needed before surgery can be planned, and transfer to rehabilitation centres after surgery may be delayed for the geriatric population. These may be the reasons why the mean length of hospital stay was considerably high. For the moment, on the basis of these circumstances in this specific population, our hospital has organised a 'geriatric pathway', whose aim is to reduce the length of hospital stay and the complication rates.

Conclusion

In historical series, surgery for intracranial meningiomas in patients aged $\geq$80 years has been described as feasible[6,19,27,28]. More recent series[10,17,18,20] have reported decreasing postoperative mortality rates. Perioperative overall morbidity should be better assessed and predicted, inasmuch as it significantly influences functional outcome.

Functional benefit should be the main goal of surgery in selected patients. Strong correlations between length of hospital stay and both functional improvement and overall survival not only reflect patients' preoperative status but also support global treatment encompassing surgery and medical care.

Ethical approval

This retrospective chart review of human participants was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The Human Investigation Committee of Sainte Anne Military Hospital approved this study. After acceptance, it was registered as n°2018/004.

Informed consent was obtained from all individual participants.

No identifying information about participants is available in the article.

Disclosure statement

All authors certify that they have no affiliations with or involvement in any organisation or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements) or nonfinancial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

All the authors give final approval of the version to be submitted.

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