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Quality of Life Assessment in Patients with Surgically Treated Parasagittal Meningiomas

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ABSTRACT

AIM: To assess QoL in patients with PSM and identify risk factors for different levels of QoL.

MATERIAL and METHODS: Patients were contacted and interviewed via telephone. A total of 136 patients with PSM underwent surgery at our institution between 1984 and 2020. Among them, 45 had agreed to participate in the research. The scales utilized included the Functional Assessment of Cancer Therapy General (FACT-G), Brain (FACT-Br), and Meningioma (FACT-MNG). Medical records were also reviewed.

RESULTS: The mean KPS was 93.3 (70–100). Overall, the mean scores for the FACT-G, FACT-Br, and FACT-MNG scales were 98.4/108 (55–108; SD: 12.9), 179.3/200 (98–200; SD: 22.4), and 219.3 (119–248; SD: 29.7). Considerable variability in scales scores was observed among those with the same KPS score. Preoperative KPS score was significantly associated with both FACT-Br [–21.64; 95% CrI (–34.04, –9.59)] and FACT-MNG [–31.88; 95% CrI (–47.24, –15.25)]. Preoperative KPS was identified as a risk factor for QoL impairment.

CONCLUSION: Variability in the scale scores among those with the same KPS score highlights the importance of structured assessment. Moreover, KPS may overlook impairments in QoL. To date, this has been the first study to assess QoL in PSM patients.

KEYWORDS: Brain tumor, Meningioma, Quality of life

ABBREVIATIONS: 95% CrI: Credibility interval, **Ant:** Anterior third, **CrI:** Credibility interval, **FACIT:** Functional Assessment of Chronic Illness Therapy, **FACT-Br:** Functional Assessment of Cancer Therapy - Brain, **FACT-G:** Functional Assessment of Cancer Therapy - General, **FACT-MNG:** Functional Assessment of Cancer Therapy - Meningiomas, **JAGS:** Just Another Gibbs Sampler (statistical software), **KPS:** Karnofsky Performance status, **L:** Large size, **M:** Middle size, **Mid:** Middle third of the superior sagittal sinus, **Post:** Posterior third of the superior sagittal sinus, **PSM:** Parasagittal meningiomas, **QoL:** Quality of life, **S:** Small size, **SSS:** Superior sagittal sinus, **vs:** Versus, **WHO:** World Health Organization

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INTRODUCTION

Meningiomas, which arise from the arachnoid cap cells (8,17,26), are the most frequent primary brain tumors (24). Studies have shown that meningiomas can develop across several locations within the brain, with diverse clinical presentations (4,7,17,28).

Parasagittal meningiomas (PSM) are defined as those that fill the sinodural angle, with no brain parenchyma interposed between the lesion and the superior sagittal sinus (SSS) (10). This location is the second most common intracranial site for meningioma development (7,10,17,18,21,34).

Surgery remains the primary treatment for PSM, with the extent of resection, among other factors, predicting the likelihood of recurrence (7,11,18,31). Surgery for these lesions can be challenging, especially in cases with venous sinus infiltration (29).

These tumors can be classified into three groups based on their location: anterior third, between the crista galli and coronal suture; middle third, between the coronal and lambdoid sutures; and posterior third, posterior to the lambdoid suture (5). The most frequent location is the middle third of the SSS, which can present with a predominantly crural paresis and a higher risk of functional impairment (9-11,13-15). Headache, visual loss, and epilepsy have also been identified as frequent symptoms (33).

Most surgical series on PSM have assessed patients from a functional point of view using the Karnofsky Performance Scale (KPS). However, the quality of life (QoL) has been poorly assessed in these patients (30).

There are specific and validated scales designed to assess cancer patients in general, such as the Functional Assessment of Cancer Therapy—General (FACT-G) (22), and patients with brain malignant neoplasms, such as Functional Assessment of Cancer Therapy—Brain (FACT-Br) (36). For the evaluation of patients with meningiomas, Zlotnick et al. designed a scale with elements from the FACT-G and FACT-Br, as well as site-specific assessment for meningiomas based on the Functional Assessment of Cancer Therapy—Meningioma (FACT-MNG). The latter, however, still lacks validation from studies. On all scales, scores are directly proportional to the estimated QoL.

Using the previously described scales, the present study therefore aimed to assess the QoL in patients with PSM who underwent surgical treatment and identify risk factors for different levels of QoL.

MATERIAL and METHODS

This study included patients with confirmed histological diagnosis of PSM who underwent surgery between 1984 and 2020. Medical records were reviewed for data collection.

After evaluating tumor size, the lesions were grouped into small, medium, and large for those with a linear diameter of <3 cm, between 3 and 6 cm, and >6 cm, respectively, for statistical analysis purposes (5,9,11,12).

Regarding location, the lesions were grouped into the middle third, which has greater functional impairment (5,9,11,12) and non-middle third lesions for statistical analysis purposes.

After also reviewing surgical records, the extent of resection was classified as described by Simpson: grade I, complete resection with excision of the dura attachment; grade II, resection of all visible tumor remnants and coagulation of the dura attachment; grade III, macroscopically complete resection without coagulation of the dura attachment and with the possibility of remaining tumor in the venous sinus or hyperostotic bone; grade IV, incomplete resection; and grade V, biopsy (28). For statistical analysis purposes, the extent of resection was categorized as either Simpson I or others.

After combining radiological and surgical information, the extent of SSS invasion was classified into six grades as described by Sindou: type I, fixation on the lateral wall of the sinus; type II, invasion of the lateral recess; type III, lateral wall invasion; type IV, invasion of the sidewall and roof; type V, completely occluded sinus; and type VI, occluded sinus and extending beyond its walls (Figure 1) (1,29). Sindou's types were grouped between low grade (I and II) and high grade (III, IV, V, and VI) for statistical analysis.

The scales applied included FACT-G, FACT-Br, and FACT-MNG (Figure 2). Licensing by the Functional Assessment of Chronic Illness Therapy System (FACIT System) was obtained. The patients' KPS score was also evaluated.

There was a tendency toward an increase in the mean KPS score, albeit not statistically significant perhaps due to the small number of patients in each group. Because of this, patients were grouped into those who had a KPS of 100 or <100.

KPS scores both before the surgery and at last assessment were used for analysis.

Patients were contacted to obtain permission for study participation. A trained interviewer described the study and administered the interview via telephone. Questionnaires took, on average, between 10 and 20 min to complete.

Only patients and physicians had access to the responses, thereby preserving confidentiality. Only collaborative patients who agreed to complete the scales were included, excluding those who were debilitated or unable to answer the questions.

A total of 136 patients with PSM underwent surgery at our institution between 1984 and 2020. Among them, 45 agreed to participate in the research. This study was approved by our institution's ethics committee. Consent was obtained for all participants via telephone.

To compare the means of the dependent variables according to the categories of each independent variable, simple and multiple linear regression models were utilized under a Bayesian approach. Differences between means and 95% credibility intervals (95% CrI) were determined. In each case, covariates were adjusted for in the multiple models. All statistical analyses were conducted using JAGS from R 4.1.1 software.

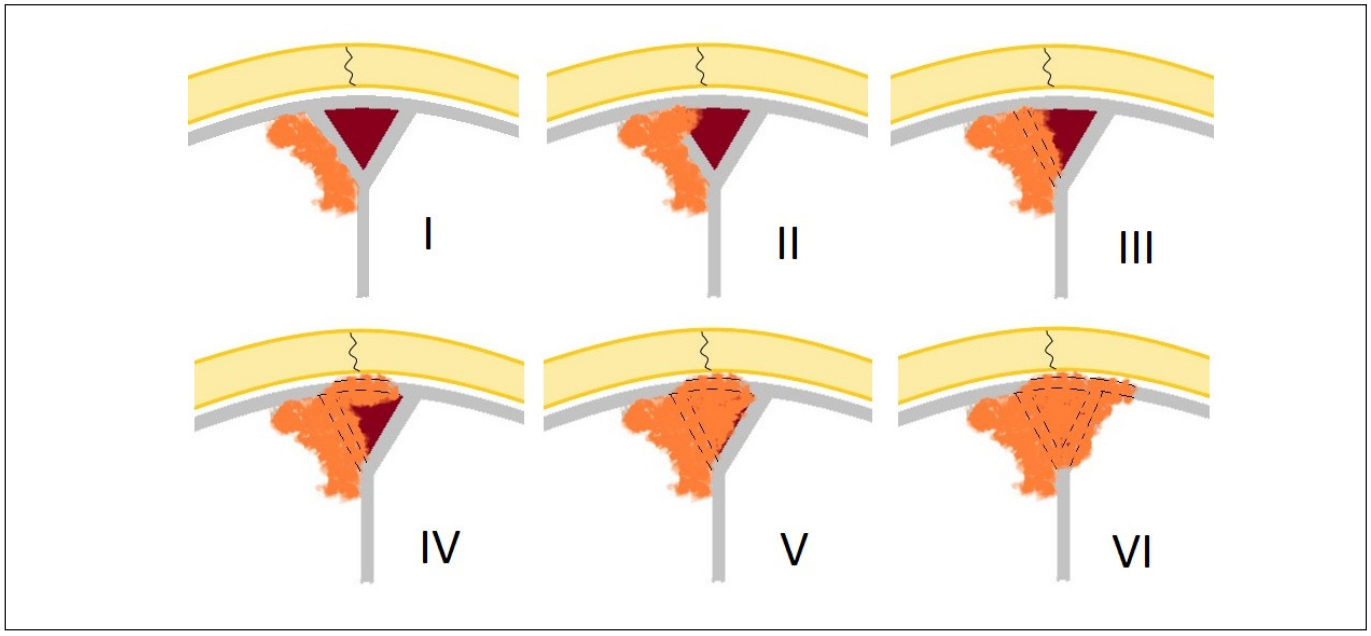

Figure 1: Illustration showing different aspects of parasagittal meningiomas according to the original description from Sindou Classification - adapted from Sindou (29).

A) FACT-G

		Not at all	A little bit	Some-what	Quite a bit	Very Much
	Physical Well-Being					
GP1	I have a lack of energy	0	1	2	3	4
GP2	I have nausea	0	1	2	3	4
GP3	Because of my physical condition, I have trouble meeting the needs of my family	0	1	2	3	4
GP4	I have pain	0	1	2	3	4
GP5	I am bothered by side effects of treatment	0	1	2	3	4
GP6	I feel ill	0	1	2	3	4
GP7	I am forced to spend time in bed	0	1	2	3	4
	Social/Family Well-Being					
GS1	I feel close to my friends	0	1	2	3	4
GS2	I get emotional support from my family	0	1	2	3	4
GS3	I get support from my friends	0	1	2	3	4
GS4	My family has accepted my illness	0	1	2	3	4
GS5	I am satisfied with family communication about my illness	0	1	2	3	4
GS6	I feel close to my partner (or the person who is my main support)	0	1	2	3	4
GS7	I am satisfied with my sex life	0	1	2	3	4
	Emotional Well-being					
GE1	I feel sad	0	1	2	3	4
GE2	I am satisfied with how I am coping with my illness	0	1	2	3	4
GE3	I am losing hope in the fight against my illness	0	1	2	3	4
GE4	I feel nervous	0	1	2	3	4
GE5	I worry about dying	0	1	2	3	4
GE6	I worry that my condition will get worse	0	1	2	3	4
	Functional Well-Being					
GF1	I am able to work (include work at home)	0	1	2	3	4
GF2	My work (include work at home) is fulfilling	0	1	2	3	4
GF3	I am able to enjoy life	0	1	2	3	4
GF4	I have accepted my illness	0	1	2	3	4
GF5	I am sleeping well	0	1	2	3	4
GF6	I am enjoying the things I usually do for fun	0	1	2	3	4
GF7	I am content with the quality of my life right now	0	1	2	3	4

B) FACT-Br: FACT-G questionnaire + site specific questions (brain)

		Not at all	A little bit	Some-what	Quite a bit	Very Much
	Additional Concerns					
Br1	I am able to concentrate	0	1	2	3	4
Br2	I have had seizures (convulsions)	0	1	2	3	4
Br3	I can remember new things	0	1	2	3	4
Br4	I get frustrated that I cannot do things I used to	0	1	2	3	4
Br5	I am afraid of having a seizure (convulsion)	0	1	2	3	4
Br6	I have trouble with my eyesight	0	1	2	3	4
Br7	I feel independent	0	1	2	3	4
NTX6	I have trouble hearing	0	1	2	3	4
Br8	I am able to find the right word(s) to say what I mean	0	1	2	3	4
Br9	I have difficulty expressing my thoughts	0	1	2	3	4
Br10	I am bothered by a change in my personality	0	1	2	3	4
Br11	I am able to make decisions and take responsibility	0	1	2	3	4
Br12	I am bothered by the drop in my contribution to the family	0	1	2	3	4
Br13	I am able to put my thoughts together	0	1	2	3	4
Br14	I need help in caring for myself (bathing, dressing, eating, etc.)	0	1	2	3	4
Br15	I am able to put my thoughts into action	0	1	2	3	4
Br16	I am able to read like I used to	0	1	2	3	4
Br17	I am able to write like I used to	0	1	2	3	4
Br18	I am able to drive a vehicle (my car, truck, etc.)	0	1	2	3	4
Br19	I have trouble feeling sensations in my arms, hands, or legs	0	1	2	3	4
Br20	I have weakness in my arms or legs	0	1	2	3	4
Br21	I have trouble with coordination	0	1	2	3	4
An10	I get headaches	0	1	2	3	4

C) FACT-MNG: FACT-Br questionnaire + SF-36* (questions concerning physical capabilities) + Tumor-site specific questions

		Not at all	A little bit	Some-what	Quite a bit	Very Much
	SF-36 questions					
	I am limited in performing vigorous activities, such as running, lifting heavy objects, participating in strenuous sports	0	1	2	3	4
	I am limited in performing moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	0	1	2	3	4
	I have difficulty climbing several flights of stairs	0	1	2	3	4
	I have difficulty walking several blocks	0	1	2	3	4
	I have difficulty bathing or dressing myself	0	1	2	3	4
	Parassagital/Falx Meningioma					
	My short term memory is worse	0	1	2	3	4
	My leg is weak	0	1	2	3	4
	My leg is numb	0	1	2	3	4
	My arm is weak	0	1	2	3	4
	My arm is numb	0	1	2	3	4
	I have a blind spot in my vision	0	1	2	3	4

Figure 2: Questionaires of the assessed scales in the study: **A)** FACT-G questionaire; **B)** FACT-Br site-specific questions **C)** FACT-MNG.

Data Availability Statement

All data generated or analyzed during this study area included in this article. Further enquiries can be directed to the corresponding author.

RESULTS

The mean age was 49.11 years (4.4–74.1) at the time of surgery and 59.39 years (16.1–84.7) at the time of the last assessment. The mean follow-up duration was 9.98 years (0.68–37.34).

There was a predominance of women (84.4%) among the included patients. Only one patient had type 2 neurofibromatosis, with the others being non-syndromic.

Tumor volume ranged between 0.9 and 209.9 mL (mean 40.1 mL). Moreover, 42.2%, 35.5%, and 22.2% of the lesions were located in the middle third, anterior third, and posterior third of the SSS, respectively.

Most tumors were classified as Sindou type I (31.1%), followed by type II (24.4%), type IV (17.8%), type III (13.3%), and type VI (11.1%).

Gross total resection was achieved in 82.2% of the patients (64.4%, 17.8%, and 17.8% of the resections were classified as Simpson I, II, and IV, respectively). Moreover, 41 patients (91.1%) had World Health Organization (WHO) grade 1 meningiomas, whereas 4 (8.9%) had grade 2 meningiomas.

The mean preoperative KPS score was 93.8 (60–100), with the majority being 100 (66.7%). There was a small reduction in the mean KPS score [to 92.5 (60–100)] during the immediate postoperative period, and recovery in the last KPS evaluated [to 93.3 (70–100)]. Evolution of KPS was summarized in Table I.

Overall, the mean FACT-G, FACT-Br, and FACT-MNG scales scores were 98.4/108 (55–108; SD: 12.9), 179.3/200 (98–200; SD: 22.4), and 219.3 (119–248; SD: 29.7), respectively.

We found considerable variability in the scare scores among those with the same KPS during the last assessment. These findings are summarized in Table II.

Preoperative KPS score was significantly associated with the scores of both FACT-Br [difference between means of –21.64; 95% CrI (–34.04, –9.59)] and FACT-MNG [difference between means of –31.88; 95% CrI (–47.24, –15.25)]. However, after adjusting for tumor volume and location as covariates, no significant association had been observed.

Conversely, the KPS score at the time the scales were completed was not significantly associated with the values obtained from the scales.

No significant association was found between tumor size and QoL. Similarly, no significant association was observed between lesion location and scale scores, between greater sinus invasion and worse QoL, and between the extent of resection and QoL scores.

The results of the statistical analysis are summarized in Table III.

Table I: Evolution of KPS. Numbers of Individuals in Preoperative, Early Postoperative and Late Postoperative Periods were Specified

KPS value	Preoperative	Early postoperative	Late postoperative
100	31	30	28
90	5	4	8
80	2	2	6
70	4	8	3
60	2	1	0
50	1	0	0

DISCUSSION

Meningiomas are common benign intracranial tumors that are characteristically slow-growing and, eventually, asymptomatic (20). PSM accounts for 21%–31% of intracranial meningiomas (9).

Table II: Variability in Scale Scores According to KPS Range

KPS	Number of patients	Scale	Minimum	Maximum	Average (SD)
70	3 (6.7%)	FACT-Br	119/200	145/200	129.7 (11.1)
		FACT-MNG	133/248	164/248	153.0 (14.2)
80	6 (13.3%)	FACT-Br	153/200	183/200	168.7 (10.4)
		FACT-MNG	189/248	224/248	201.1 (12.7)
90	8 (17.8%)	FACT-Br	156/200	191/200	177.2 (12.2)
		FACT-MNG	189/248	227/248	216.0 (14.9)
100	28 (62.2%)	FACT-Br	98/200	200/200	187.4 (19.3)
		FACT-MNG	119/248	248/248	231.2 (24.7)

Table III: Statistical Analysis of Associations between the Scores on FACT-Br and FACT-MNG Scales and the Following Variables: KPS, Size, Location, Simpson Grade and Sindou Type. Associations with Statistical Significance were Highlighted in Bold

Category	Variable	Model	Average difference	CrI 95%
Preoperative KPS (100 vs <100)	FACT-Br	Simple	-21.64	**-34.04, -9.59**
	FACT-MNG		-31.88	**-47.24, -15.25**
	FACT-Br	Covariates: localization and volume	-9.26	-25.73, 4.84
	FACT-MNG		-16.21	-36.16, 3.48
Last KPS (100 vs <100)	FACT-Br	Simple	-9.78	-24.95, 5.55
	FACT-MNG		-15.35	-33.25, 3.48
	FACT-Br	Covariates: Simpson	-10.12	-23.98, 4.88
	FACT-MNG		-16.21	-34.51, 2.34
Simpson	FACT-Br	I vs II-IV	7.95	-6.35, 23.26
	FACT-MNG		12.63	-5.91, 32.42
Sindou	FACT-Br	I-II vs III-VI	-3.36	-17.03, 9.93
	FACT-MNG		-3.1	-21.53, 14.63
Location	FACT-Br	Mid vs Ant and Post	4.07	-9.81, 17.13
	FACT-MNG		6.73	-9.98, 24.43
Size	FACT-Br	S vs M	-2.24	-20.09, 15.44
		S vs L	-1.01	-20.83, 17.52
		M vs L	1.24	-15.27, 17.46
	FACT-MNG	S vs M	-6.33	-26.73, 15.43
		S vs L	-2.18	-25.05, 21.88
		M vs L	4.16	-17.85, 26.88

Ant: *Anterior third,* ***CrI:*** *Credibility interval,* ***L:*** *Large size,* ***M:*** *Middle size,* ***Mid:*** *Middle third,* ***Post:*** *Posterior third,* ***S:*** *Small size;* ***vs:*** *versus.*

While surgery offers the potential for cure, the prospect of surgical excision raises concerns regarding eventual functional deficits and possible deleterious effects on QoL (20,30). However, only a few studies have assessed QoL using standardized and validated scales (20). Most of the available research had used Short-Form 36 (SF-36) or EuroQol-5D scales that, though validated, are crude instruments for specifically evaluating central nervous system diseases (30).

Although the brain module of the FACT scale (FACT-Br) can overcome these drawbacks, this scale is designed to assess malignant diseases and side effects of adjuvant therapy (20,30).

One study that used an adapted FACT-Br questionnaire in 165 meningioma patients found that 77% of the patients self-reported satisfaction with QoL. The authors defined satisfaction with QoL based on answers of "quite a bit" or "very much" to question GF7 ("are you satisfied with your quality of life"). Using this criterion, 86.7% [39] of our patients can be considered satisfied with their QoL. Nonetheless, given that different sites of meningiomas had been grouped, comparisons between the present and previous studies was not possible (20). Meningiomas have heterogeneous clinical presentations depending on location, and different QoL impairments are expected (35). Therefore, we opted to evaluate only patients with PSM in our study.

Differences in meningioma locations along the SSS influences both clinical presentation and surgical difficulty. Lesions located in the anterior third of the SSS have been described as the most favorable, with the SSS being generally resectable *en bloc* without clinical impairment in this location. Moreover, a lower mortality rate has been reported in this subset of patients (9). Lesions located in the posterior third of the SSS are the least frequent and least studied, although visual impairment and seizures have been described (3,9). However, Biroli et al. had described favorable outcomes for PSMs located in the posterior third of the SSS, which were comparable to those located in other SSS areas (3). PSMs located in the middle third of the SSS were associated with a higher incidence of transient or permanent motor function deterioration as either a presenting symptom or during the postoperative period. Thus,

some authors have correlated this location to worse functional outcomes (12) and higher mortality rates (9).

Therefore, for comparative analysis, patients were grouped according to the location of the PSM, namely middle third and non-middle third. However, no significant association was found [mean differences: FACT-Br 4.07, 95% CrI (9.81, 17.13); FACT-MNG 6.73, 95% CrI (9.98, 24.43)]. Similarly, other studies showed no association between location and postoperative complications (19), functional status (9), or discharge disposition (19).

The extent of SSS invasion has been suggested to increase surgical complexity (5,29), risk for complications (15), and higher recurrence rates (2). Similarly, lesion size has been associated with increased SSS invasion, higher reoperation rates (16), WHO histological grades 2 and 3 (23), need for irradiation (16), and greater peritumoral brain edema (27). Lesions <3 cm have also been associated with better functional status (33).

In contrast, the current study did not demonstrate worse QoL results in patients with greater Sindou type [I–II vs. III–VI mean difference for FACT-Br –3.36, 95% CrI (–17.93, 9.93) and FACT-MNG –3.1, 95% CrI (–21.53, 14.63)] or larger tumors [S vs L mean difference for FACT-Br –1.01, 95% CrI (–20.83, 17.52) and FACT-MNG –2.18, 95% CrI (–25.05, 21.88)]. Accordingly, other studies found no correlation between functional outcomes and tumor size (9,19) or extent of SSS invasion (19). Moreover, our findings for long-term survivors showed that these factors may not be critical for this subset of patients.

The extent of resection has been identified as an independent factor for tumor recurrence (7,11,18,25), with studies showing higher KPS scores for those with Simpson grade I–II disease (33). However, our findings did not demonstrate better QoL scores for Simpson I patients [mean difference for FACT-Br 7.95, 95% CrI (–6.35, 23.26) and FACT-MNG 12.63, 95% CrI (–5.91, 32.42)].

Given that FACT-MNG scales have not been evaluated in the published series, no comparison could be made with our results. However, we believe that the mean score of 219.3/248 (SD 29.7), though heterogeneous and associated with high KPS scores, represented favorable outcomes for most patients.

FACT-Br was quantitatively analyzed in meningioma patients, with mean scores of 146.1 and 131.7 for non-epileptic and epileptic patients, respectively (32). Similarly, another study showed that baseline scores for brain metastasis patients ranged from 143.6–144.4 (6). Therefore, our patients demonstrated better results compared to those included in the previous study (mean: 179.3; SD 22.4).

The variability of the scores among those with the same KPS score highlights the importance of a structured QoL assessment. KPS functional assessment may overlook impairments in QoL, for which good outcomes must be sought (30). A difference of ≥10 points in the total QoL scales score was considered clinically relevant (6), and a SD of 11.1, 10.4, 12.2, and 19.3 were found for KPS scores of 70, 80, 90, and 100, respectively, which suggested the heterogeneity of these groups of patients. Moreover, no significant association was found between the KPS at the time of the assessment and overall scores. However, preoperative KPS scores appear to be a risk factor for long-term QoL impairment both in FACT-Br [difference between means of –21.64; 95% CrI (–34.04, –9.59)] and FACT-MNG [difference between means of –31.88; 95% CrI (–47.24, –15.25)].

Limitations

The number of questions and time spent answering them may be a noteworthy drawback and limiting factor for routine clinical use of the scales.

Another limitation of this study was that we assessed long-term survivors, among whom surgical complexity may not be an important factor.

Moreover, selection bias is noteworthy: only 45 of the 136 could be contacted and consented to participate.

CONCLUSION

Given that PSMs are complex diseases, QoL assessments help physicians understand the impact of surgical treatment on the patients. Our series demonstrated favorable long-term QoL results and that factors associated with greater surgical complexity were not associated with worse QoL or functional status. Despite the importance of QoL assessments in surgical planning and follow-up, this has been the first study to assess QoL specifically in PSM patients. Considering the heterogeneity and complexity of this disease, the decision for surgical treatment should include not only functional status but also expected QoL.

DATA AVAILABILITY STATEMENT

All relevant data generated or analyzed during this study area included in this article. Further enquiries can be directed to the corresponding author.

AUTHORSHIP CONTRIBUTION

Study conception and design: RIP, SNFS, RAMC, DCA, RSO, BOC

Data collection: RIP, SNFS, RAMC

Analysis and interpretation of results: RIP, SNFS, RAMC, DCA, RSO, BOC

Draft manuscript preparation: RIP, SNFS, RAMC

Critical revision of the article: RIP, SNFS, RAMC, DCA, RSO, BOC

Other (study supervision, fundings, materials, etc...): RSO, BOC

All authors (RIP, SNFS, RAMC, DCA, RSO, BOC) reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Alvernia JE, Sindou MP: Preoperative neuroimaging findings as a predictor of the surgical plane of cleavage: Prospective study of 100 consecutive cases of intracranial meningioma. J Neurosurg 100(3):422-430, 2004
2. Balik V, Kourilova P, Sulla I, Vrbkova J, Srovnal J, Hajduch M, Takizawa K: Recurrence of surgically treated parasagittal meningiomas: A meta-analysis of risk factors. Acta Neurochir 162(9):2165-2176, 2020
3. Biroli A, Chiocchetta M, Gerosa M, Talacchi A: Surgical treatment of parasagittal and falcine meningiomas of the posterior third. Acta Neurochir 154(11):1987-1995, 2012
4. Böker DK, Meurer H, Gullotta F: Recurring intracranial meningiomas. Evaluation of some factors predisposing for tumor recurrence. J Neurosurg Sci 29(1):11-17, 1985
5. Bonnal J, Brotchi J: Surgery of the superior sagittal sinus in parasagittal meningiomas. J Neurosurg 48(6):935-945, 1978
6. Brown PD, Ballman KV, Cerhan JH, Anderson SK, Carrero XW, Whitton AC, Greenspoon J, Parney IF, Laack NNI, Ashman JB, Bahary JP, Hadjipanayis CG, Urbanic JJ, Barker FG, Farace E, Khuntia D, Giannini C, Buckner JC, Galanis E, Roberge D: Postoperative stereotactic radiosurgery compared with whole brain radiotherapy for resected metastatic brain disease (NCCTG N107C/CEC·3): A multicentre, randomised, controlled, phase 3 trial. Lancet Oncol 18(8):1049-1060, 2017
7. Chan RC, Thompson GB: Morbidity, mortality, and quality of life following surgery for intracranial meningiomas. A retrospective study in 257 cases. J Neurosurg 60(1):52-60, 1984
8. Choy W, Kim W, Nagasawa D, Stramotas S, Yew A, Gopen Q, Parsa AT, Yang I: The molecular genetics and tumor pathogenesis of meningiomas and the future directions of meningioma treatments. Neurosurg Focus 30(5):E6, 2011
9. Colli BO, Carlotti CG, Assirati JA, Dos Santos MB, Neder L, Dos Santos AC: Parasagittal meningiomas: follow-up review. Surg Neurol 66 Suppl 3:S20-27; discussion S27-28, 2006
10. Cushing H, Meningiomas. Their classification, regional behaviour, life history, and surgical end results. Bull Med Libr Assoc 27:185, 1938
11. DiMeco F, Li KW, Casali C, Ciceri E, Giombini S, Filippini G, Broggi G, Solero CL: Meningiomas invading the superior sagittal sinus: Surgical experience in 108 cases. Neurosurgery 55(6):1263-1272; discussion 1272-1274, 2004
12. Elzarief AA, Ibrahim MF: Long-term follow-up of motor function deterioration following microsurgical resection of middle third parasagittal and falx meningioma. Egypt J Neurol Psychiatr Neurosurg 54(1):9, 2018
13. Hoessly GF, Olivecrona H: Report on 280 cases of verified parasagittal meningioma. J Neurosurg 12(6):614-626, 1955
14. Giombini S, Solero CL, Lasio G, Morello G: Immediate and late outcome of operations for Parasagittal and falx meningiomas. Report of 342 cases. Surg Neurol 21(5):427-435, 1984
15. Han MS, Kim YJ, Moon KS, Lee KH, Yang JI, Kang WD, Lim SH, Jang WY, Jung TY, Kim IY, Jung S: Lessons from surgical outcome for intracranial meningioma involving major venous sinus. Medicine 95(35):e4705, 2016
16. Hortobágyi T, Bencze J, Varkoly G, Kouhsari MC, Klekner Á: Meningioma recurrence. Open Med 11(1):168-173, 2016
17. Huntoon K, Toland AMS, Dahiya S: Meningioma: A review of clinicopathological and molecular aspects. Front Oncol 10:579599, 2020
18. Jääskeläinen J: Seemingly complete removal of histologically benign intracranial meningioma: Late recurrence rate and factors predicting recurrence in 657 patients. A multivariate analysis. Surg Neurol 26(5):461-469, 1986
19. Jimenez AE, Khalafallah AM, Huq S, Horowitz MA, Azmeh O, Lam S, Oliveira LAP, Brem H, Mukherjee D: Predictors of nonroutine discharge disposition among patients with parasagittal/parafalcine meningioma. World Neurosurg 142:e344-e349, 2020
20. Kalkanis SN, Quiñones-Hinojosa A, Buzney E, Ribaudo HJ, Black PM: Quality of life following surgery for intracranial meningiomas at Brigham and Women's Hospital: A study of 164 patients using a modification of the functional assessment of cancer therapy-brain questionnaire. J Neurooncol 48(3):233-241, 2000
21. Kallio M, Sankila R, Hakulinen T, Jääskeläinen J: Factors affecting operative and excess long-term mortality in 935 patients with intracranial meningioma. Neurosurgery 31(1):2-12, 1992
22. King MT, Stockler MR, Cella DF, Osoba D, Eton DT, Thompson J, Eisenstein AR: Meta-analysis provides evidence-based effect sizes for a cancer-specific quality-of-life questionnaire, the FACT-G. J Clin Epidemiol 63(3):270-281, 2010
23. Magill ST, Young JS, Chae R, Aghi MK, Theodosopoulos PV, McDermott MW: Relationship between tumor location, size, and WHO grade in meningioma. Neurosurg Focus 44(4):E4, 2018
24. Ostrom QT, Patil N, Cioffi G, Waite K, Kruchko C, Barnholtz-Sloan JS: CBTRUS statistical report: Primary brain and other central nervous system tumors diagnosed in the United States in 2013-2017. Neuro Oncol 22(12 Suppl 2):iv1-iv96, 2020
25. Przybylowski CJ, Hendricks BK, Frisoli FA, Zhao X, Cavallo C, Borba ML, Gandhi S, Sanai N, Almefty KK, Lawton MT, Little AS: Prognostic value of the Simpson grading scale in modern meningioma surgery: Barrow Neurological Institute experience. J Neurosurg 2020 (Online ahead of print)
26. Riemenschneider MJ, Perry A, Reifenberger G: Histological classification and molecular genetics of meningiomas. Lancet Neurol 5(12):1045-1054, 2006
27. Shin C, Kim JM, Cheong JH, Ryu JI, Won YD, Ko Y, Han MH: Association between tumor size and peritumoral brain edema in patients with convexity and parasagittal meningiomas. PLoS One 16(6):e0252945, 2021
28. Simpson D: The recurrence of intracranial meningiomas after surgical treatment. J Neurol Neurosurg Psychiatry 20(1):22-39, 1957
29. Sindou M: Meningiomas invading the sagittal or transverse sinuses, resection with venous reconstruction. J Clin Neurosci 8 Suppl 1:8-11, 2001
30. Solheim O, Jakola AS: Quality of life outcomes in meningioma surgery. Handb Clin Neurol 170:311-321, 2020

31. Spille DC, Hess K, Bormann E, Sauerland C, Brokinkel C, Warneke N, Mawrin C, Paulus W, Stummer W, Brokinkel B: Risk of tumor recurrence in intracranial meningiomas: Comparative analyses of the predictive value of the postoperative tumor volume and the Simpson classification. J Neurosurg 134(6):1764-1771, 2020
32. Tanti MJ, Marson AG, Jenkinson MD: Epilepsy and adverse quality of life in surgically resected meningioma. Acta Neurol Scand 136(3):246-253, 2017
33. Wang B, Zhang GJ, Wu Z, Zhang JT, Liu PN: Surgical outcomes and prognostic factors of parasagittal meningioma: A single-center experience 165 consecutive cases. Br J Neurosurg 36(6):756-761, 2021
34. Wilson CB: Meningiomas: Genetics, malignancy, and the role of radiation in induction and treatment. The Richard C. Schneider Lecture. J Neurosurg 81(5):666-675, 1994
35. Wu A, Garcia MA, Magill ST, Chen W, Vasudevan HN, Perry A, Theodosopoulos PV, McDermott MW, Braunstein SE, Raleigh DR: Presenting symptoms and prognostic factors for symptomatic outcomes following resection of meningioma. World Neurosurg 111:e149-e159, 2018
36. Zlotnick D, Kalkanis SN, Quinones-Hinojosa A, Chung K, Linskey ME, Jensen RL, DeMonte F, Barker FG, Racine CA, Berger MS, Black PM, Cusimano M, Sekhar LN, Parsa A, Aghi M, McDermott MW: FACT-MNG: Tumor site specific web-based outcome instrument for meningioma patients. J Neurooncol 99(3):423-431, 2010