20
The Novel "CLASS" Algorithmic Scale for Patient Selection in Meningioma Surgery

Joung H. Lee and Burak Sade

Introduction

The very basic tenet of medicine is that a treatment is given if the treatment's benefits far outweigh the risks. In the previous chapter, both benefit and risk factors for meningioma surgery were described and reviewed. To briefly reiterate, the risk factors associated with outcome following meningioma surgery include the following: patient's preoperative co-morbidity (C), tumor location (L), patient's age (A), tumor size (S), and the symptoms/signs (S) caused by the tumor. Additionally, a history of prior surgery and radiation were also found to be significant risk factors. The benefit factors, which are largely conceptual and difficult to quantify, include alteration of the natural history, with a chance to cure when Simpson grade 1 resection is performed, and reversal or improvement of neurologic signs and symptoms. Tumor size and neurologic signs/symptoms, although significant risk factors, simultaneously represent only two benefit factors in meningioma surgery. The larger the tumor, the greater is the potential benefit for the patient following surgery. Similarly, when patients present with neurologic symptoms or deficits, there is potential for reversal, improvement, or stabilization of symptoms following surgery. The more severe or reversible the symptoms or deficits are, the greater the benefit would be for the patient.

Based on the previous chapter's data relating to the factors influencing outcome following meningioma surgery, we aimed to develop a novel and simple standardized guideline to help select patients for meningioma surgery. Following the basic principle of medicine described above, this scale simply weighs and assesses the risks and benefits of surgery for an individual patient with meningioma.

The novel "CLASS" algorithm is based on balancing the risks against benefits of surgery (Fig. 20-1). Co-morbidity (C), tumor location (L), and patient age (A) are included as risk factors, whereas tumor size (S) and neurologic signs and symptoms (S) are included as benefit factors. A score is assigned to each factor: risk factors are graded from −2 to 0 while benefit factors are graded from 0 to +2. A score of +1 was added to the total score in the presence of radiographic progression and −1 for previous history of surgery and/or radiation therapy.

Co-morbidity: Co-morbidity was graded using the widely used American Society of Anesthesiologists (ASA) preoperative patient assessment scale [1]. A score of 0 was assigned for ASA Grade I patients, −1 for Grade II, and −2 for Grade III patients. Since ASA grade IV or V patients are most often not considered for meningioma surgery, these groups were not included.

Location: Tumor location was classified based on the experience of the senior author. "Low-risk" locations included convexity and lateral skull base (lateral and middle sphenoid wing, posterior petrous) and were given a score of 0. Olfactory groove, planum sphenoidale, tentorial (lateral/paramedian), parasagittal, intraventricular, cerebellopontine angle, falcine, posterior/lateral foramen magnum as well as para-sigmoid and para-transverse sinus locations constituted the "moderate risk" group and were assigned a score of −1. The "high-risk" locations included clinoidal, cavernous sinus, tuberculum sellae, tentorial (medial/incisural), ventral petrous, petroclival and anterior/anterolateral foramen magnum, for which a score of −2 was given.

Age: A score of 0 was assigned for patients who are 60 years of age or younger, −1 for 61–70 years and −2 for 71 years or older.

Size: A score of 0 was given if the maximum tumor size was 2 cm or less, +1 for between 2.1 and 4 cm, and +2 for tumors larger than 4.1 cm.

Signs and symptoms: A score of 0 was assigned for incidental tumors and +1 for mild symptoms or irreversible neurologic deficits. A score of +2 was assigned for severe symptoms or reversible neurologic deficits.

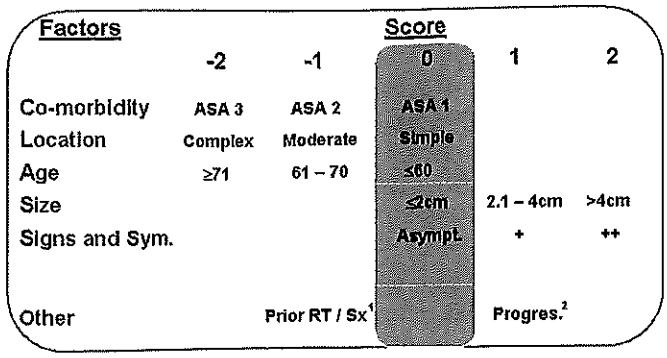

FIG. 20-1. The CLASS algorithmic scale
[1] Sx = surgery
[2] Progres. = radiographic progression

Validity of the CLASS Algorithmic Scale

The following study was conducted to test the validity of this scale by assessing the outcome with respect to the preoperative CLASS score. For all 300 patients who had been reviewed for the assessment of the risk factors, the total CLASS score was calculated and divided into three groups: Group I patients had a total score of +1 or above, Group II 0 or −1, and Group III −2 or below. Early outcome at 6 weeks was assessed using the Glasgow outcome scale (GOS) [2], and postoperative neurologic and medical complications were recorded.

Chi-square and Fisher's exact test were used for the comparison of the groups. A logistic regression model was built to compare each group in terms of the odds of having "bad" GOS (GOS 1–3) and neurologic/medical complications. A p-value of 0.05 and below was accepted as statistically significant.

Results

One hundred and nine patients (36.3%) had a CLASS score of 1 or above (Group I), 154 (51.4%) had a score of 0 or −1 (Group II), and 37 patients (12.3%) had a score of −2 or below (Group III).

Poor outcome (GOS 1-3) was seen in 1.8% (2/109) in Group I, 3.9% (6/154) in Group II, and 16.2% (6/37) in Group III patients (Fig. 20-2). The odds of poor outcome was 936% higher for Group III than that for Group I patients ($p < 0.05$) (Table 20-1). There was no statistically significant difference in outcome between Groups I and II.

Neurologic complications were encountered in 7.3% (8/109) in Group I, 15.6% (24/154) in Group II, and 24.3% (9/37) in Group III. Both Groups II and III had significantly higher odds for having neurologic complications than Group I ($p=0.021$). Medical complications were 1.8% (2/109) for Group I, 6.5% (10/154) for Group II, and 10.8% (4/37) for Group III. Similarly, Groups II and III had significantly higher odds for having medical complications as compared to Group I ($p=0.015$) (Fig. 20-3, Table 20-2).

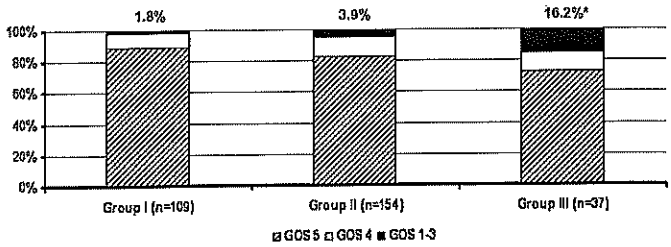

FIG. 20-2. GOS at 6 weeks according to CLASS score (* $p = 0.016$)

TABLE 20-1. Odds of Having Unfavorable Outcome According to the CLASS Score.

Factor	Odds ratio	95% Confidence interval
Total CLASS score		
Group III vs. Group I[a]	10.36	1.99–53.89
Group II vs. Group I[b]	2.17	0.43–10.95

[a] Odds of having an unfavorable outcome for Group III is 936% higher than Group I.
[b] No significant difference between Groups I and II.

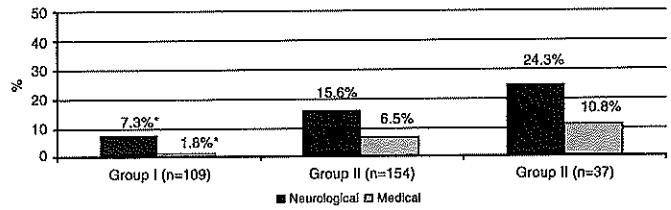

FIG. 20-3. Neurologic and medical complications according to the CLASS score (* $p = 0.021$ and 0.015, respectively).

TABLE 20-2. Odds of Having Neurologic or Medical Complications According to the CLASS Score.

Factor	Odds ratio	95% Confidence interval
Neurologic complications		
Group III vs. Group I[a]	4.06	1.43–11.48
Group II vs. Group I[a]	2.33	1.101– 5.41
Medical complications		
Group III vs. Group I[a]	6.48	1.14–37.01
Group II vs. Group I[a]	3.71	0.80–7.31

[a] Odds of having a neurologic or medical complication are significantly higher in Groups II and III, as compared to Group I.

Utility of the CLASS Algorithmic Scale

In order to assess the utility of the proposed algorithm, 236 new consecutive patients with meningiomas were prospectively evaluated in the outpatient setting between September 2004 and March 2006. Each patient was blindly assessed, and assigned to an appropriate CLASS group (I, II, or III). The decision regarding the surgical management of the patient was made by the senior author, who did not know to which group the patient was assigned.

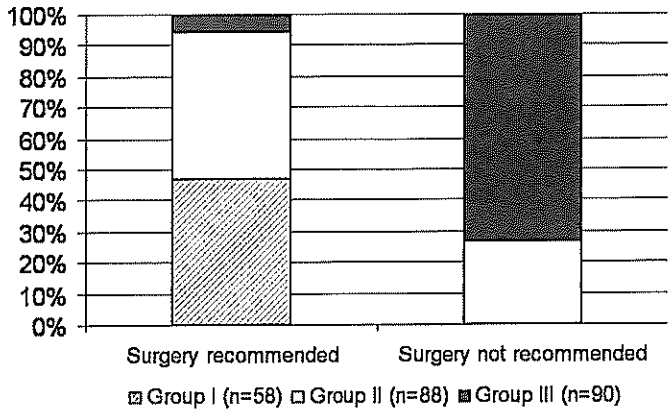

FIG. 20-4. Distribution of patients into "surgery recommended" and "surgery not recommended" groups vs. "CLASS" scores

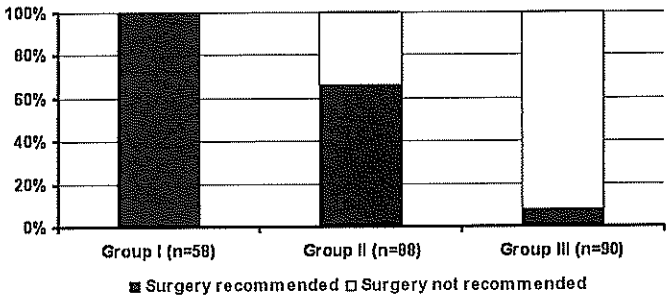

FIG. 20-5. Eligibility of patients for surgery according to CLASS groups

There were 58 patients (24.6%) in Group I, 88 (37.3%) in Group II, and 90 (38.1%) in Group III. Surgery was recommended to 123 patients (52.1%). Of these patients, 47.2% were in Group I, 47.2% in Group II, and 5.6% in Group III. Of the 113 patients for whom surgery was not deemed warranted, 26.5% were in Group II and 73.5% in Group III (Fig. 20-4). All patients in Group I and 58 (65.9%) in Group II were recommended surgery, as compared to only 7 (7.8%) in Group III (Fig. 20-5).

The high correlation of the "CLASS" scores with our decision making demonstrated the reliability and utility of this algorithm in our practice. It is important to note that all of Group I patients were recommended surgery. Only 7 patients (5.6%) in Group III were recommended surgery, all of whom had presented with progressive visual deterioration.

Case Examples

Case 1

A 58-year-old woman presented with an incidental diagnosis of a 10-mm left ventral petrous meningioma (Fig. 20-6). Her medical history was significant for a controlled hypertension, mitral valve prolapse, and a past Guillain-Barré disease. Neurologic exam was completely within normal limits. She had a total CLASS score of −3 [C:−1, L:-2, A:0, S:0, S:0]. She was managed conservatively, since the risks of the surgery exceeded its potential benefits.

Case 2

A 57-year-old woman presented with right-sided hearing loss and facial numbness. Her MRI revealed a 24-mm superior petrous meningioma on the right (Fig. 20-7). Her medical history was unremarkable. Neurologic exam confirmed a partial hearing loss on the right. Her total CLASS score was 1 [C:0, L:-1, A:0, S:1, S:1], and surgery was recommended. Note the score of

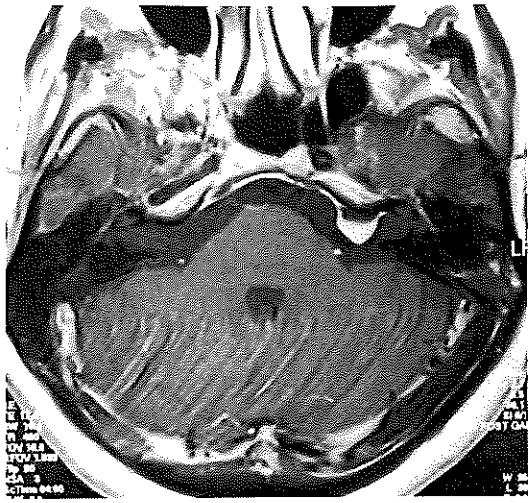

FIG. 20-6. T1-weighted postcontrast axial image of a 10-mm ventral petrous meningioma on the left

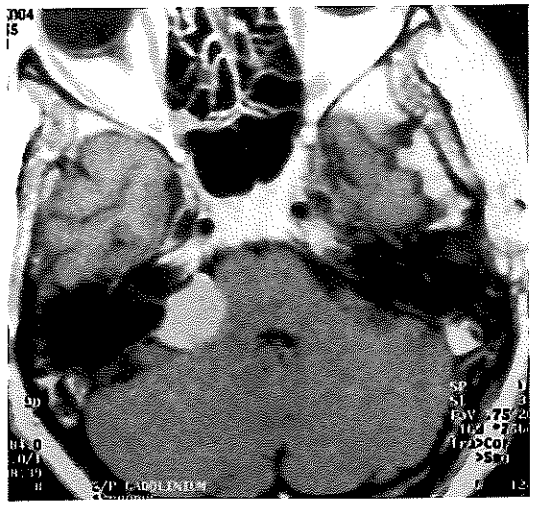

FIG. 20-7. T1-weighted postcontrast axial image of a 24-mm superior petrous meningioma on the right

symptoms of +1, since partial hearing loss on one side is generally perceived as a mild symptom, and is usually irreversible.

Case 3

A 52-year-old man presented with an incidental diagnosis of a 20-mm right antero-lateral foramen magnum meningioma (Fig. 20-8A, B). His medical history was remarkable for a controlled type 2 diabetes mellitus. His neurologic exam was completely within normal limits. His initial total CLASS score was 3[C:-1, L:-2, A:0, S:0, S:0]. The risks of the surgery exceeded the benefits and therefore he was managed conservatively.

The same patient came for his routine 6-month follow-up visit. By that time he had developed a recent onset of right-sided occipital headache and neck pain. His neurologic exam was still within normal limits, but his new MRI revealed the growth of the tumor from 20 to 28 mm (Fig. 20-8C, D). His new CLASS score was 1 [C:-1, L:-2, A:O, S:1, S:2, (O:1)]. This time the benefits of the surgery exceeded the risks, and he was recommended surgery. Note that the headache described by the patient was severe, new onset, was attributable to the tumor, and was highly likely to be reversible with its removal. Because of these features, a symptom score of +2 was assigned.

Case 4

A 78-year-old woman presented with recent onset of word-finding difficulty and a right fronto-temporal headache. Her tumor was diagnosed elsewhere, and she was managed conservatively. She presented to our clinic with her follow-up MRI, which showed a 40-mm middle sphenoid wing meningioma on the right (Fig. 20-9), which demonstrated that the tumor had grown.

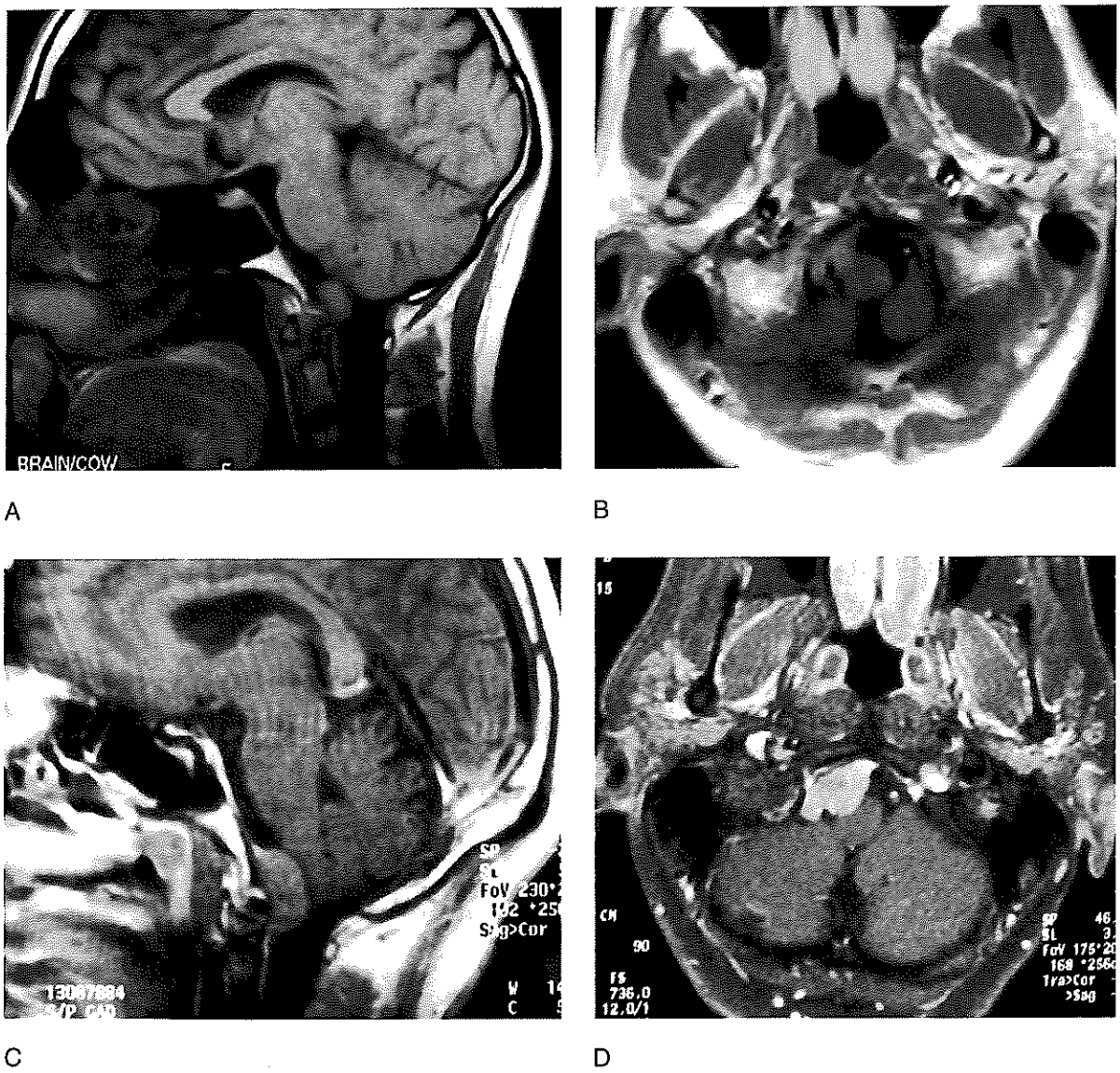

FIG. 20-8. T1-weighted (A) sagittal and (B) postcontrast axial image of a 20-mm antero-lateral foramen magnum meningioma on the right. (C) Postcontrast sagittal and (D) axial views of the same patient with the tumor reaching 28 mm in size

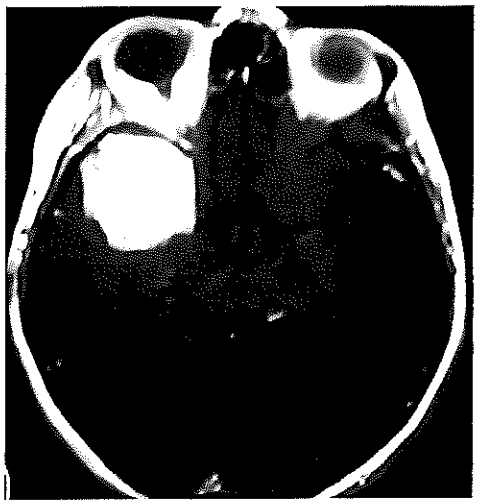

FIG. 20-9. T1-weighted postcontrast axial view of a 40-mm middle sphenoid wing meningioma on the right

Her medical history was unremarkable. Neurologic exam was normal, except for some short-term memory impairment. Her total CLASS score was 1 [C:0, L:0, A:-2, S:1, S:1, (O:1)], and she was offered surgery. It was not certain whether her memory problem was reversible or not. Therefore, her symptom score was +1. It is important to note that despite her advanced age, she was still in the lowest risk group for surgery and had an excellent postoperative outcome.

Conclusion

This simple algorithm is based on the basic tenet of surgery, which is to recommend surgery only if the benefits of the procedure far exceed the risks. It is helpful in selecting meningioma patients for surgery in incidental tumors in all age groups, patients with significant medical illnesses, young patients with small tumors, elderly patients with large tumors, as well as elderly patients with mild symptoms.

This scale is simple in its design and application. In addition to its applicability, simplicity and practicality were two of the major priorities in developing this scale. Therefore, similar to the Spetzler-Martin grading of arteriovenous malformations [3], we simply assigned a score of equal weight for each factor and avoided any further mathematical equations, which would have rendered the scale impractical and difficult to remember.

In summary, surgery is recommended for CLASS Group I and no surgery for Group III patients. For Group II patients, surgery may be considered with caution, knowing that the risks of postoperative complications and unfavorable outcome are higher than in Group I. For Group III patients, surgery can still be recommended if the circumstances of the individual case warrant surgical management (i.e., significant reversible deficit, patient preference), with the knowledge that risks of postoperative complications and unfavorable outcome are significantly higher than the other two groups.

Acknowledgments. We would like to thank Tao Jin, M.S., from the Department of Biostatistics, Cancer Center, Cleveland Clinic, for his assistance in the statistical analysis of the data.

References

1. Owens WD, Felts JA, Spitznagel EL Jr. ASA physical status classification. Anesthesiology 1978;49:239–43.
2. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet 1974;2:81–4.
3. Spetzler RF, Marin NA. A proposed grading system for arteriovenous malformations. J Neurosurg 1986;65:476–83.