中華癌醫會誌 (J. Chinese Oncol. Soc.) 25(1), 38-45, 2009

journal homepage:www.cos.org.tw/web/index.asp

Original Article

Olfactory Groove Meningiomas: Surgical Experience from 35 Cases

Shu-Mei Chen[1,2], Kuo-Chen Wei[1], Shih-Tseng Lee[1], Tai-Ngar Lui[1], Yung-Hsing Hsu[1], Tzu-Kang Lin[1], Chi-Cheng Chuang[1], Peng-Wei Hsu[1,2], Chieh-Tsai Wu[1], Tsung-Che Hsieh[1], Sai-Cheung Lee[1], Chen-Nen Chang[1]*

[1]*Department of Neurosurgery, Chang Gung Memorial Hospital, Chang Gung University, Kweishan, Taoyuan, Taiwan*
[2]*Graduate Institute of Clinical Medical Sciences, College of Medicine, Chang Gung University, Kweishan, Taoyuan, Taiwan*

Abstract.

Background: Olfactory groove meningiomas (OGMs) account for about 10% of all intracranial meningiomas. We report on the clinical outcomes and recurrence rate of OGMs after surgical treatment in our neurosurgery department.

Methods: The authors searched the database at the Department of Neurosurgery, Chang Gung Memorial Hospital, Chang Gung University, Linkou for cases of OGM treated between May 1992 and September 2005. A retrospective study was conducted by analyzing the charts of the patients. The mean follow-up period was 63 mo (range, 12–178 mo).

Results: Thirty-five patients underwent 39 OGM surgeries. Tumor diameter ranged from 2 to 7 cm (average, 4.8 cm). In 21 surgeries (53.8%), the tumor was removed by bifrontal craniotomy via a subfrontal approach; 6 surgeries (15.4%) involved bi-fronto-orbital craniotomy; 5 (12.8%) were accomplished by bifrontal craniotomy via an interhemispheric approach; 6 (15.4%) were performed via a unilateral subfrontal approach; and 1 (2.6%) was performed via a pterional approach. In the primary operations, total and subtotal removal were achieved in 29 (82.9%) and 6 patients (17.1%), respectively. Nine patients (25.7%) experienced surgery-related complications, the majority being 4 cases of cerebrospinal fluid leakage. There was no operative mortality and no new cases of permanent focal neurological deficit. No recurrences were reported in 31 patients (88.6%).

Conclusions: Although OGMs are located at the base of the skull, a well-trained neurosurgeon can use modern microsurgical techniques with an appropriate surgical approach and obtain an excellent clinical result.

Keywords **:** olfactory groove, meningioma, surgical treatment

原著論文

35 例嗅溝腦膜瘤之手術治療經驗

陳淑美[1,2] 魏國珍[1] 李石增[1] 雷大雅[1] 許永信[1] 林子淦[1] 莊啟政[1] 徐鵬偉[1,2] 吳杰才[1]
謝宗哲[1] 李世祥[1] 張承能[1]*

[1] *長庚大學長庚紀念醫院林口總院 神經外科*
[2] *長庚大學醫學院臨床醫學研究所*

中文摘要

背景：嗅溝腦膜瘤約佔所有顱內腦膜瘤之百分之十，我們在此報告本神經外科部門手術治療嗅溝腦膜瘤之臨床結果及復發率。

研究對象及方法：本文作者針對曾於 1992 年五月至 2005 年九月間，於林口長庚紀念醫院神經外科系手術治療過的嗅溝腦膜瘤個案進行調查。此一回溯研究方法為收集病歷資料再分析之，平均追蹤時間為 63 個月（12 至 178 個月）。

研究結果：總共 35 個病患經歷了 39 個嗅溝腦膜瘤手術。腫瘤大小從 2 至 7 公分，平均 4.8 公分。其中 21 個(53.8%)手術，使用雙側額部開顱術合併額葉下接近法，6 個(15.4%)使用雙側額部併眼眶開顱接近法，5 個(12.8%)使用雙側額部開顱術合併大腦半球間接近法，6 個(15.4%)使用單側額葉下接近法，1 個(2.6%)使用 pterional 接近法。在第一次手術的病例中，29 個(82.9%)達到腫瘤完全切除，另外 6 個(17.1%)達到腫瘤次全切除。共有 9 例發生術後合併症，以 4 例腦脊髓液外漏最多。並無手術相關死亡病例，亦無造成新的神經缺損。31 個(88.6%)病患無復發之發生。

探討：雖然嗅溝腦膜瘤手術屬於顱底手術，但只要是訓練良好之神經外科醫師加上先進的顯微手術技術，並選擇適當的手術接近法，就可得到極佳的手術治療結果。

關鍵字: 嗅溝、腦膜瘤、手術治療

INTRODUCTION

Meningiomas are usually benign, slow-growing tumors, originating from the arachnoidal cap cells. They account for approximately 20% of all primary intracranial tumors [1-3]. Olfactory groove meningiomas (OGMs) account for about 10% of all intracranial meningiomas [4]. Most OGMs occupy the floor of the anterior cranial fossa, extending all the way from the crista galli to the tuberculum sellae [5]. As they grow, OGMs push the optic nerves and the optic chiasm downward and posteriorly. By the time of diagnosis, OGMs are often very large and/or infiltrating or involving surrounding vascular or nervous structures, making tumor removal challenging.

A number of varied surgical approaches have been applied for tumor removal. Traditionally, frontal or bifrontal craniotomy combined with a subfrontal approach is used most often. More recently, however, some surgeons have used a pterional or interhemispheric approach. More extended approaches, including transbasal, subcranial, and fronto-orbital approaches, frontal or bifrontal craniotomy combined with orbital or nasal osteotomies, and craniofacial resection have been utilized for resection of OGMs expanding into the paranasal sinuses, nasal cavity, or orbits.

In this article, we present the clinical results from the surgical treatment of 35 patients with OGMs via bifrontal, unilateral subfrontal, pterional, interhemispheric, and bi-fronto-orbital approaches.

MATERIALS AND METHODS

Patient Population

From May 1992 through September 2005, our neurosurgical team operated on 35 patients with OGM tumors from among 1693 patients with intracranial meningiomas at the Department of Neurosurgery, Chang Gung Memorial Hospital, Chang Gung University, Taipei, Taiwan.

There was a significant female predominance (22 patients; 62.9%). Patient ages ranged from 32 to 68 y (average, 50.9 y) (Table 1). All patients underwent preoperative and postoperative neuroimaging studies,

***Corresponding author**: Chen-Nen Chang M.D.

*通訊作者：張承能醫師

Tel: +886-3-3281200 ext.2412

Fax: +886-3-3285818

E-mail: justin@cgmh.org.tw

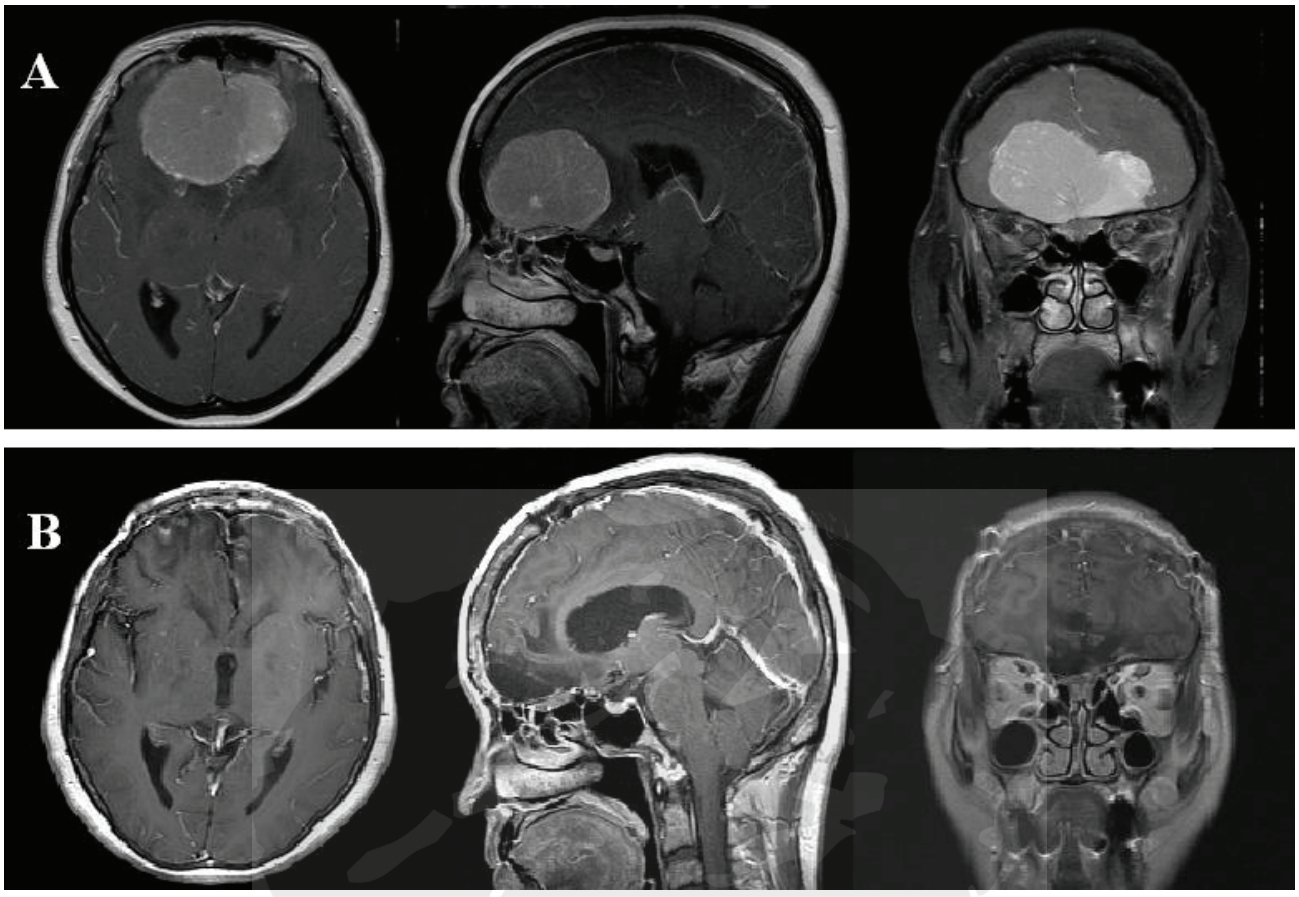

Figure 1. A, MRI scan with gadolinium enhancement revealing a large olfactory groove meningioma. B, postoperative MRI scan with gadolinium enhancement showing no evidence of tumor recurrence 2 years after resection

including computed tomography (CT) and/or magnetic resonance imaging (MRI) (Figure 1).

Twenty-seven patients (77.1%) had tumors 4 cm or more in diameter. Tumors were centered on the midline in 29 patients (82.9%). Six tumors (17.1%) extended laterally (4 to the right, 2 to the left). No patient showed a tumor extending to the ethmoidal sinus, frontal sinus, nasal cavity, and/or the orbital area.

Surgical Approaches

These 35 patients underwent a total of 39 operations, including 4 secondary operations for the treatment of recurrence or regrowth. The surgical goal was radical tumor resection, unless safe removal was precluded by significant invasion of the vascular complex or optic nerves.

Twenty-one surgeries (53.8%) in patients with large tumors were performed through bifrontal craniotomy with the subfrontal approach, and 6 surgeries (15.4%) were performed via a bi-fronto-orbital approach. Five patients (12.8%) were operated on via an interhemispheric approach. We used the unilateral subfrontal approach in 6 surgeries (15.4%) and the pterional approach in 1 surgery (2.6%) for small and/or lateralized tumors.

The bifrontal, unilateral-subfrontal, interhemispheric, and pterional approaches were performed as described previously. The bi-fronto-orbital approach was made through a bi-frontal craniotomy with additional bilateral supraorbital rim osteotomy.

Table 1. Demographic data of 35 patients operated for olfactory groove meningioma

Characteristics	No. of patients (%)
Sex	
Male	13 (37.1%)
Female	22 (62.9%)
Age (yr)	
Mean	50.9
Range	32~68

RESULTS

Clinical Features

Headache (18 patients; 51.4%), changes in the mental function (11 patients; 31.4%), and anosmia (10 patients; 28.6%) were the most common symptoms on presentation. At the time of presentation, 9 patients (25.7%) demonstrated visual impairment, 8 (22.9%) had epilepsy, while 7 (20.0%) had motor deficits (Table 2).

Surgery

Total removal in the primary operation was achieved in 29 patients (82.9%) and in 32 of the total 39 operations (82.1%). Subtotal removal in primary operation was achieved in 6 patients (17.1%), with the tumor adhering to the optic nerve and/or the vascular structures (Table 3).

Morbidity and Mortality

The most frequent postoperative complication was cerebrospinal fluid (CSF) leakage, which occurred in 4 surgeries (10.3%) and resulted in 1 wound infection (2.6%). Rhinorrhea was seen in 1 of these patients, and it ceased after several days of lumbar drainage. CSF leakage from the wound was seen in the other 3 patients; in 1 patient, it ceased after several days of lumbar drainage, while in another, it was stanched by externally compressing the wound with gauze. The third patient with persistent CSF leakage underwent reoperation for dura repair. Two patients (5.1%) suffered from intracranial hematoma, and surgical evacuation was performed. Both hemorrhages occurred in the tumor bed after surgeries using the interhemispheric approach. One patient (2.6%) had deep vein thrombosis. There were no reports of seizures immediately after surgery. There was no new permanent neurological deficit besides anosmia. The postoperative complications are demonstrated by the classification of surgical approach in the Table 4.

Recurrence

Among the 29 patients who had undergone surgeries with total removal in the primary operations, 3 suffered from an OGM recurrence, necessitating a secondary operation. In 1 of these patients, the recurrence was detected by CT imaging 7 y and 10 mo after the first surgery, and he needed another operation to treat it. The pathological reports from his first operation indicated meningothelial meningioma; however, the tumor had progressed to malignant meningioma by the time of the second operation. In another case where total removal was achieved in the first operation, a recurrence necessitated a secondary operation 1 y 6 mo after the first surgery. The histological diagnosis from both operations was atypical meningioma.

Subtotal removal in the primary operation was achieved in 6 patients. Five of these patients did not report regrowth from 12 to 77 mo after the surgery (average, 49.2 mo). In the sixth case, a residual tumor growth was found within 1 y after subtotal resection

Table 2. Presenting signs and symptoms in olfactory groove meningioma patients

Signs and symptoms	No. of patients (%)
Headache	18 (51.4%)
Mental change	11 (31.4%)
Olfactory impairment	10 (28.6%)
Visual impairment	9 (25.7%)
Seizure	8 (22.9%)
Motor deficit	7 (20.0%)
Incontinence	2 (5.7%)
Sinusitis	1 (2.9%)
Hallucination	1 (2.9%)

(Simpson grade IV) by bifrontal craniotomy with the subfrontal approach. This patient underwent a second operation with subtotal removal via the pterional approach, taking into account the tumor attachment to the optic nerve and internal carotid artery.

DISCUSSION

In 1938, Cushing and Eisenhardt published a report describing the clinical presentation and surgical treatment of 29 patients with OGM [3]. Surgical techniques have evolved since then, and OGM has been the subject of many publications, but the optimal surgical approach is still equivocal. At present, the approaches vary from a wide craniotomy to minimally invasive techniques. The bifrontal approach, proposed by Tönnis [6], is advocated for large OGMs. This approach allows less retraction on the frontal lobes and facilitates direct exposure to almost every side of the tumor.

The disadvantages of the subfrontal approaches have been stressed by authors who proposed the pterional approach for the removal of OGMs [7-9]. The pterional approach provides a lateral frontobasal exposure, which provides easier access to the anterior cerebral artery, internal cerebral artery, and optic nerve. However, the distance to the contralateral portion is increased if the tumor has extended widely.

In our surgical series, bifrontal craniotomy with the subfrontal approach was used in a majority of patients. A unilateral subfrontal approach is preferred by some authors for small tumors [4,10-12]. In our surgical series, the unilateral subfrontal approach was also used for small and/or lateralized OGMs.

Cranial base approaches have been developed recently. The addition of basal osteotomy to the procedure allows a lower exposure for tumor removal and reduces brain retraction. Variations include transbasal, subcranial, and fronto-orbital approaches, frontal or bifrontal craniotomy combined with orbital or nasal osteotomies, and craniofacial resection. The tumor invasion into the frontal base can be accessed easily, facilitating early detachment of the tumor. Disadvantages of these approaches include the time-consuming nature and the higher risk of CSF fistula caused by the opening of the frontal sinus. In our series, extension to the paranasal sinuses was not seen in any patient. Patients who develop a tumor expanding into the paranasal sinuses or orbits may be referred to ENT surgeons, thus eliminating chances of neurosurgical follow-up. Although there was no predominant tumor invasion in the paranasal sinuses or orbits, 6 tumors were removed via bi-fronto-orbital approaches, because of the advantages of less brain retraction and direct exposure to the frontal base.

With the advent of microsurgical techniques, the mortality rates in surgeries for OGMs have declined to

Table 3. Outcome according to surgical approach

Approach	No. of operations	Total resection	Subtotal resection	Recurrence	Residual growth
Bifrontal craniotomy with subfrontal	21	19	2		1
Interhemispheric	5	4	1	2	
Bi-fronto-oribital	6	4	2		
Unilateral subfrontal	6	5	1	1	
Pterional	1		1		
Total	39	32	7	3	1

near zero [4,7,9,13,14]. However, there are still potential surgical complications, including CSF leakage, meningitis, postoperative hemorrhage, subdural hygroma, worsening vision, motor deficits, and postoperative seizure [5,12,15,16]. Some authors have argued that opening the frontal sinus during bifrontal or unifrontal approaches creates the risk of CSF fistulas and subsequent infection [7,9]. Even in our series, the most frequent postoperative complication was CSF leakage, which occurred in 4 surgeries (10.3%), including 1 CSF rhinorrhea, and resulted in 1 wound infection. Three happened in cases of bifrontal craniotomy with the subfrontal approach, and 1 in a bi-fronto-orital approach. These results are consistent with the belief that opening the frontal sinus during craniotomy creates the risk of CSF fistula or infection. In case of postoperative CSF rhinorrhea, lumbar drainage is usually sufficient for treatment [17], as was shown in 1 patient in our surgical series. Postoperative intracranial hematoma with resultant surgical evacuation was observed in 2 patients, both treated via an interhemispheric approach. The narrow operative field may have resulted in incomplete hemostasis.

Since the advent of modern microsurgery, the percentage of gross total tumor resection of OGMs has ranged from 77.3 to 100% in microsurgical series [9,17-22]. The percentage of gross total resection (Simpson Grade I or II) was also high (82.9%) in our primary surgical series. The separate rates of total tumor removal did not differ significantly among the different approaches used in our series.

In the literature, the recurrence rate for OGMs ranged from 5 to 41% after 10 to 20 years of follow-up [12,16,18,19,23,24]. The tumor recurrence rate depends on the extent of tumor removal and the duration of the follow-up period. In our surgical series, the overall tumor recurrence rate was 11.4% during a follow-up period of 5.3 years. The recurrence rate in patients undergoing operation via the interhemisphric approach was higher (40%) compared with that via other approaches. No recurrences were seen in patients operated through the bifrontal or bi-fronto-orbital approach with total resection. Only 1 residual growth developed after subtotal resection via the bifrontal approach. The choice of approach seems to influence tumor recurrence, excluding the extent of tumor resection. We believe that the greater length and narrow operative field in the management of the dural attachment and/or hyperostotic bone make the extent of tumor removal difficult, resulting in a higher recurrence rate for the interhemispheric approach.

CONCLUSIONS

We analyzed a series comprising a variety of surgical approaches for the treatment of OGM with a long follow-up period in Taiwan. The clinical results were good—zero operative mortality, low morbidity, and low recurrence or regrowth rate. The risk of postoperative intracranial hematoma and recurrence rate for OGMs surgery seem to be higher by interhemi-

Table 4. Postoperative complications according to surgical approach[a]

Approach	No. of operations	CSF leak/ rhinorrhea	Wound infection	ICH	Brain swelling	DVT
Bifrontal craniotomy with subfrontal	21	3	1			1
Interhemispheric	5			2		
Bi-fronto-oribital	6	1			1	
Unilateral subfrontal	6		1			
Pterional	1					
Total	39	4	2	2	1	1

[a]CSF, cerebrospinal fluid; ICH, intracranial hemorrhage; DVT, deep vein thrombosis

spheric approach.

Although the OGMs are located at the base of the skull, a well-trained neurosurgeon can use modern microsurgical techniques with an appropriate surgical approach and obtain a good clinical result.

REFERENCES

1. McDermott MW, Wilson CB. Meningiomas. In: Youmans JR, ed. Neurological Surgery. Fourth ed. Philadelphia: WB Saunders Company, pp2782-2825, 1996.
2. Rachlin JR, Rosenblum ML. Etiology and biology of meningiomas. In: Al-Mefty O, ed. Meningiomas. New York: Raven Press, pp27-35, 1991.
3. Cushing H, Eisenhardt L. The olfactory meningiomas with primary anosmia. In: Cushing H, Eisenhardt L, ed. Meningiomas. Springfield: Charles C. Thomas, pp 250-282, 1938.
4. Symon L. Olfactory groove and suprasellar meningiomas. In: Krayonbühl H, ed. Advances and Technical Standards in Neurosurgery. Vienna: Springer-Verlag, pp 67-91, 1977.
5. Bakay L, Cares HL. Olfactory meningiomas: report on a series of twenty-five cases. **Acta Neurochir 26:** 1-12, 1972.
6. Tönnis W. Zur Operation der Meningeome der Siebbeinplatte [in German]. **Zentralbl Neurochir 1:** 1-7, 1938.
7. Hassler W, Zentner J. Pterional approach for surgical treatment of olfactory groove meningiomas. **Neurosurgery 25:** 942-947, 1989.
8. Hassler W, Zentner J. Surgical treatment of olfactory groove meningiomas using the pterional approach. **Acta Neurochir Suppl 53:** 14-18, 1991.
9. Turazzi S, Cristofori L, Gambin R, et al. The pterional approach for the microsurgical removal of olfactory groove meningiomas. **Neurosurgery 45:** 821-826, 1999.
10. Kempe LG. Operative Neurosurgery. New York: Springer-Verlag, pp 104-108, 1968.
11. Obeid F, Al-Mefty O. Recurrence of olfactory groove meningiomas. **Neurosurgery 53:** 534-543, 2003.
12. Solero CL, Giombini S, Morello G. Suprasellar and olfactory meningiomas: report on a series of 153 personal cases. **Acta Neurochir 67:** 181-194, 1983.
13. Ojemann RG. Olfactory groove meningiomas. In: Al-Mefty O, ed. Meningiomas. New York: Raven Press, pp 383-392, 1991.
14. Samii M, Ammirati M. Olfactory groove meningiomas. In: Samii M, ed. Surgery of the Skull Base: Meningiomas. Berlin: Springer-Verlag, pp 15-25, 1992.
15. El Gindi S. Olfactory groove meningioma: surgical techniques and pitfalls. **Surg Neurol 54:** 415-417, 2000.

16. Melamed S, Sahar A, Beller AJ. The recurrence of intracranial meningiomas. **Neurochirurgia 22:** 47-51, 1979.
17. Nakamura M, Struck M, Roser F, et al. Olfactory groove meningiomas: clinical outcome and recurrence rates after tumor removal through the frontolateral and bifrontal approach. **Neurosurgery 60:** 844-51, 2007.
18. Mirimanoff RO, Dosoretz DE, Linggood RM, et al. Meningioma: analysis of recurrence and progression following neurosurgical resection. **J Neurosurg 62:** 18-24, 1985.
19. Tsikoudas A, Martin-Hirsch DP. Olfactory groove meningiomas. **Clin Otolaryngol 24:** 507-509, 1999.
20. Hentschel SJ, DeMonte F. Olfactory groove meningiomas. **Neurosurg Focus 14(6):** e4, 2003.
21. Goffin J, Fossion E, Plets C, et al. Craniofacial resection for anterior skull base tumours. **Acta Neurochir 110:** 33-37, 1991.
22. Spektor, Valarezo J, Fliss DM, et al. Olfactory groove meningiomas from neurosurgical and ear, nose, and throat perspectives: approaches, techniques, and outcomes. **Neurosurgery 57:** 268-79, 2005.
23. 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:** 461-469, 1986.
24. Mathiesen T, Lindquist C, Kihlstrom L, et al. Recurrence of cranial base meningiomas. **Neurosurgery 39:** 2-9, 1996.