Clinical Research

The Eyebrow Mini-Craniotomy for Olfactory Groove Meningiomas

Necati ÜÇLER[1,a], Ali NEHİR[1], Yiğit AKSOĞAN[1], Berna UĞUR[2], Murat GEYİK[1]

[1]*Gaziantep University, Department of Neurosurgery, Gaziantep, Türkiye*
[2]*Gaziantep University, Department of Anesthesiology and Reanimation, Faculty of Medicine, Gaziantep, Türkiye*

ABSTRACT

Objective: Open craniotomies and nasal approaches are the most common ways to treat olfactory groove meningiomas. However, the supraorbital eyebrow approach has been used in some cases recently. We aimed to evaluate the patients' surgical outcomes who were treated with the supraorbital eyebrow approach.

Material and Method: We evaluated 17 patients with olfactory groove meningiomas undergoing the supraorbital eyebrow approach from February 2018 to November 2022. A retrospective analysis of patients was performed with eyebrow approaches of our database of 17 who had supraorbital craniotomy for olfactory groove meningioma removal. Patients were evaluated based on pathology, resection rate, complications, and cosmetic results.

Results: Patients' grade with olfactory groove meningioma was World Health Organization grade 1, and the mean Ki-67 was 1.4. The resection grade was Simpson Grade 1. The satisfaction of patients with cosmetic outcomes was perfect. None of the patients underwent postoperative reoperation. Only one patient underwent rehospitalization in the postoperative period for evaluation due to a suspected wound infection.

Conclusion: Supraorbital eyebrow craniotomy is an effective keyhole approach for the surgery of olfactory groove meningiomas. Future surgical treatment of more types of anterior fossa lesions, with increasing patient numbers and multicenter studies, will employ this technique.

Keywords: *Supraorbital Eyebrow, Olfactory Groove, Meningioma.*

ÖZ

Olfaktuvar Oluk Menenjiomları İçin Kaş İçi Mini-Kraniyotomi

Amaç: Olfaktuvar oluk menenjiomları genellikle açık kraniyotomi ve burun yaklaşımlarıyla tedavi edilirken, son dönemlerde seçilmiş vakalarda supraorbital kaş içi yaklaşımı uygulanmaktadır. Bu çalışmada kaş içi yaklaşımla cerrahi yapılan hastaların cerrahi sonuçları değerlendirilmiştir.

Gereç ve Yöntem: Şubat 2018 ile Kasım 2022 tarihleri arasında supraorbital kaş içi yaklaşımı ile olfaktüvar oluk menenjiomu ameliyatı geçiren 17 hasta retrospektiv olarak incelenmiştir. Hastaların patolojik bulguları, rezeksiyon oranları, komplikasyonları, ve kozmetik sonuçların değerlendirilmesi yapılmıştır.

Bulgular: Hastaların tamamında olfaktuvar oluk menenjiomu bulunmakta olup, Dünya Sağlık Örgütü grade 1 olarak sınıflandırılmıştır ve ortalama Ki-67 proliferasyon indeksi 1.4 bulundu. Rezeksiyon derecesi Simpson grade 1 olarak belirlenmiştir. Kozmetik sonuçlardan elde edilen hasta memnuniyeti mükemmel düzeydedir; hiçbir hasta postoperatif yeniden müdahale gerektirmemiştir. Postoperatif dönemde yalnızca bir hasta, şüpheli yara enfeksiyonu nedeniyle yeniden hastaneye yatırılmıştır.

Sonuç: Hastaların tamamında olfaktuvar oluk menenjiomu bulunmakta olup, Dünya Sağlık Örgütü grade 1 olarak sınıflandırılmıştır ve ortalama Ki-67 proliferasyon indeksi 1.4 bulunmuştur. Rezeksiyon derecesi Simpson grade 1 olarak belirlenmiştir. Kozmetik sonuçlardan elde edilen hasta memnuniyeti mükemmel düzeydedir; hiçbir hasta postoperatif yeniden müdahale gerektirmemiştir. Postoperatif dönemde yalnızca bir hasta, şüpheli yara enfeksiyonu nedeniyle yeniden hastaneye yatırılmıştır.

Anahtar Sözcükler: *Supraorbital Kaş, Olfaktuvar Oluk, Menenjiom.*

Bu makale atıfta nasıl kullanılır: Üçler N, Nehir A, AksoğanY, Uğur B, Geyik M. Olfaktuvar Oluk Menenjiomları İçin Kaş İçi Mini-Kraniyotomi. Fırat Tıp Dergisi 2025; 30(4): 217-222.

How to cite this article: Ucler N, Nehir A, AksoganY, Ugur B, Geyik M. The Eyebrow Mini-Craniotomy for Olfactory Groove Meningiomas. Firat Med J 2025; 30(4): 217-222.

ORCID IDs: N.Ü. 0000-0002-0561-5819, A.N. 0000-0003-2254-6840, Y.A. 0000-0003-0002-8786, B.U. 0000-0003-0044-363X, M.G. 0000-0003-2166-9144.

Today, cosmetic results are considered important in medical applications as well as morbidity and mortality. In general, cranial pathologies and the surgical approaches used to treat them are associated with significant risk. While minimally invasive surgery may come to mind for patients with a small skin incision, surgeons prefer to access the pathology through a corridor that provides the best view and minimizes damage to the surrounding tissue (1). Patients and surgeons have different perspectives on the approach they choose. Minimally invasive methods are approaches that bring these two sides closer to each other.

A variety of surgical approaches have been used to treat olfactory groove meningioma, including largely invasive, extended bifrontal, interhemispheric, orbitozygomatic, pterional, and nasal approaches (2-6). These approaches are generally sufficient. However, cosmetic results in these approaches can be a cause for concern. By combining the instruments used in narrower corridors with the microscope, researchers have

[a]Yazışma Adresi: Necati Üçler, Gaziantep University, Department of Neurosurgery, Gaziantep, Türkiye
Tel: 0505 479 2933 e-mail: necati_ucler@yahoo.com
Geliş Tarihi/Received: 29.11.2024 Kabul Tarihi/Accepted: 04.06.2025

developed various minimally invasive methods in transcranial pathologies (6, 7). Among these, supraorbital eyebrow mini-craniotomy (eyebrow approach) is used safely today (1, 7-9).

Primarily, the eyebrow approach is effective in treating anterior fossa tumors, arachnoid cysts, and aneurysms (10). The eyebrow approach allows for easy visualization of the ipsilateral frontal lobe, the medial part of the contralateral frontal and ipsilateral temporal lobes, the ipsilateral Sylvian fissure, the ipsilateral olfactory groove, the cribriform plate region, the parasellar region, and the prepontine cistern in the surgical field (11, 12).

We evaluated the results of olfactory groove meningiomas operated in our clinic with the supraorbital eyebrow mini-craniotomy approach, together with the literature.

MATERIAL AND METHOD

Clinical materials

This study was initiated after the approval of our faculty's local ethics committee (approval number: 2023/201). We retrospectively evaluated 17 patients who underwent surgical treatment of olfactory groove meningiomas evacuation in our hospital between February 2018 and November 2022.

We obtained data from the patient's records and directly reviewed the imaging. Demographic and clinical characteristics included age, sex, vision impairment, and anosmia. Within 48 hours before surgery, we evaluated the tumor characteristics and suitability for the surgical approach using computed tomography (CT) and magnetic resonance imaging (MRI).

Patients older than 18 years of age who had previously undergone olfactory meningioma surgery with the eyebrow approach and meningioma cases located mainly in the cavernous sinus, sella, diaphragm, and clinoid were not included in the study.

There are no definitive indications for the supraorbital approach. However, we believe the following factors should be considered when evaluating the surgical approach: (1) If the tumor extends from the cribriform plate into the ethmoid sinus, the supraorbital approach alone may not be sufficient according to Simpson grade 1. (2) If the defect in the nasal sinuses cannot be adequately repaired during the supraorbital approach, another approach should be considered.

Surgical Technique

After general anesthesia, endotracheal intubation, and placement of a Foley catheter, the patient is fixed in a Mayfield three-pin head holder with two pins on the ipsilateral posterior cranium and the one-pin site on the contralateral frontal bone. We operated on patients with the head elevated to enhance jugular venous drainage, reflected the head backward to augment gravity-assisted brain retraction, and used no retractors.

Depending on the location of the lesion, it would be more appropriate to choose the non-dominant side so that the dominant frontal lobe is least damaged, especially to reach both sides.

The skin incision was limited to the eyebrow starting from just 0.5-1 cm lateral to the supraorbital notch (Figure 1). The skin incision length was approximately 3-4 cm. For cosmetic concerns, the orbicularis oculi muscle was pushed down, and the frontalis muscle was cut flush with the skin incision. Placing the skin incision laterally to the supraorbital notch is crucial to prevent forehead numbness due to damage to the supraorbital nerve during surgery.

The pericranium was incised starting from the anterior end of the linea temporalis following retraction of the upper edge of the skin incision using fish hooks. A small D-shaped 3.0 by 1.5 cm craniotomy was performed in the supraorbital area. The skin incision is made along the eyebrow without cutting the hair of the eyebrow (Figure 1).

After the inner lip of the orbital rim and orbital prominences were drilled out, the dura was opened in a C-shaped fashion and reflected inferiorly. Following gentle retraction of the frontal lobe, cerebrospinal fluid (CSF) was aspirated till identification of the ipsilateral optic nerve and carotid artery (Figures 1, 2).

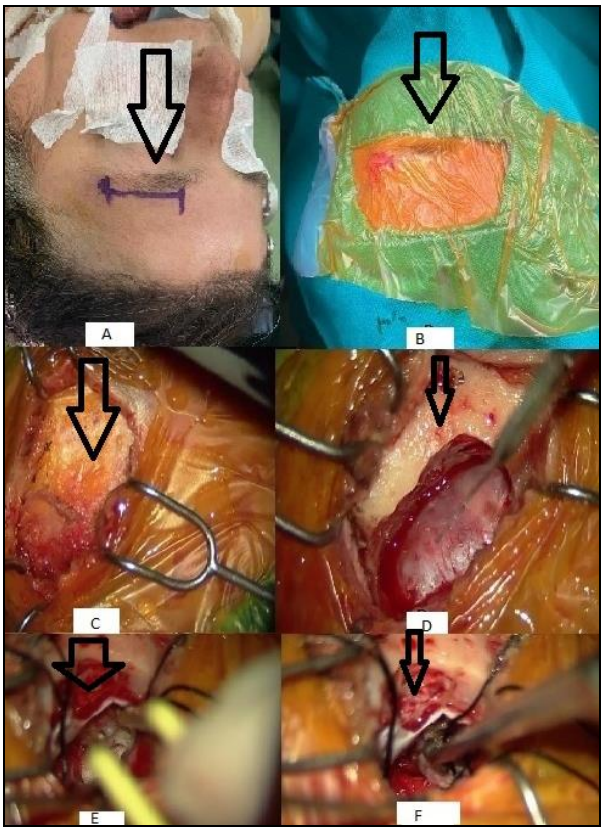

Figure 1. A: *The skin incision was limited to the eyebrow starting from just 0.5-1 cm lateral to the supraorbital notch,* ***B:*** *The sterile draping of the surgical field,* ***C:*** *Skin incision,* ***D:*** *Dural opening,* ***E:*** *Operation and hemostasis by bipolar cautery,* ***F:*** *Removal of the tumor.*

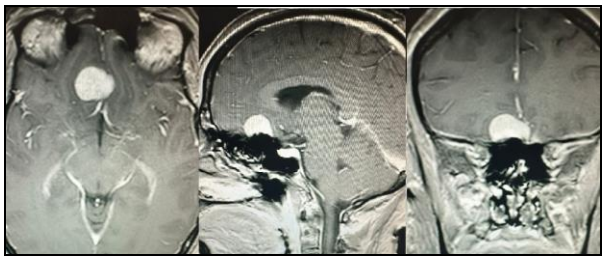

Figure 2. *The MRI showing the tumor before surgery.*

The medial part of the tumor was dissected until freeing the tumor from the peripheral structures (Figure 1, 2). After the tumor was de-vascularized and debulked, the tumor was resected (Simpson Grade 1). The bleeding was controlled and stopped. The dura was closed watertight. The bone flap was replaced and fixed with mini plates.

Routine follow-up MRI or CT were obtained regularly at 72 hours, 3, 6, and 12 months postoperatively (Figures 3, 4).

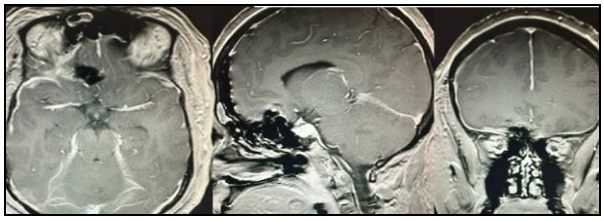

Figure 3. *The MRI showing postoperative surgical excision of the tumor.*

Figure 4. *3D CT showing the postoperative bony anatomy of the approach.*

Statistical Analysis

Data were analyzed using both Microsoft Excel (Microsoft, Redmond, Washington) and GraphPad Prism Version 6 (GraphPad Software Inc., La Jolla, California, USA). One-way analysis of variance (one-way ANOVA) was used to evaluate differences in tumor volume.

RESULTS

We retrospectively evaluated data from 17 patients between February 2018 and November 2022. The mean age was 50±5.4 years. Fifteen patients were female, and two patients were male. The mean follow-up time was 11.4±5 months. All of their patients had follow-up periods of up to 3 months. The average hospital stay was 3.7 days. Table 1 displays the patients' information.

Table 1. *Patients'characteristics.*

The demographic features of the study	Value
Total patients	17
Total operations	17
Female	15
Male	2
The mean age (years)	50 ± 5.4years
The mean length of follow-up (months)	11.4 ± 5 months
The mean max tumor volumer (cm^3)	20.0 ± 14.2 cm3 (range 2.2– 45.9 cm3)
Length of hospital stay (days)	3.7 days
Death	0/17

At the time of discharge, 3/17 patients had graded frontalis palsy. It was observed that these improved in the controls within the first month. All of the patients reported that they were satisfied with the cosmetic results at the 3-month follow-up. The frontal sinus was entered in 2/17 patients and obliterated with adipose tissue. None of these patients had a cerebrospinal fistula, wound infection, forehead collapse, or a problem requiring reoperation in the early or late postoperative period (Table 2).

Table 2. *The surgical results.*

Olfactory groove meningiomas	15/17(WHO grade 1), 2/17 (WHO grade 2)
Mean Ki-76 index	1.4 % (range: 1-3%).))
Mean Operation duration	2.4 hours
Frontal sinus entry	1/17 (%5.8)
Anosmi	1/17
Frontalis palsy	3/17
Temporalis atrophy, eyealopesia, CSF fistula, supraorbital pseudomeningocele	0/17
Lumbar drainage	1/17
Tumor resection (Simpsongrade)	1
Meningitis	0/17
Recurrence at follow-up	0/17
The mean skin incision length	4 cm

None of the patients had eyebrow alopecia or temporal muscle atrophy. The patients reported no additional complaints regarding their chewing functions. None of our patients developed stroke, postoperative hematoma, a supraorbital pseudomeningocele, or a seizure. No

additional preventive medical treatment for seizures was given. Anosmia developed in 1/17 of our patients postoperatively, and anosmia resolved in this patient's 2-month follow-up. The pathology results indicated that 15 patients had meningiomas classified as World Health Organization grade 1, while 2 patients had grade 2 meningiomas. The mean preoperative tumor volume was 20.0±14.2 cm^3 (range 2.2-45.9 cm^3). All our patients underwent Simpson grade 1 olfactory groove meningioma resection, which involves the complete removal of the underlying bone and associated dura. Mean Ki-67 indexes were 1.4% (range: 1-3%). During the follow-up, no patient showed any signs of recurrence.

The average duration of the operation was 2.4 hours, during which we did not administer any additional blood elements or transfusions. We readmitted one of our patients, who had a frontal sinus entry, to the hospital for a skin infection evaluation one month after discharge, but we did not perform any additional procedures or operations.

Only one patient underwent preoperative lumbar drainage for brain relaxation during dissection, and this was removed in the early postoperative period.

DISCUSSION

In the neurosurgical discipline, where exposure is everything, cosmetics are essential, full respect for normal anatomy is required, and maximum resection of pathology is aimed for, there were serious discussions when "supraorbital eyebrow mini-craniotomy" was first applied in olfactory groove meningiomas (5, 13). It is natural to have concerns about each surgical intervention during a supraorbital eyebrow mini-craniotomy. However, with the increase in case volumes and the publication of long-term results, these concerns gradually diminished. The development of complications and their resolution with neurosurgical methods has encouraged surgeons. In this study, we shared the results of the patients we treated with supraorbital eyebrow mini-craniotomy for olfactory groove meningiomas. Our results seem consistent with the literature. Based on this, we think that a similar microsurgery method was used in line with the literature.

In our study, 17 olfactory groove meningioma patients were evaluated. Despite the absence of recurrence in our Simpson grade 1 resection patients and the absence of mortality in our postoperative follow-ups, we anticipate satisfactory surgical outcomes, including cosmetic problems and short hospital stays.

Most surgeons avoid the supraorbital eyebrow mini-craniotomy approach due to the potential legal issues associated with an incision in a socially prominent facial area. However, for cosmetic results, the skin incision should be cut aesthetically, monopolar and bipolar bleeding should be avoided as much as possible, and these conditions can be managed with tampons and retractors. In our study, temporalis atrophy, eye alopecia, CSF fistula, and supraorbital pseudomeningocele were seen in 0/17 patients. In another study, high cosmetic results were reported (14). In the study, cosmetic satisfaction among patients is high: in 1 study, 84% of patients rated their cosmetic outcome as "very pleasant," and the rate of permanent frontalis palsy was 2.1% (9). The rate of permanent forehead numbness was 3.4% (13). Although it is necessary to be careful when dissecting the skin, subcutaneous, bone, and muscle in cosmetic results, we think the same situation should be maintained in closing the last part of the surgery and dressing.

In our study, we performed Simpson grade 1 resection on 17 patients with olfactory groove meningioma. The mean max tumor volume was 20.0±14.2 cm^3 (range 2.2-45.9 cm^3). Our patients did not affect the cavernous sinus, the optic apparatus, the carotid artery, and the pituitary infundibulum structures. If these structures are affected, our surgical view will be reduced with the supraorbital eyebrow mini-craniotomy approach, and we will not be able to dissect vascular and neurological structures. We believe that Simpson Grade 1 and 2 resections were successfully performed with this approach, as the tumors in our study patients were relatively small in volume and did not compress vital neurovascular structures.

Our mean follow-up period was 11.4±5 months. We did not have any additional recurrences during this period. Despite the request for a longer follow-up, we anticipate no recurrence, given our mean Ki-76 index of 1.4% (range: 1-3%), which includes total tumor resection. In this context, future studies can evaluate our tumor volume and degree of resection for potential recurrence.

Performing the surgery without entering the frontal sinus is essential regarding infection and CSF fistula. However, when we encounter this complication, it can be managed with classical frontal sinus-filling methods such as abdominal fat tissue and frontal sinus cranialization. In this study, the frontal sinus occurred in 2/17 (11.7%) patients. Other studies (3, 4) have estimated this rate to be approximately 21.6%. Although these numerical data vary depending on the number of patients and surgical technique, it is a manageable problem in general. The literature review identified CSF leakage and wound complications as the most common complications (5,15). It has been emphasized that olfactory groove meningiomas are located in the midline as CSF problems and that methods that prevent dura and CSF fistula may not be adequately performed during surgery. Although this is valid for giant meningiomas, our microsurgery and the tumor volume we applied could easily be seen on the recessed cribriform plate. In addition, our lumbar drainage application in the preoperative period not only facilitated the dissection but also helped to prevent postoperative CSF fistula. The presence of CSF fistula and supraorbital pseudomeningocele 0/17 in our study may be related to this. Despite the potential for CFS fistula complications during the supraorbital eyebrow mini-craniotomy approach, a

study found this problem to be more manageable and less common compared to the endoscopic method (2, 14, 16).

Our study had several limitations. This was a single-center study and, therefore, may have been subjected to selection bias. However, the use of this surgical technique is becoming widespread, and the results will be more evident as all these study results are published soon. Hence, we instituted strict inclusion and exclusion criteria. Our sample size was small, and we performed a short-term follow-up. The general drawback of minimal cranial approaches is the loss of proximal control of arterial structures during surgery due to the small size of the surgical space. In our study, no serious complications were encountered due to our relatively small space. New approaches that are alternatives to classical surgical approaches are rightly always approached with hesitation. It is natural to have reservations about this approach. However, with increased technical skills, this approach may be an alternative to the different concerns and wishes of selected patient groups. Our results may guide future studies in similar groups.

Supraorbital eyebrow mini-craniotomy can be used in the treatment of many anterior fossae, from arachnoid cysts to aneurysms, and the approach that is likely to become routine in some selected cases should be multicenter with a large number of patients. We evaluated the complications in our study and managed them using classical microsurgery solutions. The supraorbital eyebrow mini-craniotomy method is safe, gives good cosmetic results, and may have lower morbidity rates. It allows for good exposure, resection, and release of neurovascular structures. Adding endoscopy, neuronavigation techniques, and imaging techniques during surgery will, of course, make it easier to remove more large tumors that affect neurovascular structures with fewer problems.

REFERENCES

1. Czirják S, Szeifert GT. The role of the superciliary approach in the surgical management of intracranial neoplasms. Neurol Res 2006; 28:131-7.
2. Bitter AD, Stavrinou LC, Ntoulias G et al. The Role of the Pterional Approach in the Surgical Treatment of Olfactory Groove Meningiomas: A 20-year Experience. J Neurol Surg B Skull Base 2013; 74: 97-102.
3. Feigl GC, Staribacher D, Britz G, Kuzmin D. Minimally Invasive Approaches in the Surgical Treatment of Intracranial Meningiomas: An Analysis of 54 Cases. Brain Tumor Res Treat 2024; 12: 93-9.
4. Fountas KN, Hadjigeorgiou GF, Kapsalaki EZ, Paschalis T, Rizea R, Ciurea AV. Surgical and functional outcome of olfactory groove meningiomas: Lessons from the past experience and strategy development. Clin Neurol Neurosurg 2018; 171: 46-52.
5. Roa Montes de Oca JC, Gonçalves Estella JM, Nieto-Librero AB et al. Olfactory Groove Meningiomas: Comprehensive assessment between the different microsurgical transcranial approaches and the Endoscopic Endonasal Approaches, systematic review and metanalysis on behalf of the EANS skull base section. Brain Spine 2022; 2: 101661.
6. Xie B, Qin C, Zhang S, Zhang C et al. A novel classification for guiding the surgical approach for cranio-orbital lesions: a single institution case series of 45 cases and a literature review. Neurosurg Rev 2024; 47: 71.
7. Zador Z, Gnanalingham K. Eyebrow craniotomy for anterior skull base lesions: how I do it. Acta Neurochir (Wien) 2013; 155: 99-106.
8. Paladino J, Mrak G, Miklić P, Jednacak H, Mihaljević D. The keyhole concept in aneurysm surgery--a comparative study: keyhole versus standard craniotomy. Minim Invasive Neurosurg 2005; 48: 251-8.

9. Park J, Woo H, Kang DH, Sung JK, Kim Y. Superciliary keyhole approach for small unruptured aneurysms in anterior cerebral circulation. Neurosurgery 2011; 68: 300-9
10. Ansari SF, Eisenberg A, Rodriguez A, Barkhoudarian G, Kelly DF. The Supraorbital Eyebrow Craniotomy for Intra- and Extra-Axial Brain Tumors: A Single-Center Series and Technique Modification. Oper Neurosurg (Hagerstown) 2020; 19: 667-77.
11. Li Y, Rey-Dios R, Roberts DW, Valdés PA, Cohen-Gadol AA. Intraoperative fluorescence-guided resection of high-grade gliomas: a comparison of the present techniques and evolution of future strategies. World Neurosurg 2014; 82: 175-85.
12. Sastry R, Bi WL, Pieper S et al. Applications of Ultrasound in the Resection of Brain Tumors. J Neuroimag 2017; 27: 5-15.
13. Reisch R, Perneczky A, Filippi R. Surgical technique of the supraorbital key-hole craniotomy. Surg Neurol 2003; 59: 223-7.
14. Banu MA, Mehta A, Ottenhausen M et al. Endoscope-assisted endonasal versus supraorbital keyhole resection of olfactory groove meningiomas: comparison and combination of 2 minimally invasive approaches. J Neurosurg 2016; 124: 605-20.
15. Ormond DR, Hadjipanayis CG. The Supraorbital Keyhole Craniotomy through an Eyebrow Incision: Its Origins and Evolution. Minim Invasive Surg 2013; 2013: 296469.
16. Komotar RJ, Starke RM, Raper DM et al. Endoscopic endonasal versus open transcranial resection of anterior midline skull base meningiomas. World Neurosurg 2012; 77: 713-24.