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ADVANTAGES AND DISADVANTAGES OF THE SUPRAORBITAL KEYHOLE APPROACH TO INTRACRANIAL ANEURYSMS

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SUMMARY – The fundamental tendency to be as minimally invasive as possible and to achieve a maximum of efficacy in the treatment of patients has existed since the beginning of surgery. In treating intracranial aneurysms the most widely used approach is pterional or frontotemporal approach described by Yasargil. The increasing knowledge of microsurgical anatomy, improved preoperative diagnostic techniques, and well adapted microsurgical instruments have led to the development of minimally invasive approaches. The supraorbital keyhole approach *via* an eyebrow incision is one of these minimally invasive procedures. Since it was first described by Perneczky it has raised debates on its advantages and disadvantages. The authors present their experience in using the supraorbital keyhole approach in treating intracranial aneurysms.

Key words: *Intracranial aneurysm – surgery; Craniotomy – methods; Neurosurgical procedures; Surgical procedures, minimally invasive*

Introduction

Surgical approaches for intracranial aneurysms were developed long time ago. The most popular approach is frontotemporal or pterional approach described by Yasargil[1,2]. This approach can be used in treating aneurysms of the anterior and posterior circulation as well. However, various surgical complications have been associated with this approach, especially the unacceptable cosmetic effect. In order to overcome these problems, the supraorbital keyhole approach was developed and described by Perneczky[3]. This approach claimed to be minimally invasive. The potential advantages of this approach are that it reduces operative morbidity, especially ameliorating the cosmetic effect. Nevertheless, the supraorbital keyhole approach suffers from some limitations.

The aim of this study was to evaluate the advantages and disadvantages of the supraorbital keyhole approach in the intracranial aneurysm surgery.

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Patients and Methods

From 1986 till 2003, 1130 patients with intracranial aneurysms were operated on at University Department of Neurosurgery, Sestre milosrdnice University Hospital, Zagreb. From 2000 till 2003, 30 patients with intracranial aneurysms were treated surgically by use of supraorbital keyhole approach. There were 18 anterior communication artery (AcoA) aneurysms, 4 internal carotid artery (ICA) aneurysms, 4 posterior communicating artery (P-comm) aneurysms, 3 middle cerebral artery (MCA) aneurysms, and one basilar artery (BA) aneurysm (Table 1).

Table 1. Patients operated on by supraorbital keyhole approach

Aneurysm location (n)	Number of cases (N=30)
Anterior communicating artery	18
Internal carotid artery bifurcation	2
ICA – anterior choroid artery	2
ICA – posterior communicating artery	4
Middle cerebral artery	3
Basilar artery	1

There were ten male and 20 female patients aged 24-78. Twenty-seven patients were operated on within the first 48 hours of subarachnoid hemorrhage (so-called early surgery). The patient with basilar artery aneurysm and two patients with P-comm aneurysms did not experience subarachnoid hemorrhage. Of 27 patients with acute subarachnoid hemorrhage, 18 patients were Hunt-Hess score 1, seven patients were Hunt-Hess score 2, and the remaining two were Hunt-Hess score 3.

According to the amount of blood on initial computed tomography (CT) of the brain, as described by Fisher, there were 15 patients with Fisher score 2, eight patients with Fisher score 3, and four patients with Fisher score 4. The patient with basilar artery aneurysm and two patients with P-comm aneurysms had no subarachnoid hemorrhage.

Postoperative recovery was expressed by a modified Rankin scale. The average postoperative follow up period was one year.

Surgical technique

The patients were placed in supine position, with head rotation by 30-60 degrees, depending on the aneurysm location. Fine adjustment of head rotation was intraoperatively accomplished by operative table movement. Eyebrow incision was used. One small burr hole at the frontozygomatic suture was made using a medium-sized burr high-speed drill. A bone flap of 3 cm in greatest diameter was adequate for brain dissection.

The dura was opened in the curvilinear fashion and reflected basally. Cerebrospinal fluid should be released by opening the basal cisterns (preoptic/optico-carotid cisterns) to facilitate brain relaxation. Forced brain retraction must be avoided. In most cases, proximal sylvian fissure dissection without temporal lobe retraction can be done. In case of brain edema, despite the removal of cerebrospinal fluid, ventriculostomy may be of use.

It is important to close the dura in a watertight fashion. If this is impossible, then duraplasty using fascia lata of a dural substitute is needed. The burred hole was filled with Gelfoam. Periorbital tear should be repaired to prevent enophthalmos. Absorbable suture material was used to close the skin incision in a continuous manner.

Results

In all 30 patients the aneurysms were successfully clipped. Postoperative recovery expressed by a modified Rankin scale is presented in Table 2. Two patients died during the first month after the surgery. The overall morbidity was 16% (5/30). In four patients we had to deal with intraoperative aneurysm rupture (ACoA=2; P-comm=1, MCA=1); five patients developed postoperative ischemia; ten of 30 patients experienced postoperative transient periorbital edema and numbness of the supraorbital area; two patients developed a mucocele from frontal sinus invasion; and one patient developed postoperative infection (Table 3). The majority of patients did not complain of their postoperative scar for cosmetic reasons.

Table 2. Postoperative results described by modified Rankin scale

Grade	Patient number (N=30)
0	7
1	8
2	5
3	5
4	3
5	2

Discussion

For years after the introduction by Yasargil, pterional approach was well accepted as the standard approach for both anterior and posterior circulation intracranial aneurysms[1,4-7]. However, since Perneczky described the supraorbital keyhole approach, many neurosurgeons have reported successful operations based on this concept[3,8-12]. Nowadays, there are many modifications of this minimally invasive surgical concept[13-18]. Basically, the keyhole concept is minimization of the size of craniotomy and, if possible, of the skin incision too. The size of craniotomy should be small yet large enough to operate without compromising the operative procedure.

Table 3. Intra/postoperative complications of supraorbital keyhole approach

Intra/postoperative complications	Number of cases (N=30)
Intraoperative aneurysm rupture	4
Postoperative ischemia	5
Periorbital edema	10
Numbness of supraorbital area	10
Mucocele from frontal sinus opening	2
Postoperative infection	1

At our Department of Neurosurgery, we performed intracranial aneurysm surgery in 1130 patients from 1986 till 2003. In most cases we used pterional approach. Due to the developing minimally invasive concept, we decided to perform the supraorbital keyhole approach in a small series of patients with intracranial aneurysms in order to compare these two approaches.

When using pterional approach, we encountered a number of previously described complications such as temporal muscle atrophy and excessive skin exposure, leading to a cosmetic deficit[19]. There was no space limitation for dissection and clipping either in anterior circulation or in posterior circulation aneurysms.

We also experienced some limitations to the keyhole approach. The major one was space limitation, especially on dealing with MCA aneurysms, in case of basilar artery aneurysm, and in patients with severe brain edema following massive subarachnoid hemorrhage.

The angle of the approach during aneurysm clipping seems to be one of the important obstacles, especially in large aneurysms. The limited size of surgical corridor (bone flap) can compromise visualization and restrict manipulation of surgical instruments in many ways.

This reflects mainly on aneurysm preparation, where, according to the literature, temporary occlusion of afferent arteries was more frequently used in supraorbital keyhole approach than in pterional approach[12,20].

In our opinion, the most appropriate intracranial aneurysms to treat *via* supraorbital keyhole approach are ACoA aneurysms, followed by ICA and P-comm aneurysms. However, some questions still exist. What does minimally invasive surgery really mean? If a lesion is treated inappropriately through a small, nontraumatic approach, this procedure cannot be considered minimally invasive but should be called maximally invasive due to the lack of efficacy. This holds true in case of specific lesions that could be treated completely through a somewhat larger approach.

The gold decision is that "surgical approach should be as large as necessary and as small as possible"[3]. As Professor Yasargil states: "The keyhole surgery does not have anything to do with a craniotomy, but it does with the brain"[4].

The supraorbital keyhole approach has proven to be one of the standard neurosurgical approaches, but it cannot replace pterional approach. The keyhole approach has many advantages, but disadvantages still persist. For neurosurgeons with less experience, the familiarity with neuroanatomy must be concerned. In cases of massive subarachnoid hemorrhage and expected brain edema, the keyhole approach is not the procedure of choice. Also, in our opinion, when treating MCA aneurysms and posterior circulation aneurysms, then pterional approach should be used. The neurosurgeons must keep in mind not to gamble with the patient's life in order to perform a minimally invasive procedure. If they feel uncertain as of which approach to use, then the conventional, pterional approach would be more appropriate. It is meaningless whether aneurysm clipping is performed through a smaller or bigger craniotomy. The postoperative results, except for the cosmetic one, do not depend on the size of craniotomy but on other factors, especially the skills of the neurosurgeon. In our opinion, the size of craniotomy, either small or large, has nothing to do with postoperative outcome in intracranial aneurysm surgery.

Nevertheless, the supraorbital keyhole approach is one of the reasonable options in the surgery of intracranial aneurysms in patients selected according to their preoperative clinical and neurological condition, and when performed by an experienced and skilful neurosurgeon.

References

1. YASARGIL MG, REICHMAN MV, KUBIN S. Preservation of the frontotemporal branch of the facial nerve using the interfascial temporalis flap for the pterional craniotomy: technical article. J Neurosurg 1987;67:463-6.
2. YASARGIL MG, FOX JL, RAY MW. The operative approach to aneurysms of the anterior communicating artery. Adv Tech Stand Neurosurg 1975;2:113-70.
3. PERNECZKY A, MULLER-FORELL W, van LINDERT E, FRIES G. Keyhole concept in neurosurgery. New York: Thieme, 1999.
4. YASARGIL MG, FOX JL. The microsurgical approach to intracranial aneurysms. Surg Neurol 1975;3:7-14.
5. LUPRET V. Microsurgical treatment and surgical approaches in treating intracranial aneurysms. In: JELIČIĆ I *et al.*, eds. Cerebrovascular surgery. Zagreb: Školska knjiga, 1985:59-72.
6. LUPRET V, VIDOVIĆ D, NEGOVETIĆ L, NOVAK M. Surgical approach to a large basilar artery bifurcation and upper basilar trunk aneurysm: case report. Surg Neurol 1990;33:404-6.
7. LUPRET V, VIDOVIĆ D, VULETIĆ S. Direct operative approach and clipping of intracavernous nontraumatic aneurysms. In: SAMII M *et al.*, eds. Surgery of the sellar region and paranasal sinuses. Berlin: Springer-Verlag, 1991:510-5.
8. MENOSVSKY T, GROTENHUIS JA, de VRIES J, BARTELS RH. Endoscope-assisted supraorbital craniotomy for lesions of the interpeduncular fossa. Neurosurgery 1999;55:106-12.

9. van LINDERT E, PERNECZKY A, FRIES G, PIERANGELI E. The supraorbital keyhole approach to supratentorial aneurysms: concept and technique. Surg Neurol 1998;49:481-90.
10. FRIES G, PERNECZKY A, van LINDERT E. Contralateral and ipsilateral microsurgical approaches to carotido-ophthalmic aneurysms. Neurosurgery 1997;41:333-43.
11. PERNECZKY A, TACHABITSCHER M, RESCH KDM. Endoscopic anatomy for neurosurgery. New York: Thieme, 1993.
12. PALADINO J, PIRKER N, ŠTIMAC D. Eyebrow keyhole approach in vascular neurosurgery. Minim Invasive Neurosurg 1998;41:200-3.
13. TANIGUCHI M, PERNECZKY A. Subtemporal keyhole approach to the suprasellar and petroclival region: microanatomic consideration and clinical application. Neurosurgery 1997;51:592-601.
14. JHO HD. Orbital roof craniotomy *via* an eyebrow incision: a simplified anterior skull base approach. Minim Invasive Neurosurg 1997;40:91-7.
15. CZIRJAK S, SZEIFERT GT. Surgical experience with frontolateral keyhole craniotomy through a superciliary skin incision. Neurosurgery 2001;48:145-50.
16. DARE AO, LANDI MK, LOPES DK, GRAND W. Eyebrow incision for combined orbital osteotomy and supraorbital minicraniotomy: application to aneurysms of the anterior circulation. J Neurosurg 2001;95:714-8.
17. STEIGER HJ, SCHMID-ELSAESSER R, STUMMER W, UHL E. Transorbital keyhole approach to anterior communicating artery aneurysm. Neurosurgery 2001;48:347-52.
18. GONZALEZ LF, CRAWFORD NR, HORGAN MA, DESHMUKH P. Working area and angle of attack in three cranial base approaches: pterional, orbitozygomatic and maxil-lary extension of the orbitozygomatic approach. Neurosurgery 2002;50:550-7.
19. WONGSIRISUWAN M, ANANTHANANDORN A, PRACHASINCHAI P. The comparison of conventional pterio-nal and transciliary keyhole approaches: pro and con. J Med Assoc Thai 2004;87:891-7.
20. JELIČIĆ I, LUPRET V, FERBER D. Temporary arterial occlusion in surgery of intracranial aneurysms. Acta Med Iug 1983;37:327-33.

Sažetak

PREDNOSTI I NEDOSTATCI SUPRAORBITALNOG PRISTUPA "KLJUČANICE" U LIJEČENJU INTRAKRANIJSKIH ANEURIZMA

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Cilj ovoga istraživanja bila je procjena prednosti i nedostataka supraorbitalnog pristupa "ključanice" u neurokirurškom liječenju intrakranijskih aneurizmatskih tvorba. Supraorbitalni pristup "ključanice" predstavlja minimalno invazivni operacijski zahvat u liječenju intrakranijskih aneurizma. Od 2000. do 2003. godine 30 bolesnika s 30 intrakranijskih aneurizma operirano je supraorbitalnim pristupom "ključanice" na Klinici za neurokirurgiju, KB "Sestre milosrdnice". U većini slučajeva bolesnici su dobro podnijeli operacijski zahvat, a poslijeoperacijski oporavak je bio zadovoljavajući. Ukupni pobol iznosio je 16%, dok su zabilježena dva smrtna slučaja zbog komplikacija nevezanih za operacijski zahvat. Supraorbitalni pristup "ključanice" predstavlja razumnu opciju u neurokirurškom liječenju intrakranijskih aneurizma kod bolesnika pažljivo prijeoperacijski odabranih s obzirom na kliničku sliku, neurološki status i lokalizaciju aneurizmatske tvorbe.

Ključne riječi: *Intrakranijska aneurizma – kirurgija; Kraniotomija – metode; Neurokirurški zahvati; Kirurški zahvati, minimalno invazivni*