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Technical Note

Suprapraorbital "key-hole" Approach for Surgical Treatment of Middle Cerebral Artery Aneurysms: Technical Limitations

Acesso Suprapraorbital "key-hole" para Tratamento Cirúrgico de Aneurismas da Artéria Cerebral Média: Limitações Técnicas

Alexandre Haddad de Souza[1]
Juan Antonio Castro Flores[1]
Carlos Eduardo Roelke[2]
Felipe Romero Vera[3]
José Carlos Esteves Veiga[1]

ABSTRACT

Objective. *To describe details and technical difficulties observed in the use of this access for the treatment of middle cerebral artery aneurysms.* ***Methods.*** *This is a retrospective study including 15 patients with middle cerebral artery aneurysm operated on using this technique (two ruptured aneurysms and 13 incidental aneurysms). We considered age, gender, laterality of the aneurysm, and whether it was ruptured. We evaluated the surgical corridor (surgical field exposure and ease of handling of the surgical instruments), surgery time, complications, functional and cosmetic results.* ***Results.*** *This access provides adequate exposure of the surgical field, but the restricted working angle makes it difficult to dissect the aneurysm and, especially, to place the definitive clip.* ***Conclusion.*** *The restriction of the working angle may compromise the safety of the surgery. It is important to determine the specific indications for this access, particularly in cases of incidental aneurysms.*

Key words: *Intracranial aneurysm; Supraorbital key-hole approach; Microsurgery .*

RESUMO

Objetivo. *Descrever pormenores e dificuldades técnicas observadas na utilização deste acesso para tratamento de aneurismas da artéria cerebral média.* ***Métodos.*** *Estudo retrospectivo de 15 doentes com diagnóstico de aneurisma da artéria cerebral média operados por esta técnica (2 aneurismas rotos e 13 incidentais). Consideramos idade, gênero, lateralidade do aneurisma, roto ou não roto. Realizamos avaliação do "corredor" cirúrgico (por meio da exposição do campo cirúrgico e conforto na manipulação de instrumentos cirúrgicos), duração do ato cirúrgico, complicações, resultado funcional pela "Glasgow outcome scale" (GOS) e cosmético.* ***Resultados.*** *Este acesso proporciona adequada exposição do campo cirúrgico, o ângulo de trabalho restrito dificulta a dissecção do aneurisma e, principalmente, a colocação do clipe.* ***Conclusão.*** *A restrição do ângulo de trabalho pode comprometer a segurança da cirurgia. É importante determinar as indicações específicas para este acesso, particularmente em casos de aneurisma incidentais.*

Palavras-chave: *Aneurisma intracraniano; Acesso supraorbitário "key-hole"; Microcirurgia.*

Introduction

Recent technological advances in neuroimaging, neuronavigation, microsurgical techniques, and especially in the endovascular treatment of intracranial aneurysms have stimulated the development of less invasive surgical procedures [1], thereby leading to a reduction in surgical time and hospitalization period and an improvement in functional and cosmetic results, while offering the same effectiveness and safety as conventional surgery [2].

Among the minimally invasive procedures, the supraorbital "key-hole" access [3] is widely used for the treatment of certain conditions, including intracranial aneurysms. In this work, we present technical details related to observations made during the application of this access approach.

Material and methods

From 2009 to 2014, the same surgical team operated on 15 patients with a diagnosis of middle cerebral artery aneurysm (two patients with ruptured aneurysms and 13 patients with

[1] MD, Hospital da Santa Casa de Misericórdia de São Paulo, São Paulo , Brazil
[2] MD, Hospital do Servidor Estadual, São Paulo , Brazil
[3] MD, MR, Hospital Barros Luco Trudeau, Santiago, Chile

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incidental aneurysms). The patients received information about the advantages and disadvantages of the respective approach (pterional and supraorbital "key-hole"). The selection of the approach was based on the characteristic of the aneurysm, the frontal paranasal sinus size, and the presence or absence of natural wrinkles in the frontal region.

Fig. 1. A. Supraciliar incision. **B.** Presence of natural wrinkles **C.** Incision following natural wrinkle orientation.

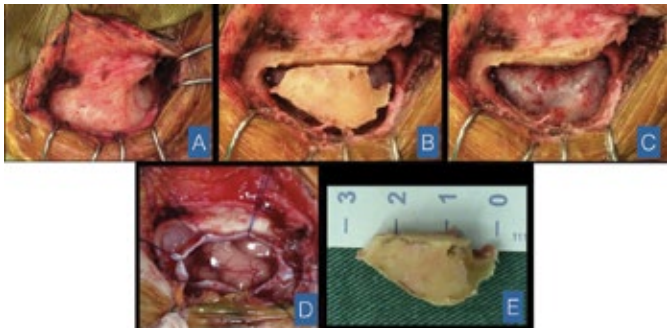

Fig. 2. A. Exposure of supraorbital region, **B.** Details of supraorbital craniotomy shape, **C.** Dural display area after craniotomy, **D.** Dural opening with basal frontal lobe exposure, **E.** Details of craniotomy extension.

The characteristics of the patient sample include age, gender, and aspects of the aneurysm. The parameters for the evaluation of the surgical corridor were:

a. Exposure of the internal carotid artery and bifurcation, and the middle cerebral artery (segment M1, bifurcation and segment M2);

b. Comfort to manipulate the surgical instruments (evaluated by the technical difficulty during the dissection and clipping).

The length of surgery (surgical time) was measured from the beginning of the incision to the completion of the cutaneous suture.

A computerized tomography (CT) scan of the skull was made in the immediate 12 hours postoperatively to detect immediate complications. The patients were evaluated on the clinic in the second week, and in the second month. At each appointment, a complete physical and neurological examination was performed.

Surgical procedure

According to the technique described by Perneczky [3]. Patients were placed in dorsal decubitus position and the head fixed with the surgical arch (Mayfield) and was positioned with 30° contralateral rotation and deflection movement, locating the malar as the highest point of the surgical field.

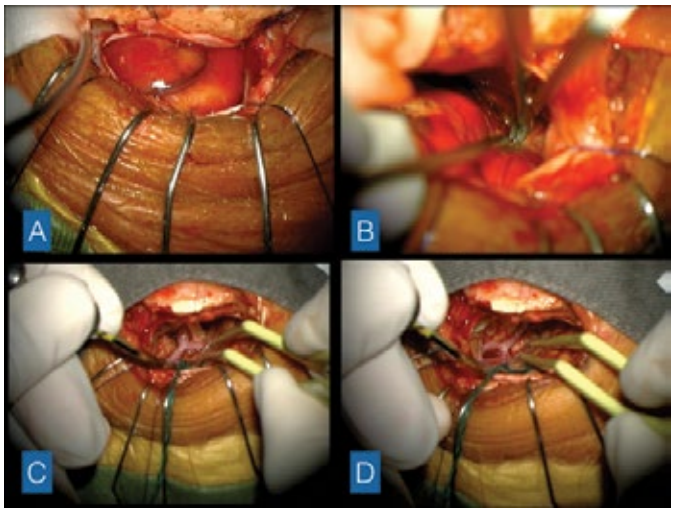

Fig. 3. A. Frontal basal exposure, **B.** "Lamina Terminalis" opening, **C.** Exposure of the optic nerve, ICA, bifurcation A1 and M1, **D.** exposure of M1, bifurcation and M2.

The cutaneous incision was initiated laterally to the supraorbital cleft ending in the superior temporal line, in the transition of the glabrous skin. In the presence of natural wrinkles, the incision was performed following the orientation of the same.

The temporal muscle is slightly dissected and retracted laterally, allowing exposure of the frontal base of the zygomatic process front. The craniotomy begins with two trepanations in this region reaching extension of approximately 2x2 cm.

In the presence of orbital bony protuberances, resection is performed a resection by drill. The dura mater is anchored and, after opening, is rebounded inferiorly.

After opening the dura mater, the basal region of the frontal lobe is exposed. At this stage, the sylvian fissure is not visible in the surgical field (Figure 3A). With the aid of the surgical microscope, a chiasmatic cistern dissection is performed to drainage of cerebrospinal fluid and obtain cerebral relaxation. In most cases, the "lamina terminalis" was opened (Figure 3B), right after this maneuver, the Sylvian fissure becomes visible

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in the surgical field and the anterograde dissection begins, with exposure of segments M2, bifurcation, M1 of the medial cerebral artery, carotid bifurcation, internal carotid and optic nerve (Figures 3 C and 3D).

Dissection performed in the aneurysm: proximal control, distal and perforating branches and anatomical neck, and finally, the placement of the definitive clip.

Table 1. Distribution of patients by age and gender.

AGE	n
41 to 50 years	2
51 to 60 years	6
61 to70 years	6
71 to 80 years	1
GENDER	
MALE	5
FEMALE	10

The closure of the dura should be watertight. If necessary, duroplasty is performed. Craniosynthesis is performed with titanium mini-plates. We use bone cement to fill bone defects. The musculocutaneous plane is sutured with absorbable wire and performed intradermal suture with 4-0 nylon wire.

Table 2. Individualized surgical time for each case.

CASE	SURGICAL TIME
1	2hs 10min
2	2hs 20min
3	2hs 05min
4	2hs 30min
5	2hs 35min
6	2hs 40min
7	2hs 19min
8	2hs 30min
9	2hs 45min
10*	3hs 15min
11	2hs 15min
12	2hs 30min
13	2hs 17min
14	2hs 20min
15	2hs 30min

**Intraoperatory rupture*

Results

A predominance of female gender (10 patients) was seen. Patients aged 51-70 years were the most frequent (range 47-74 years) (Table 1).

Eight patients had an aneurysm on the right side and seven on the left side. In eleven cases, the aneurysm was located at the bifurcation of the middle cerebral artery and four in the early frontal branch. In 13 patients, the diagnosis of the aneurysm was incidental and only two cases were related to previous subarachnoid hemorrhage and were operated on the sub-acute phase (5 and 6 days) (Table 2).

Evaluation of the surgical corridor

In all cases, we obtained adequate exposure of the ICA, carotid bifurcation, and middle cerebral artery (M1, bifurcation and M2). We observed difficulty in the dissection of the aneurysm, due to the restricted visibility and illumination, which were attenuated with the use of bayonet dissectors. In several cases, we find it difficult to place the clip as a function of limiting the working angle required by limiting the length of the craniotomy, even using tube-shaft instruments (Figure 4).

Surgery time

The mean lenght of the surgery was 2h30min (ranging from 2h5min to 2h45min). In one case lasted 3h 15 min due to the occurrence of intraoperative hemorrhage (Table 3).

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Fig. 4. Details of "tube-shaft" instruments

Complications

An intraoperative hemorrhage occurred during clip placement, in a case with prior rupture of the aneurysm. Proximal and distal temporal clippings were required to reposition the clip.

The infection rate was zero.

Surgical results

Functional result

All patients had a normal physical and neurological examination at the final evaluation in the second postoperative month GOS (Glasgow outcome scale 5). No death or sequels were seen.

Cosmetology results

No patient reported a cosmetic complaint. However, we observed apparent scarring in all. We did not observe temporal muscle atrophy (Figure 5).

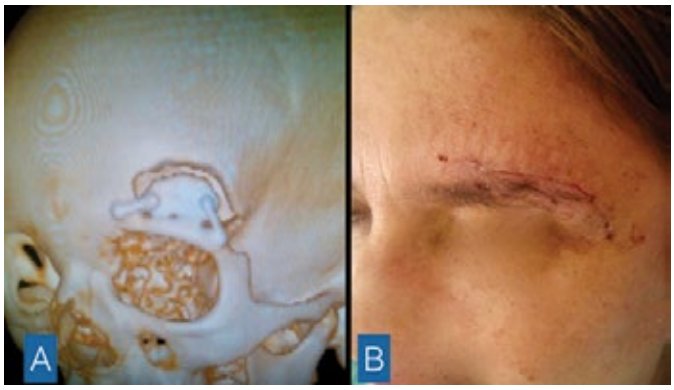

Fig. 5. A. Posoperative CT scan reconstruction illustrating the supraorbital craniotomy, **B.** Immediate postoperative aspect of the supraciliar cutaneous incision

Discussion

The classic pterional approach described by Yasargyl and Fox[4] provides a comfortable working space with adequate exposure of intracranial structures allowing several working angles. The mentioned disadvantages are mainly related to the postoperative cosmetic defect (temporal muscle atrophy and bone loss) and local pain [5].

In 1971, Wilson et al.[6] described surgeries with minimal craniotomy. In 1978, Brock described front temporal craniotomy for surgical treatment of anterior circulation aneurysms, by means of cutaneous incision of 3 to 5 cm extension [7]. In 1982, Jane described the supraorbital craniotomy with opening of the anterior orbital ceiling, minimizing the cerebral exposure and retraction [8].

In 1982, Perneczky et al. [3] described the supraorbital access "keyhole" for intracranial vascular and tumor lesions indicating advantages attributed to the smaller area of brain tissue

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exposure, short hospitalization period and better functional results. In 1998, Paladino described the supraorbital access "key-hole" [9].

Figueiredo et al. [5] demonstrated that the work area (area of exposure and working angle) in pterional mini-craniotomy is equivalent to classical access. Recent publications report the use of minimal accesses in cases of ruptured aneurysms, especially in cases of minor aneurysms and simple morphology [10, 11].

The greatest disadvantage attributed to minimally invasive accesses lies in the limited exposure of the surgical field, and especially in the restriction of manipulation of the dissecting instruments, which could compromise the safety of the surgery.

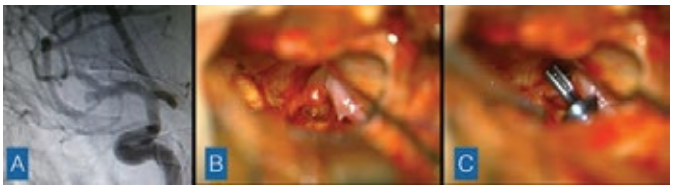

Fig 6. A. Angiographic aspect of right middle cerebral artery bifurcation and aneurysm, **B.** Intraoperative aspect of the aneurysm, **C.** After the definitive clip.

If we confront this disadvantage with the disadvantage attributed to classic access (post-operative cosmetic defects), it is opportune to consider whether by minimizing access, we would be increasing the complexity of the procedure with the risk of compromising the safety of surgery.

The aneurysms of the middle cerebral artery originate in the emergence of the collateral branch or at the bifurcation. According to Rhoton's guidelines, the clip should ideally be placed perpendicular to the afferent artery (in cases of early frontal branch aneurysms), and parallel to the efferent branches (in bifurcation aneurysms), avoiding stenosis of nearby arterial branches. In Figure 6 A, B, C the placement of the clip, due to the restriction of the working angle, did not respect this rule.

Usually we use classic pterional access, with minor modifications. We started with subcutaneous infiltration with 2% xylocaine with epinephrine, this maneuver allows efficient hemostasis. Cutaneous incision in a single plane is initiated in the median line until the identification of the squamous temporal bone le. In this way, we avoid progressing with the incision in the temporal region avoiding manipulation of the temporal muscle and lesion of the superficial temporal artery. This exposure enables a smaller craniotomy.

We used this technique in ruptured and incidental aneurysms, and we did not observe the limitations of supraorbital access "key hole". In cases of intercurrences, such as increased intracranial pressure or cerebral swelling, this access allows the enlargement of the craniotomy. According to Mori [10], minicraniotomies are aimed to "minimally invasive neurosurgery", however, these procedures carry the risk of malpractice, if the surgeon does not consider the advantages and disadvantages of this type of access.

We believe that for the planning of the surgical strategy in aneurysms of the middle cerebral artery, the "minimum invasiveness" should not be prioritized, but rather the "necessary invasiveness".

Conclusion

The supraorbital "keyhole" in cases of aneurysms of the middle cerebral artery, allows adequate exposure of the internal carotid and middle cerebral arteries. The greatest disadvantage observed is the restriction of the working angle, difficulting the resection and, especially, the placement of the definitive clip, and could compromise the safety of the surgery. Considering this limitation, it is important to determine the specific indications for this access, particularly in incidental aneurysms.

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Corresponding Author

Alexandre Haddad de Souza
Faculdade de Ciências Médicas da Santa Casa de São Paulo
Rua Dr. Cesário Motta Júnior , 61 – Vila Buarque
São Paulo, SP, Brazil, CEP 01221-020
E-mail: ahs84@hotmail.com