

DYSFUNCTION OF THE TEMPORALIS MUSCLE AFTER PTERIONAL CRANIOTOMY FOR INTRACRANIAL ANEURYSMS

COMPARATIVE, PROSPECTIVE AND RANDOMIZED STUDY OF ONE FLAP VERSUS TWO FLAPS DIERESIS

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ABSTRACT - Patients with intracranial aneurysm(s) of the carotid artery territory, treated with pterional craniotomy, were prospectively and randomly addressed to one layer flap (n=36) or myocutaneous (MC) versus two layers' dieresis (n=32) or interfascial (IF). The study protocol included the patient's sex, age, area of craniotomy, time of flap dieresis and synthesis, time of bone dieresis and synthesis, the intracranial time, including dura mater dieresis and synthesis and time of flap retraction. Before and after surgery, the patients were evaluated with examination specially oriented to V and VII cranial nerves, bi-temporal diameter measurement, the symmetry of the temporal region, temporomandibular joint (TMJ) movements and cranial CT scan. The evaluations of the TMJ dysfunctions were postoperative pain, movement limitations at mastication, occlusion, mouth aperture and lateral movements of the jaw. The statistical analysis showed that the incidence of pain at TMJ and moderate and severe temporalis muscle atrophy was observed, comparing MC and IF, and there were significant differences among these ones, being greater in IF group. We concluded that both techniques permit equivalent access to the studied intracranial aneurysm(s), and the atrophy of temporalis muscle, pain and movement limitations of the temporomandibular joint were prevalent, worse and more long-lasting in two-layers flap dieresis than in one-layer flap dieresis.

KEY WORDS: atrophy temporalis muscle, intracranial aneurysm, postoperative complications, pterional craniotomy, surgical technique, temporalis muscle, temporomandibular joint.

Disfunção do músculo temporal após craniotomia pterional para tratamento de aneurismas intracranianos: estudo comparativo, prospectivo e aleatório da diérese em camada única versus camada dupla

RESUMO - Pacientes com aneurisma(s) intracraniano(s) foram tratados pela via pterional e de modo prospectivo e aleatório submetidos às variantes técnicas, miocutânea (MC)(n=36) ou em retalho único e interfascial (IF) (n=32) ou em retalho duplo. No protocolo foram anotados o sexo, idade, área da craniotomia, período de diérese e síntese do retalho, período de diérese e síntese óssea, o período do procedimento intracraniano, incluindo o tempo de diérese e síntese da dura-máter e o período de retração do retalho. Os pacientes foram avaliados antes e após cirurgia, com exame neurológico especialmente orientado para o V e VII pares de nervos cranianos, medida do diâmetro bi-temporal, simetria das regiões temporais, movimentação da articulação temporomandibular (ATM) e tomografia computadorizada de crânio. A ATM foi avaliada em relação a dor articular pós-operatória, limitação dos movimentos a mastigação, oclusão, abertura da boca e movimentos laterais da mandíbula. A análise estatística mostrou que a incidência de dor na ATM e atrofia temporal moderada e grave, comparando MC com IF, houve diferenças significativas entre estes, sendo maior no grupo IF. Concluímos que ambas técnicas permitem acessos equivalentes aos aneurismas estudados, mas a atrofia do músculo temporal, a dor e limitações dos movimentos da ATM foi prevalente, pior e mais duradoura na diérese IF que na diérese MC.

PALAVRAS-CHAVE: aneurismas intracranianos, articulação temporomandibular, atrofia músculo temporal, complicações pós-operatórias, craniotomia pterional, músculo temporal, técnica cirúrgica.

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The temporalis muscle atrophy that follows the pterional approach is a concern for patients and neurosurgeons. For the pterional craniotomy, different incisions were employed in the scalp and temporalis muscle¹⁻⁶. To improve the anterior basal exposition of the pterional approach, the one-layer flap or myocutaneous (MC) may be splitted in two layers. This maneuver permits the sliding and translation of the temporalis muscle to posteroinferior position of the exposure and opens wide the anteroinferior pterional access by decreasing the flap width in this corner.⁵ Following the two-layers flap dieresis it is frequent the palsy of frontotemporal branches of the facial nerve (30%)²⁻⁴, temporalis muscle atrophy and temporomandibularis joint dysfunction^{1-3,7-9}. The technical interfascial variant (IF)⁴⁻⁶ drastically decreased the incidence of the frontotemporal branches' palsy of facial nerve, but not at all.¹⁰ Meanwhile, there are few reports on the temporalis muscle atrophy that follows this procedure^{2,3}.

On the other hand, the sulcus lateralis (Sylvian) access to the anterior supratentorial basal midline does not need a very low level of the flap⁷, and the inconvenience created by the flap width can be easily turned through hook traction below the sphenoid ridge^{2,3}.

To study the dilemma, there was a greater risk of flap complications with IF dieresis and technical difficulties to access the anterior supratentorial basal midline through MC dieresis, so we decided to compare them.

METHODS

Study Design

Patients with intracranial aneurysm(s) were consecutively treated with the pterional unilateral approach and randomly directed to MC (born in even years) and IF (born in odd years) flap dieresis (and synthesis), to investigate the incidence of temporalis muscle atrophy, its function and cosmetic consequences.

The study protocol included the sex and age of the patients, area of craniotomy, time of flap dieresis and synthesis (TFDS), time of the bone dieresis and synthesis (TBDS), the intracranial time, including durotomy and synthesis (TIC). The surgical period the flap was retracted in, without alleviation, was named time of flap retraction (TFR).

The craniotomy areas and the necessary flap retraction according to the number and location of aneurysms were always variable, and they were calculated by measuring the area of the elevated free bone flap. The biggest bi-temporal diameter was taken pre- and postoperatively to calculate the degree of temporalis muscle atrophy with outside caliper (Vernier).

Selection Criteria

Patients with intracranial aneurysm(s) of the carotid artery territory (except distal portion of anterior cerebral artery), treated between October 1994 and December 1995 at the Medical Sciences School Center of the Pontifical Catholic University of São Paulo (Brazil).

Exclusion Criteria

Patients with follow-up period under 6 months, infection of the surgical wound, absorption of bone flap, previous craniotomy or re-operation, severe transoperative arterial hypotension, antecedents of temporomandibularis joint (TMJ) dysfunction, mobile tooth prosthesis, and craniofacial trauma.

General Characteristics of Patients

General characteristics of patients submitted to MC and IF pterional dieresis (and synthesis) are in Table 1.

Surgical Technique

In the MC group the technique of flap's dieresis (and synthesis) was employed, as detailed in the technical note by Spetzler & Lee³, and in IF group the technique detailed by Yasargil et al.⁴⁻⁶ was employed. The procedures were always performed by the same surgical team, with the same materials and surgical tools. The flap(s) was maintained below the sphenoid ridge level by 4 hook's retractors. All aneurysm(s) were approached through the sulcus lateralis (Sylvian fissure) and appropriated basal cistern dieresis and received the same pre-

Table 1. General characteristics of patients submitted to MC and IF variants.

Group	MC (n=36)	IF (n=32)	p value
Sex (M/F)	20/16	19/13	NS**
Age (years)	45.2 ± 7.2	55.5 ± 13.4	< 0.05*
Craniotomy area (cm ²)	19.7 ± 2.1	19.6 ± 2.7	NS*
TFDS (minutes)	40.4 ± 5.8	64.9 ± 14.8	< 0.05*
TBDS (minutes)	46.8 ± 8.4	49.2 ± 8.9	NS*
TIC (minutes)	294.6 ± 110.0	299.0 ± 102.4	NS*
TFR (minutes)	341.5 ± 107.8	348.4 ± 99.8	NS*
Bitemporal diameter (cm)	14.4 ± 1.8	14.6 ± 1.4	NS*
Ophthalmic aneurysms	2	3	NS*

Caption: M/F, male/female; n, number of cases; NS, no significant; *, Fisher; **, χ^2 ; media ± standard deviation; TBDS, time of the bone dieresis and synthesis; TFDS, time of flap dieresis and synthesis;TFR, time of flap retraction;TIC, intracranial time.

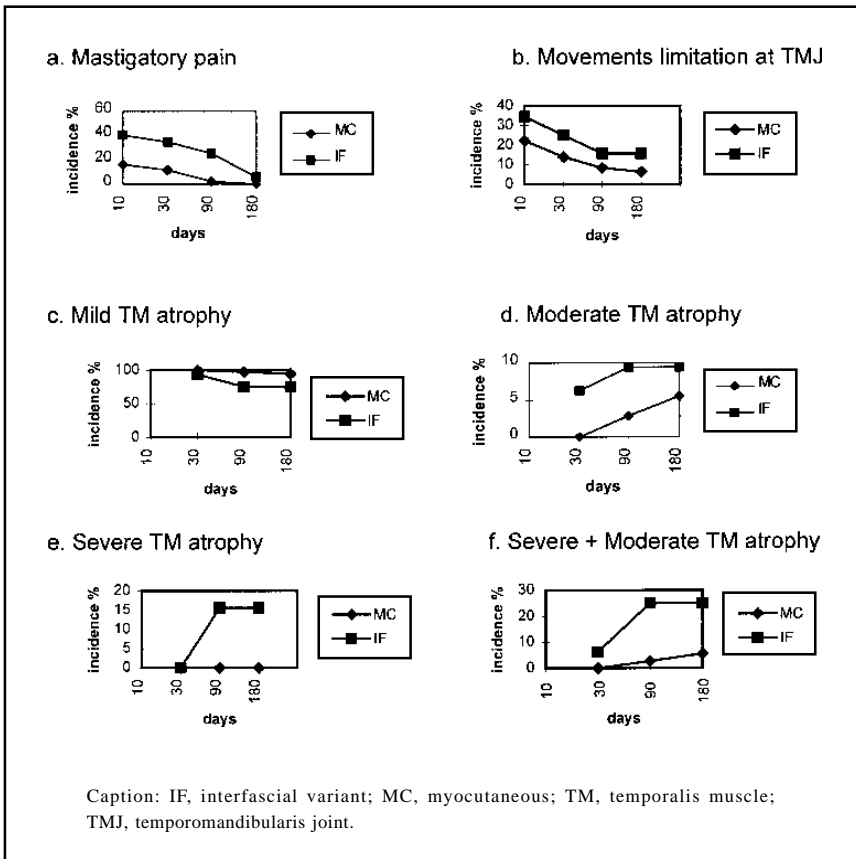


Fig 1. Incidence and evolution of TMJ's disorders.

and postoperative wound care. The ophthalmic segment aneurysm(s) were treated with extradural removal of orbital posterior roof, lesser sphenoid bone covering the superior and medial surface of superior orbital fissure. The anterior clinoid process was removed intradurally.

Evaluation and Results Criteria

Before and after surgery (7-10, 30, 90, and 180 days), the patients were evaluated with examination specially oriented to V and VII cranial nerves, bi-temporal diameter measurement, the symmetry of the temporal region, TMJ's movements and cranial CT scan. All patients were evaluated by the bucomaxillofacial team. They were not informed on the surgical procedures. The treatments of TMJ dysfunctions was made with non-hormonal anti-inflammatory drugs, orthodontics and physiotherapy.

The evaluations of the TMJ dysfunctions were postoperative pain, movement limitations at mastication, occlusion, aperture and lateral movements of the jaw. The classifications of these dysfunctions' degrees were: *mild*, when regressed before 3 months; *moderate* with impairment between 3 and 6 months; and *severe* when persisted after 6 months.

The degrees of temporalis muscle atrophy were given through the percentile reduction of postoperative bi-temporal diameter: *mild* when bellow 5%; *moderate* between 5 and 10%; and *severe* over 10%.

Statistical Methods

Data from the experiments were evaluated according to the qui-square (χ^2) or Fisher test. An alpha of 5% was considered statistically significant.

RESULTS

Of the 80 original patients, 12 were excluded due to study criteria. The remaining 68 patients' data, were submitted to the χ^2 test for sex and Fisher exact test (F) to determine the differences' distribution of the MC and IF groups, (Table 1) and to analyze study results (Fig 1).

Figure 1 presents the incidence and evolution of the TMJ's studied complications in both groups.

The statistical analysis showed no differences in both randomized groups, related to the following data (Table 1): sex ($\chi^2=0.10$; $p=0.75$), craniotomy area ($F=0.03$; $p=0.86$), TBDS ($F=1.31$; $p=0.26$), TIC ($F=0.03$; $p=0.86$) and TFR ($F=0.07$; $p=0.78$).

On the other hand, there were significant differences in the age ($F=16.07$; $p=0.0009$) and TFDS ($F=97.02$; $p=0,00000...$) data among groups, being greater in IF group.

The incidence of pain at TMJ, after 10 days ($\chi^2= 4.83$; $p=0.03$), 30 days ($\chi^2=5.33$; $p=0.02$) and 90 days ($\chi^2=7.29$; $p=0.007$) of the evolution was significantly longer in the IF group, but in 180 days (F ; $p=0.22$) there were no differences. In the MC group, the pain reduced precociously up to 90 days ($\chi^2=3.96$; $p=0.04$), and in the IF group the pain significantly reduced later, between 90 and 180 days ($\chi^2=4.27$; $p=0.04$). (Fig 1a)

The proportion of patients with movements limitation at TMJ, after 10 ($\chi^2=1.24$; $p=0,26$), 30 ($\chi^2=1.35$; $p=0.25$), 90 ($\chi^2=0,87$; $p=0.35$) and 180 ($\chi^2=1.86$; $p=0.17$) days was similar in both groups. There were no statistically significant differences in evolution of this alteration in MC and IF series (Fig 1b).

There was no difference in postoperative evolution of the moderate temporalis muscle atrophy, in 30 (F ; $p= 0.21$), 90 ($\chi^2=1.25$; $p=0.25$) and 180 ($\chi^2=0.36$; $p=0.55$) days, in both groups (Fig 1d).

The severe temporalis muscle atrophy showed us significant difference in evolution starting after 90 (F ; $p=0.02$) and 180 (F ; $p=0.02$) days, comparing MC and IF. And more, the incidence of such complication increased significantly in IF group between 30 and 90 (F ; $p=0.03$) days. (Fig 1e). When analyzed in conjunction, moderate and severe temporalis muscle atrophy was observed, comparing MC and IF, after 90 ($\chi^2=7.29$; $p=0.007$) and 180 ($\chi^2=5.11$; $p=0.02$) days, and there were significant differences of these kinds of atrophy in the groups (Fig 1f).

Figure 2 shows the severity evolution pattern of the temporalis muscle atrophy.

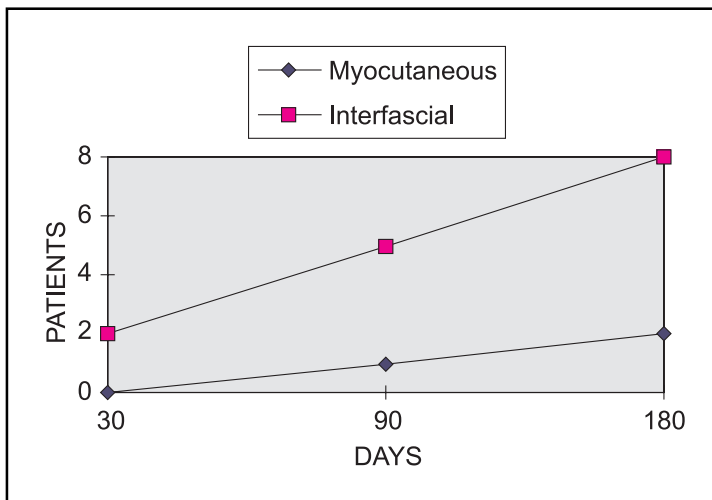


Fig 2. The severity evolution pattern of the temporalis muscle atrophy in MC and IF.

DISCUSSION

In both analyzed techniques, myotomy (and synthesis) of the *pars horizontalis* of the temporalis muscle occurred, which was also responsible for final occlusion of the jaw and subperiosteal disassemble of the temporal insertion of the temporalis muscle. In the study, both groups showed that the function of mandible final occlusion had been altered and always followed by mild temporalis muscle atrophy (Fig 1c). Since the skeletal muscle was cut (and sutured), and there was no remarkable regeneration of its fibers and its healing and the muscle repair was made by fibrous tissue¹¹, it is likely that this temporalis muscle mild atrophy and the final weakness of the jaw occlusion observed in the study can be imputed to such maneuvers.

In these procedures, traction, compression and flexion of the base flap occurred, which were maintained without alleviation during TFR. Without intermittent retraction, the flap was submitted to ischemia⁸. In the study, there was not significant difference in the TFR between the groups, but the IF technique permits major traction, torsion and kinking of the flap pedicle¹². In this way, the flap irrigation (and drainage) in IF technique is worse than MC technique, with direct or indirect (kinky) compromise of the deep temporal arteries¹². In the study, there was a severity progressive pattern of temporalis muscle atrophy in both groups (Fig 2). But the severity profile of the temporalis muscle atrophy was worse in the IF group.

So, the IF variant promotes more damage to the temporalis muscle irrigation (and drainage) responsible for postoperative temporalis muscle ischemic atrophy.

The pain and movement limitation of the mouth aperture and lateral deviation of the jaw to the side of the craniotomy are a consequence of the ischemic contracture, due to temporalis muscle antagonistic movements⁹. So, the TMJ function and balance are more compromised in intensity and duration with the IF technique when compared to MC.

In the study bias, the average age distribution significantly bigger in the IF group (Table 1) does not change our conclusion, because the age is not a major influence on the inflammatory-reparative response, and there are no controlled experimental data to support such fact¹¹. The bigger TFDS observed at IF series explains itself by the greater technical complex in the making and flap synthesis of this variant, aiming the protection of the facial temporofrontalis limbs⁴⁻⁶.

There were no significant statistical differences in the remaining data analyzed in the study.

As for the additional space given by the muscular in two-layer flap making^{4,6}, this one can be surrounded by the thicker flap retraction proper to the single flap to the sphenoidal level given by several hooks^{2,3}. Since the access of the studied intracranial aneurysm(s) was always made through the lateral fissure and basal cisterns, the limitation to the access of these aneurysm(s) is a function of the craniotomy area and of the cerebral compliance at surgical moment.

In the study, the pterional approach to the intracranial aneurysm(s) studied, were through the sulcus lateralis and basal cisterns.^{4,7,12} The limitation to the intracranial access of these aneurysm(s) is only the widen opening of the Sylvian fissure and basal cisterns and cerebral compliance.

In conclusions, the MC and IF techniques of flap dieresis (and synthesis) for pterional craniotomy permit equivalent access to the intracranial aneurysm(s) studied. The risk of moderate and severe temporalis muscle atrophy and TMJ imbalance (pain and movement limitation) was prevalent, worse and long-lasting in IF dieresis than in MC. The MC technique is easier, faster, and has better TMJ function and cosmetic results than IF technique.

Acknowledgment - We thank Reinaldo José Gianini, MD, for statistical assistance.

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