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Fronto-Temporal Approach with Orbito-Zygomatic Removal

Surgical Anatomy

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Summary

Removal of the orbital rim and the zygomatic arch can be associated with fronto-temporal craniotomy to gain additional space, so as to decrease cerebral retraction. In order to quantify the gain provided by this enlarged approach, the authors underwent anatomical studies comparing the field view angle of various intracranial targets with and without orbito-zygomatic removal, in 11 fresh human cadavers with the brain in situ. The field view angle was increased, thanks to orbito-zygomatic removal, on average, by 75% in the sub-frontal approach, 46% in the pterional approach, and 86% in the sub-temporal approach.

Such approaches can be very useful for access to difficult lesions located in the vicinity of the skull base. In the last 3 years 21 patients were operated upon using this technique, with excellent results.

Keywords: Pterional craniotomy; orbito-zygomatic removal; skull base lesions.

Introduction

Access to difficult lesions located in the vicinity of the skull base, sometimes needs prolonged brain retraction, possible source of infarction and severe sequelae.

Removal of the supero-lateral rim of the orbit[2, 4, 6], the zygomatic arch[1, 7, 8], or both[3, 5], in association with fronto-pteriono-temporal approach, have been described to gain space.

With the aim to quantify this additional space, an anatomical study was undertaken in 11 fresh cadavers with brain in situ, comparing the field view angle with and without orbito-zygomatic removal.

Material and Methods

The study was carried out in all of the 11 specimen on the right side, and in 2 specimens also on the left side.

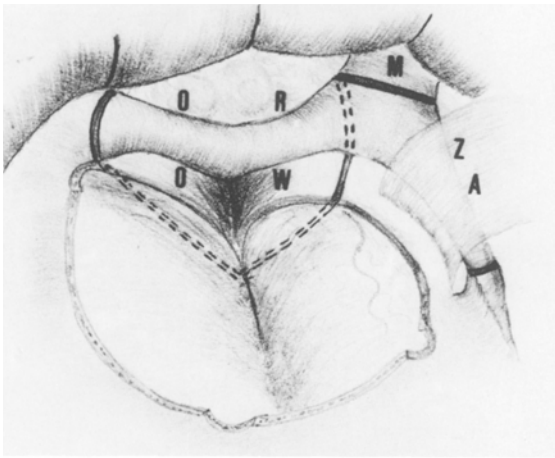
The surgical technique was the same as the one usually performed in our patients. The scalp incision begins 1 cm below the zygomatic arch, goes vertically close to the tragus, and then curves anteriorly from the temporal crest to the midline along the hair line. The skin flap is retracted passing underneath the temporal fascia, so as to respect the frontal braches of the facial nerve. The peri-orbital periosteum is detached from the supero-lateral wall of the orbit, taking care not to stretch the supra-orbital branch of the fifth nerve. The temporal muscle, together with its adherent fascia, is reflected from the superior temporal line downward to the zygoma. Skull opening is performed in two separate steps: a) pterional craniotomy and b) removal of the orbital rim and the zygomatic arch in one piece. The technique used for craniotomy is approximately the same as the one described by Yaşargil[9]. The lateral portion of the pterional ridge is extra-durally rongeured away. The second step consists of the orbito-zygomatic removal in a single piece with sagittal saw (Fig. 1A, B). The supero-lateral rim, together with the adjacent wall of the orbit, are first divided near the supra-orbital foramen under protection of the periosteum. Then the malar bone is divided taking care not to open the maxillary sinus, and the zygomatic arch is sawn through as posteriorly as possible at its temporal process. The dura is opened along the skull base. The retractors are applied on the frontal and temporal lobes without opening the Sylvian fissure. Then under the operating microscope, the basal cisterns are opened.

The gain in space was evaluated by measuring the field view angle (F.V.A.) of a given intracranial target before ($\alpha 1$) and after ($\alpha 2$) orbito-zygomatic removal. F.V.A. was defined as the angle of exposure of the target with minimal brain retraction. The targets chosen for the sub-frontal, the pterional and the sub-temporal approaches, were the optic-carotid complex, the basilar bifurcation, and the P2 segment of the posterior cerebral artery, respectively, and successively, in the same specimen.

Results

All the F.V.A. values of these targets measured in each of the 13 approaches are given in details in Tables 1, 2, and 3.

For the sub-frontal approach (the target being the optic-carotic complex), the orbito-zygomatic removal increased F.V.A. from 11 to 19° on average (Fig. 2),



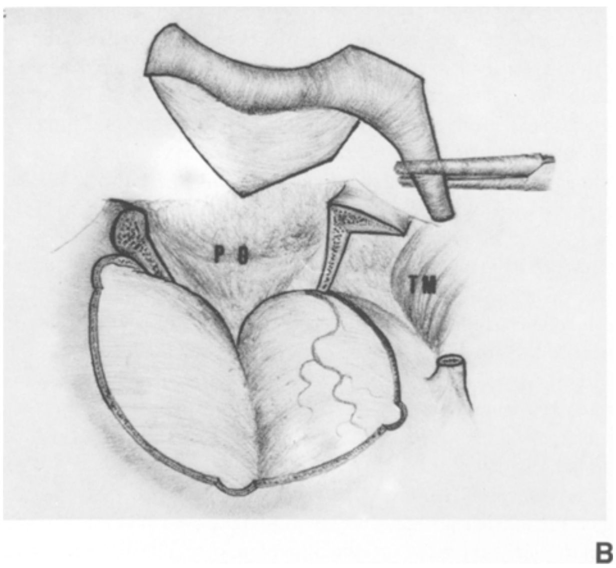


Fig. 1A and B. Right frontotemporal craniotomy before (A) and after (B) orbito-zygomatic removal. *OR* orbital rim, *OW* orbital wall. *M* malar bone. *ZA* zygomatic arch. *PO* periorbital periosteum, *TM* temporal muscle

corresponding to a gain of 75% (extremes 34, 118%) (Table 1).

For the pterional approach, without opening the Sylvian fissure (target: basilar bifurcation), F.V.A. increased from 22 to 32° on average (Fig. 3), i.e., a gain of 46% (extremes 13, 85%) (Table 2).

As regards the subtemporal approach (target = P2 segment of the posterior cerebral artery), F.V.A. increased from 8 to 14° on average (Fig. 4), i.e., a gain of 86% (extremes 51, 186%) (Table 3).

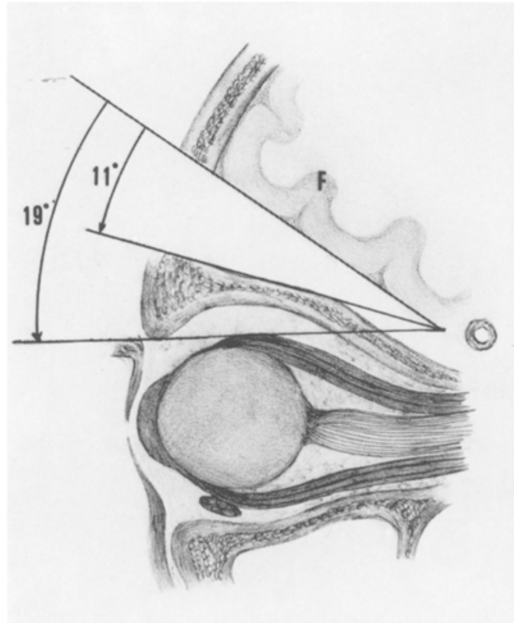


Fig. 2. Sub-frontal approach (parasagittal section) showing the average F.V.A. before (11°) and after (19°) orbito-(zygomatic) removal. *F* frontal lobe

Discussion

As demonstrated in this study, removal of the orbito-zygomatic bone in association with fronto-temporal craniotomy, in creating a significant additional space, makes the access easier to difficult lesions located in the vicinity of the skull base. This needs familiarity with the surgical anatomy of the area and expertise with the use of the sagittal saw. Provided this removal be performed carefully step by step, its dangers are minimal. However, special care must be taken not to injure the frontal branch of the facial nerve[10] and the tiny branch of m. levator palpebrae superioris. Provided the orbito-zygomatic bone be perfectely repositioned and tightly fixed, there are less cosmetic sequels with bone removal-reconstruction than with bone rongeur-resection or drilling.

To make the laboratory study easier, bone removal systematically included in the same piece the orbital rim and the zygomatic arch, whatever the target and the corresponding approach might be. Actually, the gained space came from removal of the orbital rim for the sub-frontal approach, and from removal of the zygomatic arch for the sub-temporal approach. In clinical practice, for these approaches, limited removal is sufficient, in contradistinction to the pterional one which can benefit from an entire orbito-zygomatic-removal.

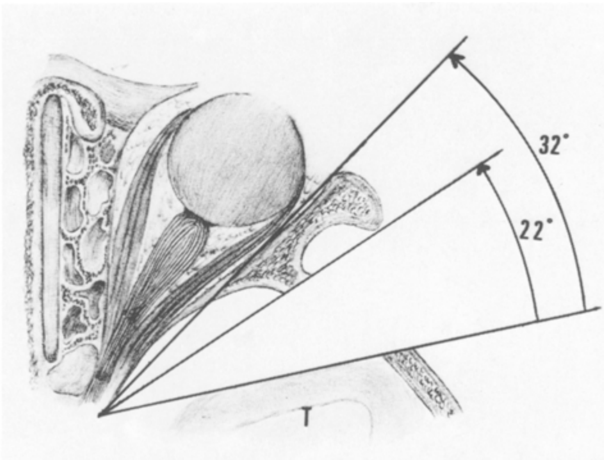


Fig. 3. Right pterional approach (horizontal section) showing the average F.V.A. before (22°) and after (32°) orbito-zygomatic removal

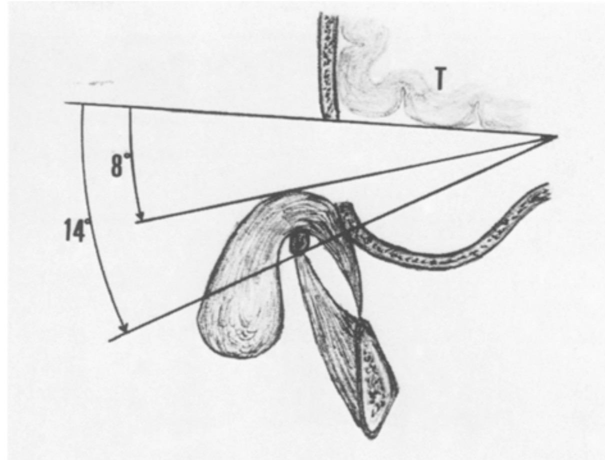


Fig. 4. Right sub-temporal approach (coronal section) showing the average F.V.A. before (8°) and after (14°) (orbito)-zygomatic removal

Table 1. *Sub-frontal Approach*. Target: optic-carotid complex

Case	F.V.A. without	F.V.A. with	Gain in degree	Gain in %
	orbito-zygomatic removal		α2-α1(°)	(α2-α1)/α1
	α1(°)	α2(°)		
1 (R)	14.5	25.2	10.7	74.1
2 (R)	14.5	19.5	5.0	34.4
3 (R)	14.5	20.7	6.2	42.7
4 (R)	9.0	17.5	8.5	94.4
5 (R)	15.5	26.0	10.5	67.7
6 (R)	8.0	17.0	9.0	112.5
7 (R)	10.7	20.0	9.3	86.9
8 (L)	8.2	17.7	9.5	115.8
9 (R)	11.0	18.0	7.0	63.6
10 (R)	6.0	12.0	6.0	100.0
11 (L)	10.5	19.5	9.0	85.7
12 (R)	13.5	21.0	7.5	55.5
13 (R)	8.0	17.5	9.5	118.7
Average	11.0	19.3	8.3	75.4

α1 (degree): field view angle (F.V.A.) before orbital rim removal
α2 (degree): field view angle (F.V.A.) after orbital rim removal
R: right side
L: left side
Removal of the orbital rim increased F.V.A. from 11 to 19° (on average), i.e. a gain of 75% (extremes 34, 118%)

Such approaches were clinically experienced with benefit, using removal 1.) of the orbital rim alone in 6 cases (1 Sylvian and 1 carotid-ophthalmic giant aneurysms, 2 berry anterior communicating aneurysms, 2 hippocampectomies for intractable epilepsy, 2.) of the zygomatic arch alone in 4 cases (1 midle cerebral fossa cylindroma, 1 high malignity cavernous sinus tumour, 1 giant P2-P3 posterior cerebral artery aneurysm, 1 trigeminal neuralgia), and 3.) of the entire orbito-zygomatic bone in 11 cases (1 cavernous sinus

Table 2. *Pterional Approach (Without Opening of the Sylvian Fissure).* Target: basilar bifurcation

Case	F.V.A. without	F.V.A. with	Gain in degree	Gain in %
	orbito-zygomatic removal		α2-α1(°)	(α2-α1)/α1
	α1(°)	α2(°)		
1 (R)	34.0	44.5	10.5	30.8
2 (R)	43.0	49.0	6.0	13.9
3 (R)	29.0	44.0	15.0	51.7
4 (R)	16.0	24.0	8.0	50.0
5 (R)	10.0	18.5	8.5	85.0
6 (R)	14.5	25.0	10.5	72.4
7 (R)	21.5	31.2	9.7	45.1
8 (L)	16.0	27.5	11.5	71.8
9 (R)	25.0	38.0	13.0	52.0
10 (R)	20.0	33.0	13.0	65.0
11 (L)	12.0	21.0	9.0	75.0
12 (R)	25.0	31.0	6.0	24.0
13 (R)	23.0	36.5	13.5	58.6
Average	22.0	32.5	10.3	46.3

α1 (degree): F.V.A. before orbito-zygomatic removal
α2 (degree): F.V.A. after orbito-zygomatic removal
R: right side
L: left side
Removal of the orbito-zygomatic arch, increased F.V.A. from 22 to 32° (on average), i.e., a gain of 46% (extremes 13, 85%)

Table 3. *Sub-temporal Approach.* Target: posterior cerebral artery

Case	F.V.A. without	F.V.A. with	Gain in degree	Gain in %
	orbito-zygomatic removal		α2-α1(°)	(α2-α1)/α1
	α1(°)	α2(°)		
1 (R)	15.0	22.7	7.7	51.3
2 (R)	11.5	18.0	6.5	56.5
3 (R)	9.5	16.0	7.0	73.6
4 (R)	10.0	15.5	5.5	55.0
5 (R)	7.5	21.5	14.0	186.6
6 (R)	4.0	10.0	6.0	150.0
7 (R)	10.0	15.7	5.7	57.0
8 (L)	4.5	10.0	5.5	122.2
9 (R)	7.0	15.0	8.0	114.2
10 (R)	8.0	16.0	8.0	100.0
11 (L)	6.0	12.5	6.2	103.3
12 (R)	5.5	11.0	5.5	100.0
13 (R)	6.0	10.0	4.0	66.6
Average	8.0	14.9	6.9	86.2

α1 (degree): F.V.A. before zygomatic arch removal
α2 (degree): F.V.A. after zygomatic arch removal
F.V.A.: field view angle
R: right side
L: left side
Removal of the zygomatic arch, incresaed F.V.A. from 8 to 14° (on average), i.e., a gain of 86% (extremes 51, 186%)

epidermoid cyst, 1 cavernous sinus meningioma, 1 cavernous sinus neurinoma, 1 cavernous sinus chordoma, 1 cavernous sinus haemangioma, 1 orbit and middle cerebral fossa lymphoma, 2 basilar bifurcation aneurysms, 1 cerebral peduncle glioma, 2 hippocampectomies for intractable epilepsy).

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