ANTRO-LATERAL MINI FRONTO-ORBITO ZYGOMATIC (MFOZ) CRANIOTOMY VIA AN EYE BROW INCISION IN THE MANAGEMENT OF ANTERIOR CRANIAL FOSSA AND SELLAR REGION LESIONS

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ABSTRACT

Background: *The attempt to approach lesions in the anterior cranial fossa and sellar region through minimally invasive craniotomies is described by different authors under various names which describe the extent of craniotomies. The purpose of this study was to describe and evaluate the results of surgical treatment of lesions in the anterior fossa and sellar region via an anterolateral mini fronto-orbito-zygomatic (MFOZ) craniotomy using an eyebrow incision.* ***Method:*** *Between January 2003 and December 2004, 22 patients with lesions in the anterior fossa and sellar region were operated on via the same approach. There were 19 extra-axial lesions; 8 meningiomas, 4 craniopharyngiomas, 6 pituitary macroadenomas, 1 suprasellar arachnoid cyst, and 3 intra-axial ones; 1 glioblastoma multiform (GBM), 1 chiasmal pilocytic astrocytoma and 1 hypothalamic glioma. The surgical results were studied retrospectively and analyzed.* ***Results:*** *Total resection was achieved in 16 cases (72.7%) (all 8 meningioma cases, 2 craniopharyniomas, 4 pituitary macro-adenomas, the suprasellar arachnoid cyst and the GBM), Subtotal resection in 3 cases (a craniopharyngioma and 2 pituitary adenomas) and Partial resection in 3 cases (a craniopharyngiomas and 2 intra-axial tumors). Complications related to the approach like CSF rhinorrhea, supra-orbital hyposthesia and loss of upward elevation of the eyebrow were temporary and easily managed and could not overweight the advantages offered like the small cosmetic skin incision, the less need for brain retraction thus minimizing morbidity and yet achieving excellent surgical exposure and good recovery. In other words it combines the advantages of the supra-orbital keyhole with the skull base approaches.* ***Conclusion:*** *The MFOZ craniotomy using an eyebrow incision is safe, effective, and both suitable and convenient for treating lesions in the anterior fossa and sellar region, with almost no adverse consequences.*

Key words: *Minimally Invasive – Minicraniotomy - eyebrow incision - anterior skull base – Sellar Region*

INTRODUCTION & BACKGROUND

A variety of neoplastic and vascular pathologies involving the anterior cranial fossa and its base back to the sellar region, including the supra and para-sellar areas, constitutes an appreciable concern to neurosurgeons. The surgical approaches to these areas vary greatly and are highly influenced by the pathology dealt with, the surgeon's experience and the facilities available. The fundamental tendency to be as minimally invasive as possible with a minimum of iatrogenic traumatization and to achieve a maximum of efficiency in the treatment of a patient has existed since the beginning of surgery. Fortunately, the increased knowledge of microsurgical anatomy, improved preoperative diagnostic techniques, and the well-adapted microsurgical instruments, contributes to the "refinement in microneurosurgical operations" [16].

The surgical approach to the anterior cranial base evolved from the pioneering work of Cushing through the efforts of a number of innovative neurosurgeons as Dandy, Frazier, Heuer, and McArthur. In 1908 Krause described the first unilateral sub-frontal approach which eventually developed into the lateral supraorbital approach and was first presented at the "Seventh International Congress of Neurological Surgery" in 1981 by Sanchez-Vazquez [12]. In 1996, he introduced a new version of the original technique that made it possible to remove larger tumors and, above all, uncover vessels in the anterior portion of the circle of Willis [11]. The approach was later adopted by Perneczky who extensively studied and developed the supraorbital keyhole approach and modified its application and introduced the endoscope to view and work in small hidden areas [8, 14]. The need for a more lateral view of the sellar region lead Heuer and Dandy in 1918 to do the first pterional or frontolateral approach to the optic chiasm and pituitary gland. In 1975 Yasergil elaborated the pterional approach in its present form with the routine removal of the sphenoid wing [17]. With the evolution of the skull base concepts of surgery, Al Mofty in 1987 introduced the removal of the orbital roof in order to approach lesions of the anterior skull base utilizing the orbital space rather than the intracranial space, thus reducing the need for brain retraction [1].

In this study we demonstrate our experience and analyze the surgical outcome of a variety of lesions in the anterior cranial fossa and sellar region approached through an en bloc Antero-lateral Mini Fronto-Orbito-Zygomatic (MFOZ) Craniotomy done via an eye brow incision.

MATERIAL & METHOD

This study includes 22 patients operated upon during the period between January 2003 & December 2004 in the Department of Neurosurgery – Cairo University Hospitals. The approach used in all cases was the MFOZ craniotomy via an eye brow incision. There were 8 males and 14 females. The age ranged between 11 months to 60 years (mean 31.6 years). The pathologies included

19 extra-axial anterior cranial fossa, sellar, supra and para-sellar regions masses; ***8 meningiomas*** (4 suprasellar (diaphragmatic), 2 olfactory groove, 1 clinoidal and 1 Optic canal), ***4 craniopharyngiomas***; ***6 pituitary macroadenomas*** (2 GH secreting and 4 non-secreting chromophobe adenomas) and **1** case of supra-sellar ***arachnoid cyst***. The three intra-axial tumors included a left frontal cystic glioblastoma multiform (GBM), Chiasmal pilocytic astrocytoma and a hypothalamic glioma (Table 1). The size of lesions ranged between 1.5-7.5 cm (mean 4.1 cm) in its maximum breadth, 1.2-6 cm (mean 3.7 cm) in the antero-posterior dimension and 1-7.7 cm (mean 4 cm) in height. Diminution of vision was the main complaint in 17 cases (72.3%), headache in 9 cases (41%), Diplopia in 4 cases (18.2%) and precocious puberty in an 11 months old male (4.5%).

The extent of tumor resection was classified into total (more than 90%), subtotal (50-90%) and partial (less than 50%). The pathology was approached via the right side in 18 cases and through the left side in 4 cases. The approach was assessed in all patients in terms of the time taken for performing the craniotomy, its appropriateness in facilitating the micro-instruments maneuverability in the field, the need for frontal lobe retraction and the cosmetic and functional outcome.

Surgical Technique

The patient is placed in the supine ***position***. The head is elevated above the level of the heart and turned between 10° and 60° to the contra-lateral side of the intended eye brow incision depending on the location of the lesion; it is increased for anterior lesions and decreased for more posterior lesions. The head is slightly extended 10 to 15° (with the cheek bone as the highest point) and fixed in a Mayfield three point head fixation (Mayfield, Ohio Medical Instrument Co., Inc., Cincinnati, OH) attached to the operating table. The ***skin incision*** is 5 cm long and is placed along the superior edge of the eyebrow, starting from the junction of its medial third with its lateral two thirds and extending laterally to just behind the frontal process of the zygomatic bone (Fig. 1a). Subcutaneous dissection along the subgaleal space is performed to expose the pericranium over the frontal bone and the temporalis fascia. Dissection should be done carefully around the supraorbital foramen medially to avoid injury of the supraorbital nerve and artery. The temporalis fascia is incised vertically few millimeters before its insertion at the anterior temporal line, leaving a small fascial cuff for reattachment during closure. A pericranial flap (Fig. 1a) exposing a 5 x 5 cm of the anterolateral surface of the frontal bone is reflected downwards with its base at the orbital rim, thereby maintaining its continuity with the periorbita, which is separated from the roof of the orbit. The pericranial flap may be of value during wound closure if the frontal air sinus was breached. The skin flap is retracted using silk sutures or fish hooks backwards (Fig. 1c).

The site for the key burr hole (Fig. 1a & Fig. 2a & b) is exposed by subperiosteal dissection of the temporalis muscle and is placed 1.5 cm behind the frontozygomatic suture or a few millimeters above the frontosphenoid suture. A second burr hole is placed just opposite and above the supraorbital notch/foramen and the third burr hole is placed 4 cm above the most lateral point of the superior orbital rim (Fig. 1a, b & Fig. 2a, b).

With careful protection of the periorbita by a spatula, an osteotome is used in disconnecting the frontozygomatic suture and connects the lateral orbital margin with the key burr hole. Also the osteotome is used to connect the lower edge of the supraorbital burr hole to the orbital cavity, doing so in a slightly lateral and downwards direction of hammering and then the orbital roof plate is cut medially through the key burr hole to connect with the extension line of that joining the supraorbital burr hole to the orbital cavity and thus separate the mini craniotomy in one piece (measuring approximately 3.5 × 3.5 cm) incorporating the antero-lateral supra-orbital frontal bone and the roof and lateral orbital walls with the orbital rim in between, extending from the supraorbital notch/foramen medially to the frontozygomatic suture laterally (Fig. 1b & Fig. 2a, b). If the frontal sinus is entered, it is exenterated by stripping and cauterizing its mucosa then it is packed with betadine soaked gel foam and covered by the pericranial flap at the time of closure. The orbital roof is opened up to the supraorbital fissure and to the optic canal by additional removal of the bone in the orbital roof (Fig. 2) to expose the globe and the orbitofrontal dura mater (Fig. 1c). The globe is depressed by a spatula and the orbitofrontal dura is opened in a T-shaped fashion with the horizontal limb along the fronto-orbital pole and the vertical limb is done directed towards the orbital apex. After dealing with the intracranial pathology, a watertight dural closure is done using silk sutures (Fig. 1c). The bone flap is fitted back in place and the bone chips gathered from the burr holes at the beginning of surgery is used to re-fill the burr holes. The pericranial flap is returned and sutured in place thus fixing and completely covering the craniotomy bone and the burr holes with no need for fixation plates or similar modality of fixing the craniotomy.

The wound is closed subcuticularly in a cosmetic fashion and usually there is no need for a drain (Fig. 5).

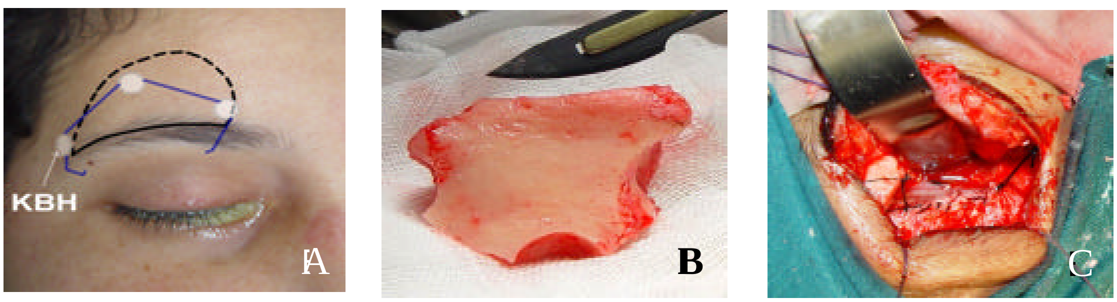


Fig. (1): Photographic pictures demonstrating the steps of performing the antero-lateral MFOZ craniotomy A. skin drawing demonstrating the skin incision (Straight line) extending along the superior margin of the eye brow, the pericranial flap (interrupted line) and site of burr holes connected together to show the size of frontal bone incorporated in the craniotomy, B. Craniotomy bone after removal in a position similar to how it faces the surgeon with the superior orbital margin facing the blade of a scalpel # 24 measuring approximately 3.5 X 3.5 cm and C. Surgical field available after depressing the globe by a spatula exposing the fronto-polar and orbito-frontal dura with the later incised in a T-shaped fashion as indicated by the suture line.

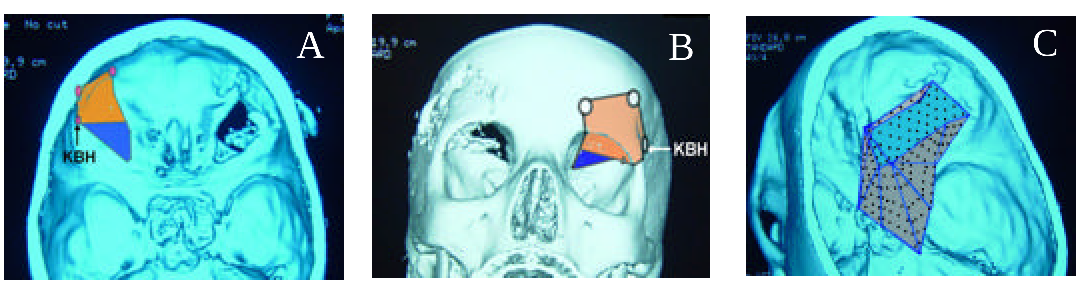


Fig. (2): Three dimensional CT scan bone window after a right MFOZ craniotomy with added shadings on the contralateral side to illustrate it, A. view from in front and below, B. view from inside the skull and C. volumetric representation of the extent of the area reached during surgery.

RESULTS

Table (1): Extent of tumor resection

	Total Resection	Subtotal Resection	Partial Resection
Meningioma (8)	8	–	--
Suprasellar (4)			
Olfactory groove (2)			
Clinodal (2)			
Craniopharyngioma (4)	2	1	1
Pituitary Adenoma (6)	4	2	--
Acromegaly (2)	1	1	
Chromophobe (4)	3	1	
Arachnoid cyst (1)	1	–	--
Intra-axial (3)	1		2
GBM (1)	1		
Optic glioma (1)			1
Hypothalamic glioma (1)			1
Total Number of cases (22)	16 (72.7%)	3 (13.6%)	3 (13.6%)

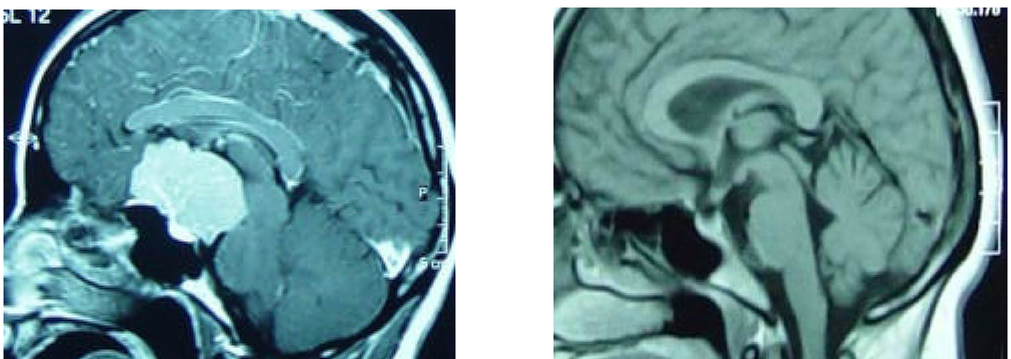
Total resection (Fig. 3) of the pathology was achieved in 16 cases (72.7%) (all 8 meningioma cases, 2 craniopharyniomas, 4 pituitary macro-adenomas (Acromegaly 1 case and Non-secreting Chromophobe 3 cases), the suprasellar arachnoid cyst and one intra-axial cystic GBM), *Subtotal resection* (Fig. 4) in 3 cases (13.6%) (a craniopharyngioma and 2 pituitary adenomas (Acromegaly 1 case and Chromophobe 1 case) and *Partial resection* in 3 cases (13.6%) (a craniopharyngioma and 2 intra-axial tumors (the optic and hypothalamic gliomas) (Table 1).

The headache resolved in 8 cases (89%). The diminished visual acuity improved in 10 cases (59%), remained stationary in 5 (29%) and deteriorated transiently in 2 cases (9%) but recovered on the third post operative month. The diplopia improved in 2 cases (50%) (A pituitary adenoma and the arachnoid cyst cases), and did not improve in 2 cases (50%) (A craniopharyngioma and optic canal meningioma cases). On the other hand, the case of clinoidal meningioma developed a partial third nerve palsy which remained stationary (4.5%). The only mortality in this study (4.5%) was a craniopharyngioma case.

An area of hyposthesia over the ipsilateral forehead occurred in 18 cases (82%). Loss of elevation of the eye brow persisted in 2 cases (9%) and recovered within 3 months in 12 others

(54.5%). Temporary collection of CSF supraorbitally occured in 4 cases (18%). Ipsilateral CSF rhinorrhea occurred in 1 case (4.5%) and stopped spontaneously during the first post-operative week. The periorbita was injures in 5 cases and was not repaired. The frontal sinus was opened in 3 cases and was packed and repaired. None of the patients developed alopesia of the eye brow or any disfiguring depression of the anterior temporalis muscle (Fig. 5).

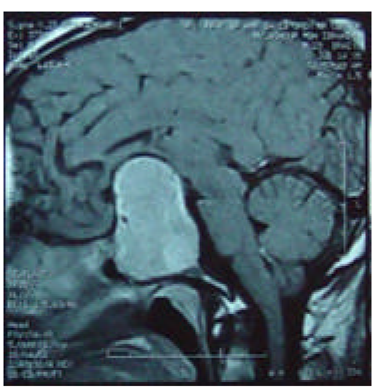
The time taken for performing the craniotomy was much shorter than that taken when performing the conventional frontal or pterional or the skull base fronto-orbito-zygomatic craniotomy.



A B

Fig. (3): Sagittal MRI of a suprasellar meningioma 4 x 4.5 x 3.5 cm in a female 42 years old A. preoperative B. complete resection and return of normal anatomy 3 months post-operative.

A



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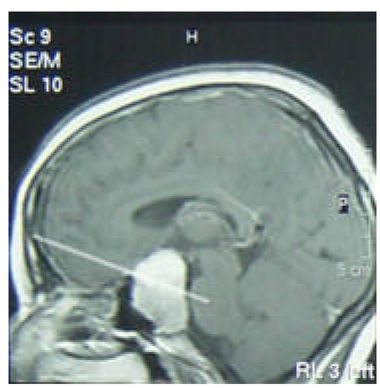

Fig. (4): Sagittal MRI of a pituitary macroadenoma involving the sellar and supra sellar region measuring 3 x 3.5 x 4 cm and causing blindness in a 29 yo male. A. Pre-operative B. Post-operative showing subtotal removal and decompression of the suprasellar structures with residual sellar part which is believed to be difficult to resect being below the plan of surgery (white line) (Hyperintense superior region of the mass represents blood soaked gel foam).

DISCUSSION

The attempt to approach lesions in the anterior cranial fossa and sellar region through minimally invasive craniotomies is described by different authors under various names which describe the extent of craniotomies like “Supraorbital rim approach” by Kaplan et al, [(5)], " Orbital roof craniotomy” by Joh, [(4)], “Trans-orbital craniotomy” by Maus & Goldman [(7)] and the supraorbital pterional approach by Al-Mefty [(1)]. The Anterolateral MFOZ craniotomy via an eyebrow incision is the name chosen by the authors to describe the surgical approach used in this study which is believed to gather the advantages offered by the aforementioned approaches combining the supraorbital keyhole concept with the skull base.

The MFOZ approach offers the following advantages:

1) The short skin incision is latter hidden by the eyebrow for an aesthetically pleasing result; **2)** The superficial temporal artery and the frontal branches of the facial nerve, as well as the supraorbital nerve and artery, are preserved; **3)** The blood supply to the region is excellent, minimizing the risk of wound-healing problems; **4)** In the presence of a craniotome the craniotomy requires only one burr hole, further reducing postoperative scarring; **5)** The medial edge of the bone flap usually is far enough from the frontal sinus to avoid the risk of rhinorrhea and infection; **6)** The small craniotomy including the orbital roof and lateral wall minimizes brain exposure, allows to work utilizing the orbital space rather than the intracranial space thus reducing the need for brain retraction and the bone flap can be repositioned and secured rapidly back into the anatomical position at the time of closure; **7)** A simple surgical exploration usually takes only approximately 10 to 15 minutes; and **8)** the size of the craniotomy is appropriate and facilitates micro-instruments maneuverability in the field making the resection of sizable masses possible. Furthermore, Jho indicated that the direct eyebrow incision provides an additional vital working space with a width of more than 1 cm at the skull base by eliminating the scalp flap which a coronal incision employs [(4)].

The total resection which is achieved in all cases of meningiomas in this series is not uncommon and was also achieved in the 47 cases of suprasellar meningiomas by Fahlbusch in 2002 using the pterional approach [(3)]

and in the 19 cases in Czirja´k series using the frontolateral keyhole [2] and those operated by a supraorbital keyhole by Wiedemayer [15]. Maira et al operated on 22 patients with craniopharyngiomas by the pterional approach and achieved total removal in 15 (68%) patients and 2 of them died [6]. Although our series is limited to 4 cases yet 2 of them were totally resected, one was subtotal and one was partial. The only mortality was the cases where subtotal resection was achieved and he died suddenly on the 5th post-operative day, presumably due to a hypothalamic infarction due to excessive manipulation and attempts to resect an adherent part to the hypothalamus. Out of the 6 pituitary macroadenomas in our series, 4 cases (66.6%) benefited by total resection of their masses. The reason for incomplete resection was attributed to the low extension of the tumor below the level of the tuberculum sellae (Fig. 4b). Shanno et al reported a 54% total resection [13] and 76% in Reisch & Perneczky [9]. The suprasellar arachnoid cyst was easily managed through the MFOZ approach. The sizes of masses dealt with in this study ranged between 1 and 7.7 cm in their maximum dimension which proves that the approach does not hinder the resection of large tumors similar to those resected in Czirja´k & Szeifert which varied between 1-6 cm's [2] and that the area covered by this approach is ample (Fig. 2c). The role of this approach in intra-axial lesions is only addressed in a few reports like that of Reisch & Perneczky [9] and it proved to be sufficient when attempting excision biopsy especially with lesions like chiasmal or hypothalamic gliomas as indicated in our series.

The complications encountered in this series were not serious and were mostly transient. The Ipsilateral supraorbital hyposthesia recovered within 3 months in 15 cases but persisted with no discomfort in 3 cases. Similar outcome is reported by most authors using the eyebrow incision [4, 11] and emphasizes the need for careful dissection around the supraorbital neurovascular bundle. Loss of elevation of the eyebrow persisted in 2 cases (9%) but completely recovered in 12 cases and could be attributed to either detachment of the frontal epicranial aponeurosis when it is transient or injury to the frontal branch of facial nerve when it is permanent as explained by Salas who experienced a 30% incidence of injury to the frontal branch of the fascial nerve with the pterional approach even with interfascial dissection [10]. The CSF rhinorrhea which occurred in 1 case (4.5%) stopped spontaneously within the first post-operative week comparative to 6.6% in Shanno's series [13]. Sanchez on the other hand reported no cases of CSF rhinorrhea [11].

All patients were satisfied and content with their cosmetic outcome aside from the temporary CSF collection which occurred in 4 cases and required the implantation of a lumbar drain in one case to resolve. The scar did not show in any of the cases (Fig. 5).

Fig. (5): Photographic picture demonstrating the postoperative cosmetic result and preserved function of eye brow elevation

CONCLUSION

The antero-lateral MFOZ craniotomy via an eye brow incision constitutes an ultimate refinement of the conventional subfrontal and the pterional approaches combining the advantages of minimally invasive and skull base surgeries. It is a safe, reliable and suitable approach for large lesions in the anterior cranial fossa, suprasellar and parasellar areas that result in minimal disruption and exposure of normal brain tissue, reduced frontal lobe retraction, and an excellent postoperative cosmetic result.

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