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Frontobasal Fractures.. Guidelines to Management

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ABSTRACT

Upper facial and anterior skull base fractures are an important Neurosurgical and plastic surgical problem. The appropriate management is controversial. Evaluation of 50 cases treated over the last four years is reviewed. The fractures were classified into anterior wall, anterobasilar and frontal skull with sinus extension. The presence of cerebrospinal fluid (CSF) leak and/or air-fluid level intracranially had been a diagnostic clue for posterior sinus wall involvement. Most closed fractures are medically monitored unless there are signs of dural tears, intracranial massive contusions and/or hematomas, or disfigurement due to bony comminutions. In those cases, surgical intervention was used to debride necrotic and contused tissues, evacuate hematomas and reconstruct the bony frame as well as air sinus isolation. In conclusion, traumatic fractures of the frontobasal skull should be managed promptly as soon as the patient's clinical general condition permits. The necrotic contused tissues should be trimmed, the air sinus should be-if necessary-ablated, the intracranial cavity must be meticulously isolated and the bony coverage might be immediately or lately designed.

INTRODUCTION

Fractures of the upper face and anterior base of the cranium (Fronto-Basal Fractures) are common neurosurgical and plastic problem of which the appropriate plan of management is a subject of controversy and debate [1]. Many classification systems were adopted for such fractures. Burstein et al. [2] suggested the following classification system according to the fracture patterns seen by computed tomography (CT) of the region of interest; Type I (Central) fracture is confined to the upper naso-ethmoid complex, central frontal squama and medial third of the superior orbital ramus. Type II (Unilateral) fracture involves the entire superior rim and upper lateral orbital wall. Type III (Bilateral) fracture involves fractures of the upper nasal-ethmoid complex, bilateral supraorbital and upper lateral orbital wall as well as bilateral frontal squama fractures. Peri et al. [3] classified the problem into anterior, anterobasilar and frontal skull fracture with sinus extension, which could be further divided into closed or open fractures and the presence or absence of dural violation and brain affection. On the other hand, Aseno et al. [4] disclosed three other clinical types; Type I was the penetrating fractures through the orbit or the ethmoid sinus. Type II was the simple or multilinear fractures, while Type III was the extensive comminuted anterior cranial fossa floor fractures. Sakas et al. [4] proposed another classification system based upon the anatomical location and the extent of the fracture in the region of interest aided by high resolution CT scanning with thin sections bone windowed coronal cuts. They classified these fractures into four major types; Type I was the cribriform plate fractures, Type II was fronto-ethmoid complex fractures, Type III was the lateral frontal fractures, while type IV was the complex fractures that have any combinations of the other three types.

Inadequately managed frontobasal fractures can result in many major aesthetic deformities as well as many life-threatening catastrophes as intracranial hematomas and infections.

The aim of the present article is to evaluate the clinical experience of the plastic - neurosurgical team as regards the management protocol and clinical outcome of cases presented with frontobasilar fractures and to establish a guideline in the management of such cases.

MATERIAL AND METHODS

Patient selection: Fifty patients with upper facial (fronto-basal skull) fractures were included in this study. They were all admitted in Kasr El-

Ainy Casualty Department between the years 1999 to 2002. All patients were seen within the first 24 hours of trauma. Polytrauma patients harboring the fronto-basal manifestations were not excluded from the study.

Diagnostic criteria: All patients were submitted to clinical evaluation as regards history and nature of the accident, association of other traumas as well as any medical past history of relevant importance. The classification system adopted in this study was that of Burstein et al. **[2]**, that classifies the fracture pattern into central, unilateral and bilateral fractures.

Radiological evaluation of the fracture site was mainly done by axial and spiral (Three-Dimensional 3D) computerized tomography (CT) scanning.

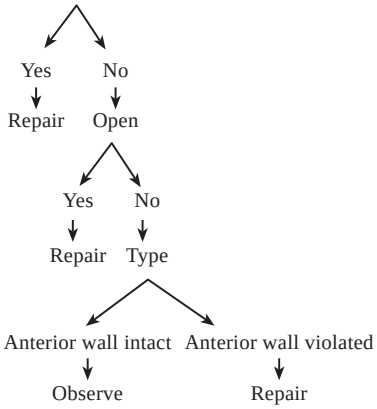
Management protocol: Once the patient was stabilized by first aid measures and vigorous management of his associate abdominal, chest, orthopedic or vascular traumas-if present-, prompt neurosurgical and plastic clinical and radiological work-up was done.

Patients with simple or minimally depressed fractures of the region of interest were clinically monitored by clinical and radiological follow-up if there was no evidence of intracranial hemorrhage seen.

Patients with comminuted or depressed fractures in whom the dislocated fragment(s) was more than 2 centimeters deep or associated with intracranial grave pathology as huge intracranial hematomas or massive frontal lobe contusions were operated upon immediately. The goals of surgery were to evacuate hematomas, debride contused tissues, dural repair and elevation and fixation of the depressed bony fragments. Titanium miniplates and screws secured fixation of the loose bony pieces.

Patients harboring air sinus violation were submitted to surgical intervention if either the condition was associated with dural lacerations and/or there was an overlying bony comminution disfigurement. In these cases, our aim was to ablate the sinus by cranialization of its cavity **[6]** with removal of the residual mucosa, isolation of its cavity by packing of the outflow passage and the remaining spaces by adipose tissues and covering of underlying dural surface with pericranial fascia while, its bony fragments refashion the anterior sinus wall. We followed the following decision tree in the treatment of frontal sinus involvement:

CSF leak and/or subarachnoid CSF-Fluid level **[6]**.



Immediate repair of the frontal bone was only done if the wound is potentially clean and there was no intracranial hypertension detected by intracranial hematomas and massive brain parenchymal contusions or edema. In such cases, delayed cranioplasty was instituted after complete normalization of the intracranial pressure. Skull defects cranioplasty was done by Methyl-methacrylate graft reinforced by a Proline mesh **[8]** that is fixed to the adjoining pericranium by sutures or to the adjoining skull bone by Titanium miniplates and screws.

Evaluation criteria: We adopted a scoring system in order to evaluate the clinical outcome of the management protocol we used. The scoring system depended on some neurosurgical as well as plastic criteria.

Neurosurgical criteria of the outcome:

1- Neurosurgical deficits.

2- Convulsions.

3- Visual affection.

4- Intracranial infections (Brain abscess or meningitis).

5- CSF leakage.

Plastic criteria of the outcome:

1- Wound infection (Soft tissue and/or osteomyelitis).

2- Wound dehiscence.

3- Aesthetic deformity.

Scoring system of the outcome:

Excellent (0), Good (1 to 3), Fair (4 to 6), Poor (7 or 8).

RESULTS

Results are shown in Tables (1-9) and Figs. (1-10).

Table (1): Number of patients according to Burstein et al's, classification system of fronto-basal fractures.

Type of fracture	Number
Type I (Central)	30
Type II (Unilateral)	11
Type III (Bilateral)	9
Total	50

Table (2): Number of patients according to fracture subtypes.

Fracture subtypes	Number
Simple (Closed) fractures	24
Compound (Open) fractures	26
Total	50

Table (3): Number of patients according to relevant clinical presentations*.

Relevant clinical presentation	Number
1- Local pain	50
2- Aesthetic deformity	39
3- CSF leak	27
4- Brain contusion/laceration	12
5- Intracranial hematomas	2
6- Diplopia	9
7- Skin laceration	30
8- Anosmia	5

* The table has no total due to multiple manifestations.

Table (4): Number of patients according to form of fracture from radiological findings*.

Fracture form	Number
Simple linear fracture	23
Compound comminuted fracture	27
Anterior sinus wall fracture	12
Anterior & posterior sinus wall fracture	11

* The table has no total due to multiple radiological findings.

Table (5): Number of patients according to intracranial manifestations*.

Intracranial manifestations	Number
Brain fungation	1
Brain contusion/laceration	4
Brain edema	37
Intracranial hematomas	2
CSF leakage	27

* The table has no total due to multiple manifestations.

Table (6): Number of patients according to mode of management.

Mode of management	Number
Conservative	22
Surgery	28
Total	50

Table (7): Number of patients according to surgical management.

Procedure	Number
Simple skin/scalp closure	2
Bone debridement	3*
Brain debridement	5
Sinus ablation	11
Cranioplasty	9
Total	30

* Two patients underwent later cranioplasty as well.

Table (8): Number of patients according to complications of management.

Type of complication	Number
Aesthetic deformity	5
Intracranial infections	1
Wound infections	3
Total	9

Table (9): Number of patients according to the outcome of management protocol.

Outcome	Number
Excellent	37
Good	7
Fair	5
Poor	1
Total	50

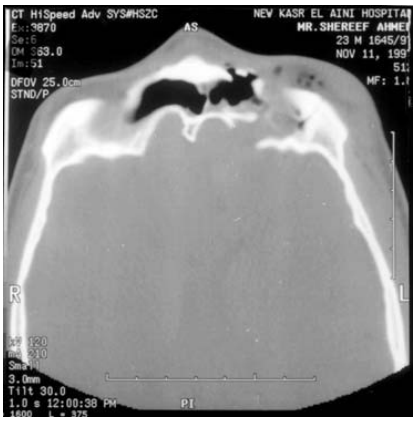


Fig. (1): CT scan of a patient showing type III fracture. There is violation of the supra-orbital margin, both anterior and posterior walls of the frontal sinus as well as the frontal squama.

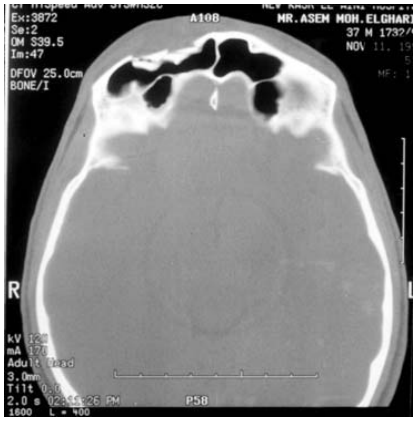


Fig. (2): CT scan of a patient showing type I fracture. There is comminution of the anterior sinus wall as well as the superior orbital margin.

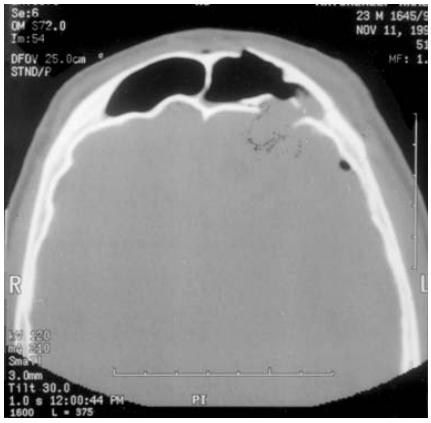


Fig. (3): CT scan of a patient harboring type II fracture showing a fissure fracture of the frontal bone with a dislocated comminuted fragment of the posterior sinus wall.

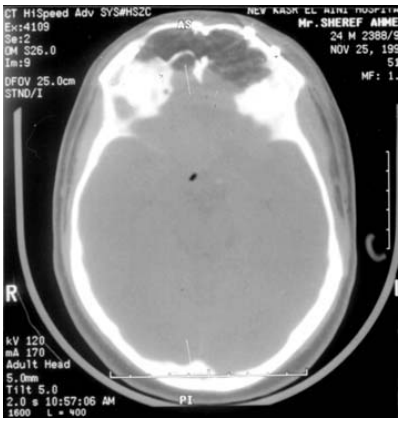


Fig. (4): CT scan of a patient with type III fracture after fixation of the comminuted supra-orbital margin and cranialization of frontal air sinuses.

Fig. (5): Plain X-ray of a patient with type I fracture showing the reconstruction of the frontal defect by Bone Cement cranioplasty fixed in place by Titanium mini-plates and screws.

Fig. (6): Spiral (3D) CT scan of a patient with type I fracture showing the depressed fracture of the outer table of the frontal bone and sinus. This patient needed elevation and fixation of the depressed fracture segment of bone.

Fig. (7): Spiral (3D) CT scan of a patient with type III fracture after fixation of the comminuted supra-orbital and Bone Cement cranioplasty of the frontal squamal defect.

Fig. (8): Photograph of a patient with type II fracture after few weeks of preliminary debridement of the comminuted potentially infected bony fragments. The supra-orbital margin was destroyed and the Levator Palpebrae Superior muscle was severed.

Fig. (9): Photograph of the same patient (Fig. 8) showing the application and fixation of the Bone Cement cranioplasty by Titanium mini-plates and screws as well as the Silicon suspensor for elevation of the eyelids.

Fig. (10): Photograph of the same patient (Figs. 8,9) after few weeks of reconstruction showing the regained contour of the frontal squama and the supra-orbital margin with functional elevation of the eyelid.

DISCUSSION

Fractures of the upper face and anterior skull base are a challenging neurosurgical and plastic problem. This article highlights the role of the plastic-neurosurgical team in delivering and efficient and high quality care for such patients.

Fifty patients with fronto-basal fractures were included in this study. All of them were clinically evaluated within the first 24 hours of injury. The fractures were either simple (24 patients) or compound (26 patients). Computerized tomography of the skull with axial cuts and bone window was done to all of them. Spiral CT images were done if needed in some cases.

Simple or minimally depressed fractures without clinical evidence (CSF leak) or radiological evidence (CSF-air level) of dural violation were seen in 23 patients and were managed conservatively by clinical monitoring and medical treatment in the form of antibiotics and pain killers. In their 3-month follow up, 22 patients

show satisfactory recovery, while one patient needed reconstruction of the frontal bone due to disfiguring deformity.

Comminuted or depressed fractures as well as those cases, in which the fracture reaches the frontal air sinus, immediate operation was done as soon as the general medical condition of the patient allowed. The depressed fragment(s) was elevated, the necrotic and lacerated tissues-including the lacerated neural tissues-were removed, the dura was closed in a watertight fashion and finally, the bone was fixed in place by miniplates and screws.

Frontal sinus repair: Open reduction and meticulous interfragment plate and screw fixation repaired the anterior wall. Internal sinus tissue packing or Foley's catheter balloon internal support had not been attempted. In cases of severely contaminated comminuted fractures with or without bony loss, immediate debridement followed by later cranioplasty yielded an accepted outcome. We used Methylmethacrylate over a Proline mesh in skull bone defects **[8]**. The graft is either fixed by Titanium miniplates and screws or by simple suturing of the edges of the Proline mesh to the surrounding periostium. Autologous bone grafts either by iliac crest or split calvarial or rib bones were not used in the present series due to the simplicity and better cosmetic outcome of the selected technique. There were no cases of local infection or other wound complications by using the Methylmethacrylate in cranioplasty in our study.

In cases of extensive frontal sinus injuries, in which both the anterior as well as the posterior walls were destroyed, sinus ablation by cranialization and packing was the preferred technique we used. In those cases, the posterior comminuted bony wall was removed, the mucous membrane was meticulously excised, the cavity was packed by fat and then covered by pericranial or fascial graft and the anterior wall was repaired by either refashioning of the comminuted fragments followed by miniplate fixation or left for future cranioplasty. Frontal mucocele or pyocele was not encountered in our series, yet a longer follow-up is needed to assess its incidence as late complication.

Conclusion:

Frontobasal skull fractures are challenging problems to the surgical practice. Harmonic teamwork management between the plastic as well as the neurosurgical specialties is mandatory. Upon admission, all patients should be resuscitated and assessed by the general surgical, orthopedic and cardiothoracic surgeons to rule out any life threatening injuries. After clinical and radiographic evaluation of the fracture, prompt surgical intervention should be immediately instituted to excise any necrotic tissues inside or outside the cranial cavity, brain isolation by meticulous dural closure, ablation of the frontal air sinuses (if necessary) and bony coverage of the region by either immediate or delayed frontal bone reconstruction.

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