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Review Article

The TN Chawla Lecture – The current management of midfacial trauma

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ABSTRACT

The management of mid-facial trauma has changed very little in the last decade with minor modifications related to orbital trauma and minimal access approaches particularly related to secondary reconstruction.

In the UK the introduction of major trauma centres has tended to concentrate the management of polytrauma patients to individual regional sites. From a maxillofacial perspective this increases craniofacial cases treated in these units. It also requires a collaborative team approach and a thorough understanding of ATLS principles.

Imaging has progressed to include rapid CT scans, individualised CBCT scans and the use of rapid prototyping models to aid in both visualisation, planning and construction of customised implants.

Finally the industry has managed to develop smaller implants with equal strength to facilitate low profile fixation which is less likely to be prominent in the midface. These also facilitate the use of endoscopic assisted procedures, which tend to be used in secondary reconstruction of the upper 1/3 and osteotomy surgery.

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1. Introduction

The management of midfacial trauma made major progress in the 80s and 90s due to the work of Gruss and Manson.^{1,2} The imprecise methods of the 70s used various external fixators, wires and intermaxillary fixation (IMF), which required long periods in intensive care to manage the associated airway issues, often necessitating temporary tracheostomy. Internal fixation using the principles of reconstruction of the facial buttresses in both length and width via wide approaches from extended intraoral and coronal access and the use of free bone grafts to bridge the defects has reduced the need for airway management and length of post-operative stay, with early mobilisation and better long term outcomes, with reduced

need for secondary reconstruction. These principles became standard management during the 90s with miniplate fixation and calvarial bone grafts to repair bone defects.

Subsequent surgical management has tried to address the issues yet to be corrected by this approach, namely accurate reconstruction of the orbital skeleton. Assessment of the orbit required more accurate radiological assessment. Initially this was done with finer slices on standard CT scans, which became faster. Recently investigation of the use of cone beam CT (CBCT) scans have permitted more detailed assessment of the orbit with reduced radiological exposure of the lens. Increasingly 3D modelling can be used to assess the defect and subsequently permit the construction of a custom made implant.

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Secondary reconstruction often uses the principles of orthognathic surgery. Whilst endoscopically assisted approaches are increasingly being used, particularly for condylar fixation, there is little place for them in primary midfacial trauma management. Access to the forehead for filling bone defects can be satisfactorily achieved with brow-lift type approaches and the filler can be placed using these minimal access approaches. Similarly, revision of Le Fort 1 level issues can be achieved if desired by minimal access endoscopically assisted Le Fort 1 osteotomies.

The following will discuss the current management of midfacial trauma and the recent advances pertinent to this field.

2. Primary assessment and management

Patients sustaining midfacial injuries often have associated cervical and cranial injuries which need to be considered in the initial phase of assessment. Stabilisation of the cervical spine should occur during airway assessment and management of airway issues due to dental injuries and bleeding into the airway may require the maxillofacial team to be involved in the immediate management of these patients. Occasionally the maxilla may be causing obstruction of the airway directly or haemorrhage into the airway from the midface may require immediate stabilisation of the maxillary fractures. Placing two fingers behind the hard palate and lifting the midface forwards will reduce the fracture. This can be held in place either with a mouth prop or even a Guedel airway. If this fails to control the bleeding then nasal or postnasal packing may be required. Consideration should be given to the presence of a base of skull fracture if this is required, hence loose gauze packing should be avoided and the use of an inflated Foley catheter in the post-nasal space may be safer. A more definitive stabilisation is really the only indication for the use of a box or Levant frame external fixator as a temporary measure to control haemorrhage until internal fixation can be safely completed.

3. Imaging of the midface

Standard assessment of midfacial fractures has progressed from the simple occipito-mental (OM) images³ to CT scans. The ability to carry out full body CT scans within seconds using spiral scanners does not significantly compromise ongoing management in the early post-injury phase. These may be reformatted to show both axial, coronal and sagittal views and even 3D images. These aid assessment of the displacement of the fractures in all 3 dimensions. The scans can be used in combination with DICOM software and a rapid prototyping machine to make a 3 dimensional model of the face, which permits planned reconstruction and preadaptation of plates, thus reducing intra-operative time.⁴

Cone beam CT scans are now being used particularly for imaging of isolated orbital fractures. They use a lower and focussed radiation dose which spares the lens, which is particularly prone to cataract formation in a non-stochastic manner.

4. Open reduction and internal fixation

Access to the midfacial skeleton is achieved through a coronal incision, infraorbital and intraoral approach. Exposure of all the fracture lines subperiosteally permits direct visualisation and anatomical reduction. The order of reduction can be above down or below up. If the mandible is stable then intermaxillary fixation will permit accurate restoration of the occlusion. Vertical height of the midface is restored by restoring the vertical buttresses of the piriform rim, zygomatic buttress and lateral and medial orbital walls. Width reconstruction is via the zygomatic arch and orbital rims with the occlusion.

Standard miniplates used include 2 mm down to 1 mm titanium. Newer alloys have now permitted equivalent strength utilising smaller plates (Matrix Midface system from Synthes) from 0.4 to 0.8 mm. These lower profile plates can be supplemented by preformed orbital titanium mesh plates which are shaped to fit standard orbital shapes and facilitate complex orbital reconstruction. The alternative use of custom made plates can be achieved if a CAD CAM model is constructed from a 3D CT scan. Ultimately if the laboratory possesses a DICOM model making machine then this can be cheaper than the preformed plates, but demands the initial cost of the DICOM machine.³

5. Orbital reconstruction

Orbital reconstruction should aim to reverse any diplopia, level the globes and restore the orbital volume. The former takes precedence and an increasing understanding of the differences in behaviour of the paediatric and young adult skeleton compared with the “older” patient has lead to a change in management protocol between these two groups. In the younger patient the bone is more flexible and there is less extraconal fat. This predisposes to greenstick type fractures and entrapment of the inferior rectus rather than the extraconal fat. This requires urgent correction and the so-called “white-eyed blow-out” should be managed by exploration and release of the rectus immediately to prevent long term ischaemic contracture and permanent restriction of upward gaze.⁵ These patients present with painful and very limited restriction of upward gaze—often not above the horizontal with minimal oedema. Older patients tend to have more swelling and bruising, less severe restriction of upward gaze which is minimally painful and a diffuse fracture of the orbital floor with loss of extraconal fat into the antrum. Management is less urgent as often the diplopia resolves and if there is no obvious deformity due to enophthalmos then no surgical correction is required. A defect greater than 50% of the orbital floor usually requires repair to prevent enophthalmos.⁶

The approaches to the orbit are well described and each carries its own morbidity from coronal, transconjunctival, blepharoplasty, midtarsal skin crease to orbital rim. The latter the author would discourage as whilst it carries minimal lid morbidity, it tends to leave a visible scar with marked long term oedema. The defect is carefully located subperiosteally and all the margins exposed. The critical margin is the

posterior limit and whilst many inexperienced surgeons become concerned beyond 40 mm, the apex is often at least 4 mm further back! There is frequently a lip as the antral wall becomes the posterior orbit rising towards the apex and this lip can be used to rest the posterior limit of the reconstruction.

Current trends are moving away from autogenous bone due to donor site morbidity and lack of long term stability. Titanium tends to be the preferred method with fixation to the intact or repaired orbital rim. This can be either in the form of a “cut-to-fit” mesh, preformed “plate” or if a CAD-CAM model has been made a custom prosthesis can be used. The latter saves intra-operative time as it has predefined the defect and assists the surgeon in knowing he has found all the surgical margins of the defect. Following this eye movement should be confirmed using a forced duction test.

During closure consider repair of the orbital septum as a defect here can lead to postseptal fat herniation requiring subsequent blepharoplasty repair. The muscle should be loosely apposed and the skin or mucosa to achieve a watertight seal. Early mobilisation exercises are advised and routine observations for at least 24 h should exclude the development of retrobulbar haematoma.

Great care should be taken in reconstructing the orbit as secondary repair is often more difficult and less successful.

6. Secondary reconstruction

Despite our best efforts, the severity of the injury, our inexperience or suboptimal wound healing can lead to complications. Whilst these are many, they can largely be subdivided into soft tissue and hard tissue problems. Soft tissue reconstruction would include secondary nerve repair and scar revisions. Hard tissue problems relate to malocclusion, orbital dystopia, persistent diplopia and cosmetic defects. Safe to say that secondary repair is often more difficult and requires expert management by an experienced surgeon.

Recently minimally invasive surgical access has come into vogue. This is particularly useful when addressing defects of the forehead area.^{7,8} Previously abandoned, upper blepharoplasty and brow incisions can give wide access to the lower forehead and nasal glabella, which are difficult to reach with coronal incisions. These can be supplemented with endoscopic brow lift approaches which can be used to insert fillers or covers to bony defects in the forehead region, or correct brow ptosis secondary to frontal branch damage. Whilst this approach is difficult to master, it carries significantly less morbidity than the coronal approach, and offers the potential to carry out reconstruction under local analgesia or at most as a day case.

7. Summary

The management of midfacial trauma has moved forward through the 80s until now. Wide approaches are now being minimised due to a generation demanding less scars, however these should not be abandoned when to do so would compromise the underlying reconstruction. We should always bear in mind that we can disguise many of our incisions and anatomical reduction of the underlying fracture will give the best long term cosmesis. Access decisions are increasingly aided by better imaging, and the ability to preform plates on a pre-operative model can guide what access is required and also reduce the operative time caused by repeated plate readjustment. Ultimately the midfacial skeleton is the scaffold for the soft tissues and inaccuracies in the scaffold will lead to cosmetic defects which are much more difficult to correct the second time around.

Conflicts of interest

The author has none to declare.

REFERENCES

1. Gruss JS, MacKinnon SE. Complex maxillary fractures; role of buttress reconstruction and immediate bone grafts. *Plas Reconstr Surg*. 1986;78:9–22.
2. Manson PN, Clark N, Robertson B, et al. Subunit principles in midface fractures: the importance of sagittal buttresses, soft-tissue reductions, and sequencing treatment of segmental fractures. *Plast Reconstr Surg*. 1999;103(4):1287–1306.
3. Sidebottom AJ, Lord TC. Single view radiographic screening of midfacial trauma. *Int J Oral Maxillofac Surg*. 1998;27:275–276.
4. Aleid W, Watson J, Sidebottom AJ, Hollows P. Technical note development of in-house rapid manufacturing of three-dimensional models in maxillofacial surgery. *Brit J Oral Maxillofac Surg*. 2010;48:479–481.
5. Joshi S, Kassira W, Thaller SR. Overview of pediatric orbital fractures. *J Craniofac Surg*. 2011;22(4):1330–1332.
6. Burnstine MA. Clinical recommendations for repair of isolated orbital floor fractures: an evidence-based analysis. *Ophthalmology*. 2002;109(7):1207–1210.
7. Strong EB, Buchalter GM, Moulthrop TH. Endoscopic repair of isolated anterior table frontal sinus fractures. *Arch Facial Plast Surg*. 2003;5(6):514–521.
8. Hewitt DK, Scheidt TD, Calhoun KH. Depressed anterior table fracture: a minimally invasive method of reduction. *Ear Nose Throat J*. 2009;88(1):734–735.