COMPRESSION OSTEOSYNTHESIS IN CRANIOFACIAL INJURIES

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SUMMARY

A simple ingenious external bone fixator has been devised for the management of craniofacial fractures based on the assumption that the proper reduction of fractures and maintaining the fracture segment in the reduced state are very important factors in primary bone healing. The Kiran fixator helps in osteogenesis by compressing the fractured segments against each other. It can be used for the management of all types of fractures of the facial bones e.g., LeFort II, LeFort III, fractures of the naso-ethmoidal complex and mandibular fractures. The use of the fixators have convincingly improved the quality of care and the results in the group of patients treated at the plastic surgery hospital in Ahmedabad.

In a normal person the co-ordinated masticatory muscle movements produce tension forces through the occluding dental surfaces to the adjoining bones (Kruger, 1981). During the process the pressure is transferred from the maxilla, to the cranial bones through the frontal, nasal, zygomatic and pterygoid plates and from the body of the mandible to the ramus and the condyles. In the event of a fracture, these forces would dislocate the fragments (Rowe and Killey, 1970). If, however, interfragmental compression of the fractured surfaces can be ensured, then the bony displacements can be prevented (Kruger, 1981 and Kenneth, 1982).

Design of Kiran Fixators

The fixator is made up of stainless steel and is available in three sizes i.e. small, medium and large. It is compact, sturdy, flexible, elegant and light in weight. It can be autoclaved and re-used. It has two main components:

I. Adjustment stud-bolt;
II. Retention clamps.

The adjustment stud-bolt is composed of a hexagonal bolt in the centre with fine threads in opposite directions. It can be moved gently by screwing movements with a spanner for the accurate adjustment of the gap between the bone edges for stable dynamic compression.

The retention clamps consist of threaded nuts attached on either side of the adjustment stud-bolt with an angled 3 mm, diameter bars (Fig. 1a). These bars have different angles e.g. 45°, 90° and 180 degree angles. The retention clamps can be positioned as desired to neutralize the tension forces at work in a given case of fracture (Fig. 1b).

Clinical Application

A small skin incision is made on one side of the site of fracture under general anaesthesia. Tissues and muscles are retracted until the bone is exposed. The periosteum is not disturbed. A hole is made through the outer cortex only in case of cranial bones while in case of other bones through the outer and just up to the inner cortex with a 2 mm diameter twist drill and/or by a hand drill. During drilling, flushing and cooling is done with saline. Self-tapping 3 mm diameter titanium pin is inserted upto the inner cortex with the “T” handle. It should be at an angle of 90 degree. The self-tapping pin is spaced at a suitable distance from the site of fracture so that it does not interfere with the endosteal blood supply. Sometimes two self-tapping pins may be required. The bone on the other site of the fracture is tackled in the same way. The soft tissues are approximated and skin sutures are applied. Small dressings are left around the
self-tapping pins. A pair of universal joints are mounted on the self-tapping pins.

Proper selection of the size and type of the fixator, placing the retention clamps between the universal joint and the direction of the movement of the adjustment stud-bolt is the key to success.

For compression or distraction of the fractured segments the fixator is placed in such a way so that the adjustment stud-bolt is parallel to the bone and is moved for compression or distraction effect (Fig. 1c).

For traction the fixator is placed in such a way so that the adjustment stud-bolt is at right angle to the bone and is moved for traction (Fig. 1d).

In multiple, transverse and in oblique fractures of the mandible after compression, sometimes the distracting forces cause angulation (lingual or buccal) or displacement in the line of the fracture. To prevent this a connecting rod may be fixed parallel to the outer

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Fig. 1a

Fig. 1b

Fig. 1c

Fig. 1d

Fig. 1. a—Design of the fixator, b, c & d—Applications of the fixators.
surface of the bone as a guide to attain an additional axial stability with another pair of universal joints (Fig. 2). To control the occlusion disturbances in the dentoalveolar fractures an interdental eyelet wiring may be done. Intermaxillary fixation becomes necessary only for the treatment of condylar fractures combined with mandibular fracture.

Final adjustment for stable reduction, immobilization and retention of the fracture edges, of the bone is secured by moving the adjustment stud-bolt, positioning the retention clamps and by locking up the universal joints in suitable positions. If teeth are present, occlusion should be checked and a perfect position of the bone fragments should be established.

Skin sutures are removed between 7th and
Fig. 3. CT scan data: a—Axial sections through mandible [a/1, a/2, a/3 & a/4], b—Coronal sections through mandible [b/1, b/2, b/3 & b/4].
Fig. 4a

Fig. 4b

Fig. 4. Compression: a—in child, b—in an adult.

Fig. 5a

Fig. 5b

Fig. 5: a—Craniozygomaticomaxillary fixation, b—Craniomandibular fixation.
16th post-operative day. After about 4 weeks if there is clinical and radiological evidence of healing, the fixator, universal joints and self-tapping pins are released and removed without the help of anaesthesia. The skin incisions become inconspicuous within no time.

**Cat scan study**

It was found that there was absence of callus formation and the fracture gap persisted for more than 8 weeks. The characteristics of the gap distances depend on the contact points, inner surface, axis, situation and the type of fracture during and after the compression. The interfragmentary gap measured 1.5 mm in width. Fracture ends were stable and nearly in normal position even after the removal of the fixator. Only in complicated

![Fig. 6. Fixators during reconstruction.](image)

![Fig. 7a](image)  
![Fig. 7b](image)
Fig. 7c

Fig. 7: a—Compression, b—Traction of the zygomatic bones, c—Traction of the ramus of mandible, d—Distraction.

Fig. 8. Fixator in position, without discomfort.

Fig. 9. Movement of temporomandibular joints are free.
fractures 1-2 mm distortions were detected post-operatively. During healing phase regeneration took place from the endosteal and periosteal spaces suggesting primary bone healing (Fig. 3a and 3b).

Observations and Result
The fixator has been found helpful in the management of facial fractures in children, adults, as well as in edentulous subjects (Fig. 4a and 4b). Cranial stabilization of the fractured bones if required can be done effectively (Fig. 5a and 5b). The fixator has been employed for immobilizing the bone grafts as well. Soft tissue repair of the tissues overlying a fracture can be carried out without any problem (Fig. 6). The fixator has been effectively used for compression (Fig. 7a), traction of the zygomatic bone (Fig. 7b), traction of the ramus of mandible (Fig. 7c) and distraction (Fig. 7d) successfully.

The fixator is neither bulky nor awkward for the patient and allows the patient to open and close his mouth in situations where intermaxillory fixation is not necessary. The patient is able to look after his oral hygiene and feeding is much more comfortable. The fixator minimally interferes with the periosteal and endosteal blood supply of the fractured segments and its use ensures primary bone healing. C. T. scan was done in some cases of fractures of the facial bones with CT-W4. The sectional series of an axial and coronal planes were taken and average values were considered.

Complications
They were few and minor, which occurred even with the precise surgical technique. They were immediate post-surgical oedema, paraesthesia, epiphora and disturbed sensations. Acute infection occurred in a case where the infected tooth was in the fracture line while in another case the open wound got infected, and it took 2-3 weeks to get cleared. Mild displacement of dentoalveolar fragment took place with occlusion disturbances and T. M. J. movements became painful in multiple fractures. A callus formation with union was observed in subcondylar region. In compound comminuted fractures of the mandible and in Le Fort fractures delayed union was seen.

Conclusion
The Kiran fixators are light in weight and have universal adaptability in management of all types of fractures of the facial skeleton. They have been found to be quite acceptable by the patients in view of the manifold advantages being offered by them (Fig. 8 and 9). C. T. scan studies have shown that primary bone healing occurs fairly early and patient is rehabilitated back to the society within a reasonable period of 4 to 6 weeks.

REFERENCES

The Author

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