Le Fort III Advancement Redesigned: 11 year Experience

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Summary
In 1993, I retrospectively reviewed Le Fort III osteotomies performed at Children’s Hospital Oakland. The cases had been performed without distraction and employed internal bone plate fixation. It was disappointing to discover the amount of midface protraction achieved, when measured on lateral cephalograms, was typically 0 to 25% of the magnitude required for reconstruction to facial norms. To address this disparity, we began a process to redesign the Le Fort III procedure with the objective of improving efficacy and reducing risks. This paper reviews a series of design modifications made to the Le Fort III procedure over the past 11 years.

Introduction
Le Fort III osteotomies are most often used to treat midface retrusion associated with syndromic craniosynostosis. Undesirable results of Le Fort III procedures are well known. Catastrophic outcomes include brain damage, blindness, and death. Serious complications include life threatening hemorrhage and sub-therapeutic advancement. Failure to achieve satisfactory correction of midface hypoplasia may be the result of inadequate protraction or relapse. Regardless of the cause, the inability to achieve anatomic correction may result in persistent airway obstruction, compromised ocular protection, and syndromic facies. Complications are most often related to a specific deficiency of the surgical design. The aim of this project was to identify critical operative events leading to major complications and to develop techniques to overcome these problems. Anesthesia related problems are an important but separate issue. Critical surgical pitfalls may be avoided by modifying the procedure and introducing new instrumentation.
Materials and Methods

Cases involving midface osteotomy that resulted in brain damage, blindness, or death were reviewed. The source of the cases included published reports, medicolegal cases, and personal accounts. Review of these cases revealed the most common situations resulting in complications. It is clear the actual number of cases resulting catastrophic outcomes is underrepresented in the literature. After specific operative events leading to catastrophic outcomes were identified, modification of standard operative procedures and instrumentation were introduced and evaluated for their ability to avoid these problems. Changes include: (1) relocating the position of the osteotomy, (2) use of piezosurgery bone cutting instruments, (3) eliminating pterygoid plate osteotomies, (4) separating the pterygomaxillary junction with a midface mobilizing instrument (5) use of internal distraction devices anchored to the zygoma (6) avoiding involvement of the temporal bone for anchorage (7) substantial intraoperative distraction (8) completing transport within 48 hours of surgery under a prolonged anesthetic, (9) enhancement of distraction sites with morphogenetic proteins and (10) maintenance of internal fixation devices for months or years.

Results

Three operative events were associated with the majority of complications that resulted in neurologic damage, blindness, or death (fig 1). All events involved unintended intracranial penetration leading to laceration of the brain, optic nerves, or intracranial vessels. The areas identified as warranting surgical design modification were: (1) pterygomaxillary dysjunction, (2) frontonasal

![Diagram of skull showing areas of interest for osteotomy and distraction devices](image-url)

*Fig 1 Catastrophic complications most often occur during (A) pterygomaxillary dysjunction, (B) frontonasal osteotomy, or (C) placement of holes or screws to anchor distraction devices (reprinted with permission, Journal of Craniofacial Surgery, March 1998).*
osteotomy, and (3) anchorage of fixation/distraction devices to the skull. No serious or catastrophic complications were experienced in our patients.

Conclusions

1. Pterygomaxillary dysjunction is typically performed with osteotomes or an oscillating saw. The unfavorable anteroposterior vector of the osteotome may create a fracture in the sphenoid bone as the pterygoid plate is forced in a posterior-superior direction. If the fracture propagates superiorly, it may enter the cranial vault and lacerate the brain or adjacent vessels. If the sphenoid fracture involves the canal housing the optic nerve, blindness may result. Vertically hypoplastic maxillas, often associated with syndromic craniosynostoses, may have increased risk of sphenoid bone fracture during pterygoid dysjunction. Use of a midface mobilizing instrument directs forces anterior in a manner to avoid fracture of the cranial base (fig 2). This method also avoids

![Fig 2 Midface mobilizing instrument avoids need for pterygoid osteotomes or saws.](image)

![Fig 3 Anchoraged of distraction device to zygoma avoids penetration of temporal bone.](image)
laceration of the internal maxillary artery which may occur during instrumentation of the site with power saws.

2. Anchoring fixation and distraction devices may involve the temporal bone. This bone is thin, mechanically weak, and has the temporal lobe of the brain on its deep aspect. Placement of fixation screws at this site has been associated with damage to the temporal lobe by drilling equipment or screw placement. Resulting brain or intracranial vessel laceration may have a lethal outcome. To avoid this complication, some surgeons place bur holes and position retractors between the brain and the path of the drill or screws. As an alternative, we have used distraction devices anchored to the zygoma (fig 3). The devices are designed to accommodate various developmental anomalies without compromising the stability of the distractor. This eliminates the risk of brain laceration during placement of distraction hardware.

3. Frontonasal osteotomy is typically initiated with a power saw and then completed with osteotomes. Despite anatomic analysis with computed tomography, intracranial penetration and laceration of the dura or frontal lobe has occurred. We propose creating a window using piezoelectric bone cutting instruments to avoid this complication. The piezosurgery instrument (Mectron, Italy), allows cutting of bone without cutting of soft tissue (fig 4). Two parallel osteotomies are performed just penetrating the cortical bone. The ultrasonic cutting method does not penetrate the dura if it should be encountered. After the cortical bone segment is removed, direct visualization of the deep structures can be made and the osteotomy continued without the hazard of intracranial penetration.

Discussion

Eleven years of experience with an evolving, modified Le Fort III have yielded no serious or catastrophic complications. Follow-up cephalometric

![Fig 4 Piezosurgery creates a frontonasal window without dural penetration.](image-url)
radiographs showed no significant relapse. All the patients completed distraction transport within 48 hours of surgery (fig 5). Catastrophic complications in Le Fort surgery most often occur as a result of predictable events. Intracranial penetration of a saw, osteotome, or fixation screw has been associated with the majority of brain injuries and deaths. Fracture of the cranial base may occur during pterygomaxillary dysjunction with osteotomes. The result
may be intracranial hemorrhage or disruption of the optic nerve. Despite the serious nature of these outcomes, little is written about the circumstances of the injuries or possible solutions. Surgical technique modifications taking advantage of new instruments and technology dramatically reduces the incidence of complications and improves the surgical outcome (fig 6). The proposed changes do not introduce any additional risks. Occurrence of catastrophic complications may be dramatically reduced by modifying the surgical design and taking advantage of new instruments.

Reference