nternational Journal of Recent Advances in Multidisciplinary Topics
Volume 3, Issue 1, January 2022
https://www.ijramt.com | ISSN (Online): 2582-7839

Complications of Lefort I Osteotomies- A Review on Pre and Post-Operative Implications

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***Abstract*: LeFort I osteotomy is routinely performed for reduction of complex midfacial fractures, correction of maxillary-zygomatic deformities, and severe orthodontic malocclusion requiring elective orthognathic surgery thus allowing movement with segmentation expansion effectively. Despite developments in the field of orthognathic surgery, a wide range of intra operative and post-operative complications like hemorrhage, neurosensory deficit, maxillary sinusitis, aseptic necrosis, Malunion, maxillary instability, loss of tooth vitality, ophthalmic problems, and nasal deformity though occurs with lower incidence play a significant role in risk assessment and overall treatment outcomes. The present review was aimed to briefly elaborate various pre-operative and post-operative complications of LeFort I osteotomies with special emphasis on their evaluation, management methods and its associated clinical implications. It was observed that overall complication ranges between 6.1% and 9% following LeFort I osteotomies that depends on several factors such as Patient compliance, surgical technique, complexity of fracture, association with vascular structures, and underlying systemic conditions. Consequently, with proper case selection, appropriate treatment planning, careful instrumentation, ideal pre-surgical orthodontic treatment, and adequate care assisted by patient education, psychological support and post-operative medications can effectively reduce complications thus decreasing patient morbidity and increasing the quality of life.**

***Keywords*: Aseptic necrosis, interdisciplinary, le fort i osteotomy, maxillary instability, orthognathic surgery.**

1. Introduction

In orthognathic surgery, LeFort I osteotomy is often recommended for correction of maxillary-zygomatic defects. Wassmund in 1927 performed the first total LeFort I osteotomy for correction of skeletal open bite with wire fixation osteosynthesis [1, 2]. Later, in 1970s, miniplates were implemented for fixation osteosynthesis in maxillofacial orthognathic surgery. With advancement in techniques and introduction of custom-made, patient-specific implants (PSIs) fixation method, currently this method is performed in combination with sagittal split ramus osteotomy and intra-oral vertical ramus osteotomy for management of wide range of dentofacial deformities at the maxillo-mandibular region that includes class II and III malocclusions, vertical and transversal maxillary problems, maxillary deficiency, and associated dentofacial irregularities [3-5]. Despite several advancements, the conventional plate fixation still remains the primary choice of osteosynthesis than wire osseous fixation owing to its stability, less complex procedure, safe to perform with low complication rate.

In spite of all the developments in the field of orthognathic surgery, a variety of intra operative and post-operative complications attributed to difference in surgical technique, surgical skill, diagnostic criteria, and patient's compliance have been reported. These include intraoperative hemorrhage, post-operative hemorrhage, unfavorable fractures of the skull base and pterygoid plates, nasal septum deviation, neurosensory defects, Trigemino-cardiac reflex, ophthalmic defects, aseptic necrosis, post-operative infections, maxillary instability, Malunion and relapse, delayed healing, maxillary sinusitis, oral fistula, loss of tooth vitality, periodontal problems and other complications leading to removal of the fixation plates and screws [6-8]. Several retrospective and prospective studies were carried out in the past to quantitatively evaluate both perioperative and postoperative complications in Le Fort I osteotomies [9-11]. Nonetheless, a brief knowledge and detailed understanding on various pathophysiological aspects of the most commonly encountered complications might help the surgeons as well as orthodontist to ensure adequate

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precautions were taken to prevent their occurrence and facilitate their management [12, 13]. It also serves as a useful guide in educating the patients with potential complications involved, estimation of risk assessment, and planning of surgical procedure with more effective patient care without compromising the overall health of the patients. Hence the present review was aimed to briefly elaborate various pre-operative and post-operative complications of LeFort I osteotomies with special emphasis on their evaluation, management methods and its associated clinical implications.

2. Methodology

A structured literature search for articles written in the English language in PubMed/MEDLINE, EBSCO host, Google Scholar, Scopus, and Web of Science databases was retrieved by using MeSH terms “LeFort I osteotomies” OR “Orthodontics” AND “Dental”, “Orthognathic surgery” AND “Complications” "Intra- and perioperative complications, Dental" OR “Midfacial fractures” OR “Management” OR "All Metadata", “Dental, Maxillary Osteotomy”.

3. Discussion

The Le Fort I osteotomy is one of the most commonly performed orthognathic surgical procedure with advantages like technical ease, wide application in several functional and aesthetic complications, dependability of its results, patients acceptability, enhanced prognosis and reduced post-operative complications. This osteotomy allows both horizontal and vertical movement and, when performed as a segmental osteotomy allows for transverse expansion. Studies by Kramer et al [1], Garg and Kaur [3], Kotaniemi KV et al [5], Eshghpour et al [6], Ulker et al [7], Bhaskaran et al [12], Wilson et al [13], demonstrated an overall complication incidence rate ranging between 6.1% to 9% following LeFort I osteotomies which varies based on several factors such as Patient compliance, surgical technique, complexity of fracture, association with vascular structures, and underlying systemic conditions. Patients who undergo segmental osteotomies or large advancements were also shown to have an increased risk of complications. Studies have also shown excessive bleeding, intraoperative hemorrhage, and compression of infraorbital nerve, tooth sensitivity, aseptic necrosis, maxillary sinusitis and unfavorable fractures being the most frequent findings requires immediate supervision, assessment and management to ensure appropriate within the given follow-up period.

1) Intra-operative and Post-operative Hemorrhage

Damage to the descending palatine artery (DPA) may occur during medial wall LeFort I osteotomy resulting in mild to moderate bleeding intra-operatively and delayed bleeding post operatively. The DPA runs downwards through the greater palatine canal with two branches namely greater palatine and lesser palatine branches of the pterygopalatine ganglion and emerges from the greater palatine foramen. The artery later runs forward in a grove during the course is more prone to vascular injury on the medial side of the alveolar border of the hard palate to the incisive canal during maxillary superior repositioning, incorrect instrumentation, osteotome placed too high into pterygopalatine fossa, bone removal around the descending palatine artery [2-4]. Kramer et al [1], Khanna et al [14] reported 1% incidence of excessive bleeding caused by DPA following maxillary osteotomies. This can be minimized by limiting the osteotomy segments, or positioning of curved osteotome at the pterygomaxillary junction, use of right angled saw to separate the maxilla from pterygoid plates, angling the posterior lateral maxillary osteotomy downwards at the time of surgery.

The common post-operative vascular complications like epistaxis and hemorrhage were assessed clinically over a period of one to two weeks as most of these signs are known to occur during the initial 24 hours following surgery with increased risk among patients with major anatomical abnormalities. Anterior or posterior epistaxis either in isolated or combined form may result from traumatic nasal intubation, however in a series of hemorrhage cases in literature following Le Fort I osteotomies, the vast majority of initial episodes occurred within the first 14 days post-operatively is often suggestive of an injury to an artery posteriorly [2-4, 14]. Post-operative bleeding or delayed bleeding requires adequate packing and stabilization through surgical site reopening followed by repositioning the maxilla to evaluate the level of vascular damage. Hypotensive anesthesia has been shown to reduce blood loss and provider better visualization of the surgical field and shorten the length of hospital stay [14, 15]. Several techniques like anterior or posterior nasal packing, packing of maxillary sinus, or cauterization of the injured vessel, ligation of the external carotid artery, angiographic embolization, piezoelectric devices, transcatheter electrocoagulation or use of tranexamic acid irrigation were suggested for preventing perioperative blood loss during orthognathic surgery [1-4, 14-16].

2) Neurosensory Defects and Disturbances

Intraoral and extraoral neurosensory deficit occurs as a result of compression, retraction or injury to branches of maxillary nerve, a division of trigeminal nerve that travels through the orbit and enters the infraorbital canal to exit onto the face through infraorbital foramen. Permanent damage, compression, retraction or transection to the infraorbital nerve during subperiosteal dissection, incorrect separation during dis-impaction primarily result in extraoral neurosensory deficit [2]. During LeFort I osteotomy the nasopalatine nerve, superior alveolar nerves and terminal branches are usually divided along the line of incision causing intraoral neurosensory deficit, alteration in the sensation of maxillary teeth, buccal mucosa and skin of the face, insensitivity or paresthesia in the region above the upper lip, followed by the lower lip and the chin [4, 17].

Extraoral neurosensory testing is carried out to evaluate facial sensation at the infraorbital region, lateral alar region and superior labial region corresponding to branches of infraorbital nerve trunk. On the other hand, intraoral testing is performed on each side just below the incision line at the incisor, premolar and molar regions corresponding to alveolar nerve branches. Garg and Kaur [3], Kahanberg and Engstrom [18], Al-Din et al [19], Sousa and Turrini [20], reported marked decreased pin prick, fine touch sensation at vestibular region (Intraoral) in

majority of the patients during the first two months that gradually re-established around 6- 12 months whereas extraoral cold sensation, pin prick sensation and fine touch sensation on the face recovered by 6 weeks post-operatively.

3) Tooth Vitality and sensitivity

Following orthognathic surgery, loss of pulpal response stimulation can occur transiently that does not require endodontic therapy frequently. During superior positioning of the maxilla, a bone cut of more than 5-6mm from the apices results in risk of root injuries and devitalization of the teeth at the position of infraorbital foramen region. In majority of the patients, involved teeth recover without treatment and respond to pulp testing around 6 months. Vitality of the tooth is tested by examining central incisors, first premolars and first molars using electric pulp stimulator, cold ethyl chloride spray, a stick of ice and hot spatula, spoon or blunt instrument on both the sides. Garg and Kaur [3], Kahanberg and Engstrom [18], De jongh et al [21] in their respective studies concluded immediate tooth vitality loss seen in more than 90% cases post-operatively but gradually regains vital response to electric and thermal pulp stimulation around 6 to 18 months. Many studies have also confirmed the reoccurrence of vitality and stimulatory function can take up to 1 year without endodontic intervention [4-8].

4) Maxillary Sinusitis

Infection, pre-existing disease, non-viable bone fragments and other local factors largely influence post-operative maxillary sinusitis following Le Fort I osteotomy. Le Fort I osteotomy can affect paranasal sinus in terms of sinus volume decrease, morphological alterations, and radiologically detectable inflammatory processes affecting the maxillary sinuses [22]. Signs and symptoms like headache, pain, nasal obstruction, difficulty in breathing, fullness at the sinus region, nasal drainage, nasal congestion or purulent nasal secretion and decreased smell sensation were evaluated at regular intervals post-operatively. Kramer et al [1], Garg and Kaur [3], Valstar, M.H.et al [22], Nocini PF et al [23] observed very low incidence (1.1% to 4.8%) with mild symptoms that usually resolved by 20-24weeks. Careful manipulation of surgical field, proper aseptic technique and ensuring sinus free of any non-viable bone fragments may prevent post-operative incidence of maxillary sinusitis.

5) Aseptic Necrosis

The risk of aseptic necrosis is increased in patients with severe anatomical irregularities, extensive dislocations, large advancements, segmental osteotomies, aplasia, craniofacial dysplasias, orofacial clefts, or vascular anomalies requiring multi-segment Le Fort I osteotomies [1, 24]. The severity of aseptic necrosis depends on degree of vascular damage caused by rupture of descending palatine artery, postoperative vascular thrombosis, palatal stripping, perforation of palatal mucosa and impaired blood supply to maxillary segments [24-26]. Clinical signs suggestive of aseptic necrosis like sloughing of tissue, dehiscence, and severe pain at the joints, decreased jaw movements and periodontal defects observed post-operatively up to period of 8 weeks should be treated by maintenance of optimal hygiene, antibiotic therapy to prevent secondary infection, heparinization, and hyperbaric oxygenation [24].

Maxillary movement type, as well as the amount of advancement, has been reported to show a significant correlation with complications. Osteotomies with large anterior movements of the maxilla of 9 mm or more have been shown to enhance the risk of ischemic complications while maxillary setback with impaction has a higher risk for complications than other movement types, followed by isolated maxillary advancement. Kramer et al [1], Garg and Kaur [3], Eshghpour et al [6], Lanigan et al [27], Mol De et al [28] reported 0.2- 1% occurrence of aseptic necrosis following orthognathic surgeries attributed to systemic and local factors such as case selection, non-segmentalization of maxilla, poor vascular supply and immuno compromised status.

6) Unfavorable fractures

Clinical evaluation aided by radiographs or computerized tomography (CT) scans assist detection of unfavorable fractures that include tuberosity fracture, pterygoid plate fracture, middle cranial fossa fracture, sphenoid bone fracture at the base of the skull. Studies have shown pterygomaxillary dislocations using a curved osteotome had marked fractures of pterygoid plates with subsequent disruption of the pterygopalatine fossa and fracture extending likely to base of skull. Many of these unfavorable fractures remain unnoticed due to lack of CSF leak because of a local soft tissue seal [1-4, 12, 29].

7) Nonunion, Malunion of fractured segments

Insufficient bone approximation, improper fixation, inappropriate bridging of the defect, poor vascular pedicle and bone grafts results in nonunion or Malunion at the surgical site may lead to maxillary instability post-operatively. After 4 weeks of inter-maxillary fixation, slight movement of the maxilla is normally noted, disappearing once functional forces are applied to the maxilla. Several factors such as missing a centric relation-centric occlusion discrepancy preoperatively; failure to achieve the desired maxillary position during isolated maxillary surgery, failure to seat the condyle because of inadequate removal of posterior bony interference and inaccurate vertical positioning results in maxillary instability [1, 3, 12, 30].

Tabrizi et al [31] noted variations and non-reliable correlation in clinical predictions based on the tooth at rest and at the maximum smile with tendency to under-correct rather than over-correct. Additional stability of the maxillary segments after fixation with miniplates was suggested by the use of palatal dressing plates. Rigid fixation using miniplates, assuring proper bone contact and maxillo-mandibular fixation for 4–6 weeks decreases relapse rate post-operatively and also prevent these complications. In case of severe non-union and high maxillary instability surgical site should be reopened followed by removal of fibrous tissue and proper rigid re-fixation is recommended to achieve predictable union of segments.

8) Ophthalmic complications

Various potential post-operative ophthalmic complications includes diplopia, abnormal or restricted movements of eye balls, extra-ocular muscle dysfunction, decrease in visual acuity or even blindness, neuroparalytic keratitis and epiphora were assessed regularly for 8 weeks. Bendor-Samuel et al [9],

Newlands et Al [32] observed fracture at the base of skull, superior orbital fissure or at the orbital canal, associated with cavernous sinus injury, probable thrombosis and carotid-cavernous fistula following LeFort I osteotomies causes oculomotor nerve palsy, abducens nerve palsy either partially or fully at ipsilateral side resulting in ophthalmic complications. Inappropriate separation of the pterygomaxillary junction, hemorrhage from pterygopalatine fossa may leak the orbital cavity through inferior orbital fissure can cause elevated intraocular pressure (IOP) or dropped systemic blood pressure (systemic hypotension) [33].

4. Conclusion

Successful outcome of LeFort I osteotomy largely depends on interdisciplinary approach upon comprehensive multi-disciplinary care and pre-operative as well as post-operative management. Despite wide range of complications mentioned above, few rare complications such as nasal deformity, nasolacrimal duct injury, blindness, deviated nasal septum, carotid-cavernous fistula and total avulsion of lateral segment of palate could also be fatal. Consequently, with proper case selection, appropriate treatment planning, careful instrumentation, ideal pre-surgical orthodontic treatment, and adequate care assisted by patient education, psychological support and post-operative medications can effectively reduce complications thus decreasing patient morbidity and increasing the quality of life.

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