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REVIEW ARTICLE

Complications Associated With Orthognathic Surgery

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Abstract

Introduction

Orthognathic surgery is a well-established treatment modality for the treatment of advanced dentofacial deformities. On the other hand, there are also numerous complications associated with orthognathic surgery.

Material & Methods

The purpose of this study was to review the literature for gathering and summarizing the pre-operative, intra-operative and post-operative complications associated with orthognathic surgery, providing adequate knowledge for the oral and maxillofacial surgeon.

Results

There is no consensus on the incidence of complications in orthognathic surgery but the most commonly reported complications were found to be hemorrhage, nerve damage, infection, bad splits or undesired fractures at the osteotomy lines or distant places, post-operative nausea and vomiting, aseptic necrosis, mal-union, non-union, relapse, and dental injuries. If timely precautions are not taken, the result of some serious complications such as hemorrhage and infections might even be lethal.

Conclusion

Surgeons need to be well prepared to avoid and manage all possible complications associated with orthognathic surgery and inform their patients extensively about these prior to the operation, getting their written consents. This will help prevent medicolegal issues, leading to better treatment outcomes and patient satisfaction.

Keywords: Orthognathic Surgery, Complications, Treatment

Introduction

Orthognathic surgery is a well-established method for the correction of dentofacial deformity^{1,2}. Orthodontia is usually sufficient for the treatment of solely dental deformities. Orthodontists can align the teeth within the alveolar bone to achieve a functional occlusion with desirable esthetics².

In the presence of dentofacial deformities, applying only orthodontic treatment would not be sufficient, and a combined treatment of orthodontia with orthognathic surgery would be necessary. These patients suffer from various types of functional deformities and poor esthetics³.

Various complications may occur in orthognathic surgery similar to any surgical operation³. The severity of these complications differ due to many risk factors, including but not limited to: clinical expertise of the surgeon, the surgical

techniques, and the factors associated with the patient¹. Some complications may even be lethal if not managed urgently and appropriately⁴. Complications associated with orthognathic surgery may be sub-divided into three major groups; Pre-operative, intra-operative and post-operative.

I. Pre-Operative Complications

1. Inaccurate Treatment Planning

Orthognathic surgery is a multidisciplinary subject. As such, orthodontists and oral and maxillofacial surgeons need to collaborate comprehensively for the definitive treatment planning. Surgeons and orthodontists usually don't know each other's limits in their treatments. They should therefore always decide together what is feasible and not for the patient during every single phase of the treatment. Otherwise, it might create a negative impact on the duration and/or the end result of the treatment, sometimes even causing irreversible

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situations⁵.

2. Root Resorption

Apical root resorption may be an undesirable side effect of orthodontic treatment⁶. Maxillary incisors are the most effected group of teeth in terms of root resorption and mandibular incisors follow the maxillary incisors^{7,8,9}. Excessive extension of the maxillary arch in class III cases may cause root resorption. The amount of expansion should be determined in advance by the analysis to be performed in the mouth and on the cast models. Additionally, if there's a lack of cooperation in between the surgeon and the orthodontist, the orthodontic treatment could be revised and/or reversed in the late phases of pre-operative planning, which could also result in possible root resorptions. If the pace of the orthodontic movements is not arranged properly, this might also result in root resorption¹⁰.

II. Intra-Operative Complications

1. Hemorrhage

Hemorrhage occurs as a nature of all surgical operations, but excessive hemorrhage needs to be prevented. The source of the hemorrhage needs to be determined intra-operatively; hemorrhage from soft tissues and hard tissues are addressed and managed differently. Unexpected intra-operative bleeding could usually be prevented by taking a good medical history. Prothrombin time, partial prothrombin time and bleeding time tests should be requested if necessary¹¹.

Iatrogenic excessive hemorrhage has several reasons: lack of hypotensive anesthesia, inaccurate flap design, traumatic surgical intervention, abnormal anatomy, and the lack of surgical skills or experience. Long-term digital pressure with damp gauze pads is usually sufficient for simple soft tissue hemorrhage. During the maxillary osteotomies, maxillary, tonsillar and descending palatine arteries, and during the mandibular osteotomies, facial and lingual arteries need to be protected carefully to prevent excessive and even massive bleeding. A large amount of oxidized cellulose and/or 0.5-1g of intravenous tranexamic acid can be used to manage the hemorrhage besides using local anesthetics with epinephrine. If the bleeding vessels can be identified, they could be clamped and tied with preferably non-resorbing 3-0 silk sutures¹². Some surgeons prefer to ligate the descending palatine arteries routinely during their Le Fort 1 osteotomies even if they are not ruptured, but there's no scientific evidence to support this application, and this might even jeopardize the viability of the maxilla. If the bleeding is severe and persistent, the external carotid artery may need to be ligated or else the situation may even be lethal¹³. Several units of blood transfusion may be necessary as required.

2. Nerve Damage and Blindness

During orthognathic surgery, infraorbital, inferior alveolar (IAN), mental, lingual and less commonly, branches of the facial nerve, might be injured¹³. Almost all patients undergoing Le Fort 1 osteotomy experience some degree of sensation loss in the maxillary teeth, buccal mucosa, palatal mucosa, alar and malar skin but these are usually transient and are

expected to disappear within 6 to 12 months¹³. Marking the maxillary canine and the first molar root tips is a useful hint to prevent performing low osteotomies, the main cause of sensation loss in the maxillary teeth. Intra-operative traction of the infraorbital nerve, direct contact to the anterior, medial and posterior superior alveolar and nasopalatine nerves may cause this paresthesia. Careful retraction of the infraorbital nerve is required to prevent long lasting paresthesia in the facial soft tissues. The recovery of sensation loss varies conforming to the degree of nerve injury and the age of the patient¹⁰. Post-operative neurosensory loss is more common than intra-operative nerve transection injury¹⁴.

IAN is the most affected nerve due to its anatomical position in the mandibular osteotomies. It is most commonly injured during the bone splitting of the sagittal split osteotomies. Risk factors are: low corpus height, class 2 malocclusion due to mandibular retrognathia, excessive mandibular advancement, genioplasty at the same session with the sagittal split osteotomy, and the age of the patient. The most appropriate site for the anterior vertical osteotomy is in between the first and the second molar region of the buccal bone to prevent nerve damage during the sagittal split osteotomy. This area usually has the thickest bone and the inferior alveolar nerve is the farthest from the lateral cortex¹³. When the osteotomy is completed, one should carefully check the position of the IAN and free it from the proximal segment with a blunt instrument if it is found to be attached to this segment. Before plating or placing transcortical screws for fixation in the mandible, care should be taken not to compress the nerve as well¹³.

Neurosensory loss in the chin and lower lip area is caused not only by IAN damage but also due to mental nerve injury during genioplasty. Excessive dissection should be avoided in the area, and myelin sheath of the mental nerve should be protected if ever possible. Some of these cases may be accompanied by the asymmetry of the lower lip however it is often unclear whether this complication is the result of motor nerve injury or direct muscle trauma¹³. As the age of the patient increases, the chance of lower lip paresthesia to be permanent also increase¹⁵.

Lingual nerve injury usually occurs due to the inaccurate flap design, careless lingual retraction or due to over drilling or placement of excessively long bicortical fixation screws during sagittal split osteotomy¹⁵. Fortunately this complication is fairly rare and usually transient¹³.

Facial nerve injury is uncommon and may rarely result due to the setback of the distal segment and placement of a retractor in the posterior ramus¹⁶.

To prevent permanent nerve damages, operations need to be performed under good direct visualization of the field, with good lighting, and excessive tensile forces and traumatic procedures need to be avoided¹³.

In case of a direct visualization of complete transection of any of the associated nerves during orthognathic surgery, it is recommended to suture it with 6-0 or 8-0 monofilament

nylon microsurgical sutures under magnification with direct clear view¹³. If the patient presents with dysesthesia findings post-operatively, a close follow-up needs to be carried out routinely for two months to see if surgical nerve repair would be necessary, and the patient needs to be referred to an oral and maxillofacial surgeon with the expertise of nerve repairs.

Post-operative abducens nerve (CN VI) paralysis and oculomotor nerve (CNIII) damage have also been reported. Optic nerve (CNII) injury causes blindness and this is undoubtedly one of the worst complications to be encountered during orthognathic surgery. A few cases were reported where xerophthalmia (dry eye) has been caused by damage to the secretory fibers of CN VI¹⁵.

3. Incorrect Osteotomy Lines and “Bad Splits”

This complication is most commonly seen in the sagittal split ramus osteotomy, which is a technique-sensitive procedure, where meticulous osteotomy lines need to be performed. Due to anatomical variations, it might be difficult to establish ideal osteotomy lines. As a result, undesirable fractures of the osteotomy line may occur¹⁷.

Before the osteotomy, guidelines should be marked with a bur or sterile pencil to prevent complications. Incorrect osteotomy lines, generally occurs in the lower part of the lateral vertical osteotomy if marking is insufficiently made. The badly fractured segment needs to be stabilized by rigid fixation methods. Fractures may occur in the buccal region of the proximal segment; this commonly happens in excessive advancements of the mandible where the proximal and distal fragments are almost non-contacting. In such cases, the condylar position is also difficult to maintain¹³.

Fractures may also occur above the subcondylar region in some cases. If so, initially, the fractured segment of the condyle needs to be anatomically repositioned and fixated; following this, the sagittal split osteotomy segments needs to be fixated¹³.

In some other cases, fractures may occur on the lingual region of the proximal segment. Presence of a wisdom tooth could increase bad splits in the mandible. Therefore, extraction of these teeth is recommended at least 6 to 9 months before the operation. Additionally, incomplete osteotomy lines in the medial horizontal ramus may cause undesired fractures in the sagittal split osteotomies. In such cases, the free lingual segment needs to be fixated to the proximal segment with two cortical screws³.

Fracture of the pterygoid lamina, instead of the pterygoid plates, is another possible complication in the Le Fort 1 osteotomy. Careful use of appropriate tools is a necessity. Apart from the pterygoid lamina, avulsion of the vomer and fracture lines may occur in the sphenoid bone and middle cranial fossa. The fracture of the anterior wall of the maxillary sinus may occur when creating modified osteotomy lines, which should be treated with plate-screw fixation¹³.

Too inferiorly planned osteotomy lines in Le Fort 1 osteotomies can result in cutting the apices of some teeth (canines and first molars) and too superiorly planned osteotomy lines could damage the infraorbital nerves; as such, these need to be avoided.

III. Post-Operative Complications

1. Dental Injuries

Fracture of a tooth or burring a segment of a tooth may occur during interdental, maxillary and mandibular osteotomies. Osteotomy lines need to be marked to prevent injury to the root tips of maxillary and mandibular teeth and there should be at least 5mm of distance in between the osteotomy line and the teeth. This distance should ideally be 10mm, however it is not always possible to establish an ideal osteotomy line due to anatomic variations. Periapical films could be helpful to measure the safe distance³. Tooth discoloration could be observed in the post-operative follow-ups, indicating a possible necrosis. Necrotic teeth need to be root canal treated to prevent periapical pathology.

2. Infection

Post-operative cellulitis, abscess, maxillary sinusitis and osteomyelitis may be seen. Infection rate is fortunately fairly low in today's world thanks to aseptic techniques. If an infection develops, it can usually be adequately treated with early diagnosis¹⁸. Small infectious areas could be treated with incision and drainage and administration of systemic and/or local antibiotics. For larger infectious areas, aggressive debridement, bone grafting or both of these could be applied⁴. Studies show that infection rate after mandibular osteotomies is higher compared to maxillary osteotomies and double jaw operations have a higher infection rate compared to single jaw operations^{4,18,19}.

3. Hematoma and Edema

Edema is intercellular blood plasma fluid and is a natural response to surgical trauma. Excessive edema could be prevented using atraumatic surgical skills, post-operative intermittent application of cold (ice) to face and use of non-steroid antiinflammatory drugs and corticosteroids²⁰. Mini vacuum drains may also help in reducing post-operative edema²¹.

Hematoma should be considered if there is significant post-operative pain, severe swelling, and local thermal increase over the skin. Ultrasonography could be used to confirm diagnosis. Hematoma needs to be treated by drainage because it may not resolve on its own and could get infected. The rapid increase in the size of a hematoma may be a sign of arterial bleeding; in such a case, first the arterial bleeding should be managed in a timely manner and then the hematoma needs to be drained consecutively.¹⁰

4. Change of Nasal Morphology

Nasal morphology changes post-operatively in maxillary osteotomies with the repositioning of the bony structures. Patients should be informed about the possible need for an additional post-operative rhinoplasty if maxillary osteotomies cause an unfavorable esthetics in the nose²².

The position of the anterior nasal protrusion, septal cartilage and vomer should all be evaluated during the operation prior to plating. Especially in maxillary impaction cases, these structures may be compressed and thus deviations from the midline might occur, which may result in airway obstruction²³. In order to prevent this, a portion of the lower nasal septal cartilage should be removed, and a groove should be prepared on the maxilla for the septum to be seated passively. If septum deviation is permanent post-operatively, a septoplasty could be performed²⁴. Some surgeons also choose to suture the nasal septum, using non-resorbable sutures, to the anterior nasal protrusion to prevent it from buckling.

Another important point to consider is to place a synch suture to prevent alar base widening post-operatively²⁵. Again, a non-resorbable suture needs to be used for this purpose.

5. Salivary Gland Injury

Parotid gland damage is usually seen following operations with an extra oral approach. There may be pain, swelling, sialocele and fistula formations in the parotid area²⁶.

6. Sinus Pathology

Chronic sinusitis after Le Fort 1 osteotomy is rare²⁷. Infection may develop post-operatively due to hematoma in the maxillary sinus. It could be prevented by peri-operative prophylactic antibiotic use and post-operative maintenance therapy with decongestant drugs. The development of sinus infection may be associated with pre-existing sinus disease, smoking, or other odontogenic infections that may result from tooth damage, the presence of debris or foreign bodies within the sinus²⁷.

7. Malocclusion

Postoperative malocclusion may result from undetectable interferences during intermaxillary fixation of the Le Fort 1 osteotomy. It can be seen as a result of relapse in maxillary transverse irregularities or due to condylar resorption in the long term²⁸. This topic is further discussed in the "Relapse" section.

8. Fistula Formation

It usually occurs due to perforation of the palatal mucosa during maxillary osteotomies. Oronasal or oroantral fistulas may occur most commonly in the area where the palatal mucosa is thinner due to osteotomy and expansive forces in the palatal midline. Extension of the palatal mucosa more than 6-8 mm is a risk factor².

9. Epiphora

Epiphora occurs if there's excessive tear production or if the nasolacrimal duct is blocked causing the tears to accumulate in the eye. It could be seen following Le Fort 1 osteotomy, and/or during partial inferior turbinectomy (if it is performed above the lateral nasal wall resulting in nasal mucosal edema). It often heals spontaneously. If excessive tear flow persists for 3 weeks, a silicone tube between the tear sac and the nasal cavity can be placed to keep the duct open²⁹.

10. Frey's Syndrome

Frey's Syndrome is a result of auriculotemporal nerve

damage³⁰. Parasympathetic fiber degeneration occurs and sweat glands are affected. Sweating of the cheeks during chewing is a typical sign. Botulinum toxin is injected for treatment³¹.

11. Avascular (aseptic) Necrosis

A large portion of blood flow in the maxilla is reduced during the first post-operative period due to various causes such as hypotensive anesthesia, osteotomies and/or clamping the vessels feeding the maxilla. However, since maxilla is a highly vascularized bone and is well perfused, avascular necrosis is a rare complication following Le Fort 1 osteotomy with an incidence less than 1%³².

Some of the complications associated with diminished blood flow in the maxilla are devitalization of teeth as a result of disruption of the blood supply, periodontal defects, gingival papillary necrosis, alveolar necrosis or necrosis of bony segments³².

The risk factors associated with the etiology of avascular necrosis are: Surgical procedures of the maxilla involving more than two bony segments, advancement of the segments over 10 mm, inadequate irrigation during osteotomies causing excessive heat production, insufficient segment stabilization, pressure caused by palatal plaque, diseases affecting vasculature, diseases impairing wound healing, smoking, and prolonged hypotensive anesthesia. If maxillary perfusion is not followed up adequately in the early phases of the post-operative period, signs of avascular necrosis may be missed causing serious outcomes.

During mandibular osteotomies, the blood supplies must be protected in order to prevent segmental devitalization of soft tissue and muscle attachments. The necrosis of the proximal segment during mandibular osteotomies is mostly seen in the intraoral vertical subcondylar osteotomy. The reason for this is the lack of adequate blood supply as a result of excessive removal of periosteum attachments¹³.

12. Temporomandibular (TMJ) Problems

A very small percentage of orthognathic patients experience TMJ problems. However, class II patients with open or deep bites and patients having dentofacial deformities with immature dental contacts are more prone to experiencing TMJ problems^{33,34}. On the contrary, TMJ disorders can be improved after orthognathic surgery since the function is improved with correct positioning of the jaws³⁵. However, this doesn't mean that the orthognathic surgery should be the first choice for TMJ disorders; instead, adequate TMJ treatments need to be carried out for TMJ patients³⁶.

After orthognathic surgery, some patients may experience a restricted mouth opening. In these cases, normal mouth opening can be restored up to two years with post-operative physiotherapy³⁷.

13. Temporomandibular Condyle Resorption

In order to be able to speak of a condyle resorption, there should be at least a shortening of the condyle by 2 mm and

a decrease in the ramus height of 6% or more compared to the pre-operative panoramic film. Condyle resorption or progressive condyle remodeling occurs in 5-10% of all surgical patients²⁸. It has been reported that condyle resorption is more frequent in patients with TMJ problems. In addition, excessive amount of mandibular advancement is a risk factor for condyle resorption¹⁵. Condylar resorption affects the volume of the condyle and the condyle-fossa relationship in three directions of space. This causes the occlusion to deteriorate towards class II and open bite³⁷.

14. Non-union or Mal-union of the Osteotomy Lines

Major risk factors for non-union and mal-union are inadequate fixation and the amount of mobility in between the bony segments¹⁰. Additional fixation is necessary in cases such as sleep apnea patients where the jaws will be advanced at least more than 7 mm. There may also be a need for an interpositional block bone grafting when there's a disimpaction of the maxilla over 5mm³⁸.

15. Relapse

Relapse is a very unpleasant post-operative change in time following orthognathic surgery¹⁰. The amount of tension and mobility in the osteotomy sites and the type of management of the soft tissues and muscle attachments, mandibular growth angle, surgeon's experience, growth potential, adequate pre-operative planning and treatment are all factors associated with relapse after orthognathic surgery^{1,39}.

Relapse could occur either in early post-operative period or in late phases of healing. Early relapse is commonly associated with the fixation method and the osteotomy technique. Late relapse occurs more often as a result of unstable forces in the stomatognathic system. In general, changes that occur less than 2 mm after treatment are not clinically significant; however changes greater than 2 mm are interpreted as relapse⁴⁰.

Studies have found that the maxillary impaction is the most stable orthognathic movement. Retracting the mandible, downward movement of the maxilla and transverse maxillary movements were found to be the least stable orthognathic procedures¹⁴.

Many factors affect the stability of the mandible after surgical advancement. Advancement of more than 7 mm is more prone to relapse. Surgical advancement of the mandible causes stretching of the soft tissues, periosteum and the supra-hyoid muscles. These structures are further stretched when the surgical procedure is combined with the advancement of the chin³⁹. In the sagittal split ramus osteotomy, anticlockwise rotation of the distal segment has been reported to cause more relapse than clockwise rotation. Mandibular advancement by counterclockwise rotation of the occlusal plane is a stable procedure in patients with healthy TMJ, while significant relapse may be seen in patients with previous existing TMJ problems. Malocclusion may be encountered when sagittal split ramus osteotomy is applied to growing individuals with Class III³⁶.

When the stability of the maxillary procedures is evaluated, it is stated that the rate of relapse is slightly higher when Le Fort 1 osteotomies are simultaneously combined with other operations. Maxillary advancements and disimpactions have accentuated soft tissue effects; therefore the risk of relapse increases. The relapse risk also increases with post-operative changes in the condylar position in an inferior and posterior direction¹¹.

16. Emotional and Psychiatric Problems

Difficulty in eating and drinking due to intermaxillary fixation after orthognathic surgery is a challenging process due to swelling and pain. Patients should be well informed prior to operation about the post-operative nutrition period. The aesthetic expectations of the patient should be thoroughly discussed and the patient should be given explanatory brochures with the most common complications.

Uncomfortable presence in the operating room and unrecognized psychological disorder prior to the operation may negatively affect the post-operative psychiatric behavior. Emotionally unstable individuals with body dysmorphic disorder may become more aggressive post-operatively and are difficult to control. Sleep apnea patients with large bimaxillary advancements may also be difficult to manage post-operatively in terms of fear of being unable to breathe. Psychiatric consultation before and after surgery is necessary in these patients¹⁰.

Conclusion

Orthognathic surgery is a commonly used treatment modality in the treatment of dentofacial deformities. Orthognathic surgical procedures also do have complication risks as every other surgical procedure. However, these operations appear to be safe procedures if they are performed by experienced surgeons in accordance with well-established surgical principles. Surgeons should inform their patients about possible complications prior to the operation and obtain the necessary consent. The patient's wishes should be discussed thoroughly prior to the operation and their expectations need to be evaluated in detail. Complications directly affect patient satisfaction and leave a negative impression following the operation. The secret to patient satisfaction is providing aesthetics and function as well as a comfortable operation and a painless, uneventful post-operative period.

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None

Authorship Contributions

Firat Selvi, Kerim Aktaş and Yusuf Keskinsoy all participated equally in the writing and editing of the manuscript as well as in the gathering of the literature needed to complete this review article.

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