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Versatile Facial Osteotomies

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Abstract

Facial Osteotomy techniques have evolved enormously over the past 20 years providing significant and often life-changing benefits to our dental patients with skeletal malocclusions. Advancements in technology and refined surgical

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techniques have resulted in improvements in surgical outcomes, a reduction in post-operative complications and a quicker recovery for today's patients undergoing orthognathic surgery. This paper aims to an update on the contemporary approach to the correction of skeletal malocclusions with facial osteotomies.

Key Words: Orthognathic Surgery, Corrective Jaw Surgery, Jaw Surgery, Facial Osteotomy, Le Fort 1 maxillary osteotomy, Bilateral sagittal split mandibular osteotomy, Genioplasty

Orthognathic surgery is the repositioning of the maxilla and/or mandible, to correct mal-alignment of the jaws and skeletal disproportion usually giving rise to dental malocclusions. It is usually performed in conjunction with orthodontic treatment that enables alignment of the arches and a detailing phase in the post-surgical period.[1]

The contemporary "work horse" procedures for the wide variety of dentofacial deformities are the:

1. Le Fort 1 maxillary osteotomy
2. Bilateral (Mandibular) Sagittal Split Osteotomy (BSSO)
3. Genioplasty

The surgery may be either a single jaw (maxilla or mandible) or both jaws (bimaxillary) ,

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with or without additional a genioplasty, depending on the diagnosis and treatment plan for each patient.

1. Le fort 1 maxillary osteotomy

The versatility of a maxillary osteotomy[2] includes the ability to:

1. Advance the maxilla to correct maxillary hypoplasia (deficiency).
2. Impact or down-graft the maxilla to reduce excessive vertical height (reduce a “gummy smile”) or to provide more tooth show respectively.
3. Rotate or level the maxilla to correct midline asymmetry or an occlusal cant.

Surgical Technique – Le fort 1 osteotomy

Incisions are made in the vestibule above the apices of the teeth from the upper right to the upper left first molar. The maxilla is exposed from the anterior nasal spine to the tuberosity and pterygoid plates. Cuts are made with a thin reciprocating saw blade or piezo-surgical saw from the lateral nasal aperture to the junction of the posterior maxilla and the pterygoid plates. The nasal septum is released with a nasal septal osteotome and the bone attachments of the lateral nasal walls are also released with an osteotome. The attachment of the maxilla to the pterygoid plates are then osteotomised and this allows the maxilla to be “down-fractured”. The maxillary blood

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supply is maintained via the soft tissue of the soft palate and the descending palatine arteries. Studies on the blood supply to the maxilla allowing the maxillary osteotomy to be safely performed have been well documented by Bell et al. The upper jaw can then be separated and mobilized and moved to the new planned position.

The movements have been previously planned and surgical splints created. The surgical splint is then placed between the teeth and the jaws temporarily wired together – intermaxillary fixation. The new position of the maxilla is then secured using titanium mini-plate fixation and mini-screws. There are usually 4 mini-plates that are bent and shaped and then secured to the maxilla into the new position. The intermaxillary fixation wires are then released.

Fig 1

2. Bilateral sagittal split osteotomy (BSSO)

The versatility of the BSSO mandibular osteotomy[3] allows the mandible to be:

1. Advanced to correct skeletal Class II malocclusion or large overjet.
2. Reduced to correct a Class III malocclusion with reverse overjet.
3. Rotated to correct a mandibular asymmetry or cant.

Surgical technique (BSSO)

An incision is made in the posterior mandible distal to the third molar and extending down

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buccally within the vestibule of the lateral mandible to approximately the region of the 2nd premolar. A flap is raised including release of the temporalise tendon attached to the asecending ramus and a lingual flap exposing the medial ramus is made. The lingula is exposed to protect the inferior alveolar nerve and a horizontal osteotomy is made above the lingula but stopping short of the posterior border of the mandible. The osteotomy is continued down the ascending ramus towards the dentition, dividing the ascending ramus in the sagittal plane until close to the distal of the first molar and extending down between the first and second molar region to the lower border of the mandible. Using osteotomes and spreading instruments, a controlled separation of the bone segments is undertaken taking care to protect and free the inferior alveolar nerve. The mandible is then placed into intermaxillary fixation with the surgical splint. If a setback is required, bone is removed buccally to allow the proximal segment to be returned to the shortened mandible. If the jaw is to be lengthened, there is a “half-thickness” gap, but due to the sagittal split sliding design, bone will predictably fill in and remodel the osteotomy site without a need for a bone graft. The mandible is fixed using titanium mini-plates and mini-screws or direct bicortical screws. The fixation is titanium and does not require removal. Fig 2

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4. Genioplasty

The versatility of the genioplasty[4] includes the ability to achieve the following movements:

1. Advancement of a retrusive chin.
2. Horizontal reduction of a prominent chin.
3. Rotation of an asymmetric chin.
4. A vertical reduction of a chin with excess height.
5. A vertical increase to lengthen a shortened chin.

A genioplasty is commonly done concurrently with the maxillary or mandibular osteotomies but may also be performed as a standalone procedure.

Surgical Technique - Genioplasty

This procedure involves making a vestibular incision in the anterior mandible. The mental nerves are located and protected. A horizontal osteotomy beneath the apices of the anterior teeth and beneath the mental foramen is completed with a reciprocating saw and the mobilized segment is then able to be advanced, reduced, rotated or vertically augmented or reduced. Fixation into the pre-planned position with pre-bent chin plates or direct bone screws is undertaken and mucosal closure is performed after re-approximation of the divided mentalis muscles.

Fig 3

Clinical Assessment of the Orthognathic Patient

Frontal Assessment

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Frontal assessment includes assessment of the vertical facial height (short or long), the amount of tooth and gingival display below the upper lip at rest and on smiling, any facial asymmetry including the presence of an occlusal cant , asymmetry of the mandibular ramus, body or chin.

Profile Assessment

The Profile assessment will include assessment of mid-facial support including nasal projection and upper lip support, throat-chin length and chin projection.

Intra-oral Asessment

Intraoral assessment includes occlusion type, midline asymmetries, arch width, overbite/open bite and presence or absence of dental crowding.

Radiographic Examination

An OPG, Lateral Cephalogram and AP Cephalogram are the basic radiographs required for most orthognathic cases. A CBCT of the facial bones is helpful for patients with facial asymmetry. The Lateral Cephalometric assessment is particularly useful to assess the degree of skeletal malocclusion, incisor angulation, occlusal plane orientation and chin anatomy. The OPG allows general dental assessment as well as to screening the condyles for abnormalities such as condylar resorption, elongation of the condylar neck and condylar enlargement.

Study Models

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Study models assist in assessment of arch alignment, arch width discrepancies and help with strategies in planning of pre-surgical orthodontic management. This may include decisions of whether dental extractions will be required or if pre-surgical arch expansion with or without surgical assistance is needed.

Treatment Planning

Prediction planning was traditionally performed manually with lateral cephalometric tracings. Today, digital planning is performed using computer software. The lateral cephalometric tracing is digitized and able to be superimposed onto an image of the patient to allow manipulation of the jaws to predict the surgical changes on the patient's profile. In more recent years, virtual surgical planning[5] has evolved further to allow the ability to plan in 3 dimensions using CT data. This allows for greater accuracy in all planes of space and technology in this area is evolving rapidly. Traditionally, surgical simulation or "Model Surgery" is performed on articulated models to create surgical templates for positioning of the jaws during surgery. Advancements in technology have now made it possible to do this planning virtually using CT data on sophisticated software.

Fig 4

Timing of Surgery

It is important that growth[6] is taken into consideration in the timing of surgery for

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stability of the final result. In cases of growth deficiency such as a class II skeletal malocclusion, it is possible to operate prior to growth cessation. However, in cases of growth excess such as patients presenting with Class III deformities, surgery is not recommended until the cessation of growth. This may be up to age 16 and over for females and age 18 and over for males. It should be noted that some patients presenting with mandibular asymmetry may have hyperactive growth in one condyle, described as "Condylar hyperplasia"[7] or "hyperactivity", which may cause the worsening of and asymmetry to continue, even after skeletal maturity. This needs to be diagnosed prior to surgery to reduce the risk of relapse. In these patients, sequential records and a Technetium Bone scan Tc99[8] may be helpful in assessing if there is hyperactivity within the condylar growth center.

The Need for Orthodontics and Treatment Time line.

Orthognathic surgery in almost all cases requires orthodontic treatment to facilitate an optimum outcome. Most patients with skeletal malocclusions have an occlusion that has "compensated" during development as a result of the jaw mal-alignment. Orthodontic treatment prior to surgery prepares the dental arches for the possibility of a stable occlusion as well as to "decompensate" the arches in order to achieve the desired facial aesthetic outcome. This process

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usually requires approximately 12 months of pre-surgical orthodontic preparation. Surgery is always done with the orthodontic appliances in place. This enables the surgeon to utilize the orthodontic appliances for fixation during surgery and to employ elastic traction after surgery. Bone healing takes approximately 6 weeks at which time the surgeon will return the patient to the orthodontist for completion of orthodontics and "fine-tuning" of the occlusion.

The Steps in orthognathic surgery are:

1. Consultation with Surgeon and Orthodontist -Treatment Plan
2. Pre-surgical orthodontics – average 12 months
3. Orthognathic Surgery - 6 weeks healing period.
4. Post-surgical orthodontics - approximately 6 months.

Fig 5

Hospitalisation and Post-operative Recovery

Modern surgical and anaesthetic techniques have revolutionised the delivery of surgical and peri-operative care for patients undergoing facial osteotomies. This includes hypotensive anaesthesia[9] to reduce blood loss. The need for blood transfusion is now a rare event in contemporary practice for the average orthognathic patient. The use of surgical saws including piezo-surgery and sophisticated instrumentation has allowed the

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surgeon to operate faster and with more precision resulting in better outcomes, faster recovery times and reduced risks and complications.

Patients typically are admitted for 1 to 2 nights for a single jaw osteotomy and 2 to 3 nights for a bimaxillary osteotomy. Intermaxillary fixation (jaws wired together) post-surgically has generally been superceded with the advent of semi-rigid internal fixation of the jaws using mini-plates and screws. This allows patients to be extubated in the operating theatre and they are encourage to talk, drink and commence the intake of eating soft foods in the immediate post-operative period. The use of intravenous steroids such as Dexamethasone assists in reducing facial swelling and oedema.

Facial swelling is usually present for 2 to 3 weeks which then subsides down to some residual oedema at 3 to 4 weeks post-surgery. Post-operative pain is managed well with “patient controlled analgesia” techniques and modern pain management combinations. On average, patients undergoing orthognathic surgery need to plan for 2 to 4 weeks of recovery before returning to their studies or work depending on the complexity of their surgery and they are required to stay on a modified soft diet for 4-6 weeks.

During the 4 to 6 week post-operative period, patients will have light “guiding elastics” placed between hooks on the orthodontic appliances to

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maintain the occlusion and to counteract muscular action on the jaw segments. The patients are closely monitored by the surgeon during the post-operative healing phase and at 4-6 weeks postoperatively, the patient is returned to the orthodontist for detailing the occlusion. It is normal for the patients to experience mental paraesthesia following a mandibular osteotomy but this is usually temporary and in the majority of cases, sensation recovers within 3 to 12 months. However, permanent paraesthesia can occur and is usually reported as between 5 to 15%.

Risks and Complications

As with all surgical procedures, there are significant risks and complications[10] that need to be discussed with the patient. Some of the risks have been reduced considerably in recent years with improved techniques and surgical expertise.

1. Le Fort 1 Maxillary osteotomy

While sophisticated surgical and anaesthetic techniques are used to reduce blood loss in orthognathic surgery there is a risk of bleeding intraoperatively or secondarily in 7-10 days from vessels entering the posterior maxilla and septum. However, this is readily controlled in the majority of cases and blood transfusion is rarely required today.

2. BSSO Mandibular osteotomy

The most common and important complication is injury to the inferior alveolar nerve during the

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BSSO mandibular osteotomy. Patients require specific informed consent related to the risk of temporary or permanent mental paraesthesia. Most patients experience temporary paraesthesia between 3 to 12 months but a small number will experience permanent paraesthesia. The percentages reported in the literature vary greatly, however, generally the incidence agreed upon is between 5 to 15%, with a systematic review in 2007 reporting an average of 12.8%.[11] New instrumentation such as the use of bone separators has reduced the incidence to 5.1% in a multi-center study.[12] The incidence is noted to be less in younger patients and cases performed by more experienced surgeons.[13]

Third molars can be removed either as a separate procedure or removed simultaneously during surgery. This decision will depend on the surgeon's preference and type of fixation used for the BSSO osteotomy. The authors preference is to remove third molars at the time of jaw surgery as the evidence supports the concurrent removal of third molars without an increase in incidence of nerve injury.[14]

Unfavourable fractures may occur during the sagittal section but with experienced surgeons this uncommon and can be managed with modification at the time of the procedure.

3. General risks of jaw osteotomies

Other risks include post-operative infection due to haematoma or the loosening of fixation

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screws and is usually easily managed . As for any surgical procedures, serious rare complications have been reported but are outside the scope of this article.

4. Relapse

Relapse of the jaw position can occur and this can be prevented or reduced by careful surgical technique (the intricasies of technique are beyond the scope of this article) close follow-up, dental elastic management and patient compliance with post-operative instructions including a soft diet.

The Benefits of Facial Osteotomies

1. Correction of severe malocclusions

A proportion of skeletal dysplasias are outside the realm of management by conventional orthodontics and orthognathic surgery provides a ready solution for such cases. This includes all patterns of malocclusion and facial disproportion.

2. Improvement in Masticatory function and speech

By aligning the upper and lower arches in an ideal relationship, masticatory function is enhanced and speech[15] is facilitated to remove lisping in the case of large Class III malocclusions and anterior open bites.

3. Improvement in airway

While not often recognised as a benefit of jaw osteotomies, maxillo-mandibular advancements have been demonstrated to provide a significant improvement in the upper airway for patients suffering from obstructive sleep apnoea (OSA). This

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procedure, with or without an advancement genioplasty has been shown to have the greatest and most stable success rates for management in OSA patients compared to other surgical modalities.[16]

4. Enhanced Facial Aesthetics

The facial aesthetic benefits of orthognathic surgery in the correction of severe skeletal malocclusions are well accepted. However, in less severe skeletal malocclusions, patients must understand the positive facial aesthetic change to make an informed decision regarding proceeding with a combination of orthodontic treatment and jaw surgery. Here, the general dental practitioner can help to assist the patients in a discussion of the benefits and consequences in choosing combined treatment versus an orthodontic camouflage treatment approach.

Ideally, a decision needs to be made from the beginning of treatment as to whether a patient will be a “surgical” or “non-surgical” case. It is important to convey to the patient and/or the patient’s parents that the orthodontic treatment mechanics will be different depending on this choice and specific tooth extractions, that are irreversible, vary according to the approach. In addition, the possible negative affect on facial aesthetics in many cases if orthodontic camouflage must be adequately described to patients.

Versatile Facial Osteotomies – Examples

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Camouflage versus Facial Osteotomy for Class III patient.

Facial compromise can occur when a skeletal Class III malocclusion is treated by orthodontic camouflage rather than surgery. This is illustrated in Case #1.

Case#1

This female patient was 35 years old on presentation. During childhood, she underwent extraction of 2 lower premolars with orthodontic retraction of her lower anterior teeth to compensate and camouflage her class 3 malocclusion. The result is severe retroclination of lower incisors and a convex facial profile with flattening of the midface, reduced upper lip support and a relatively prominent lower jaw. This patient was treated by reversal of the previous orthodontic treatment with opening up of the previous lower extraction spaces, uprighting her lower anterior teeth into a negative overjet. A maxillary advancement osteotomy was then performed and dental implants were placed to replace the missing lower premolar teeth. The result is a much more pleasing profile and facial support. This case illustrates what can happen when orthodontic camouflage is chosen as a treatment plan for a young patient in order to avoid surgery and the facial compromise that may occur.

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Fig 6 a-d

Class III Skeletal Malocclussion

These patients benefit greatly from orthognathic surgery as it is often not possible especially in severe cases, to correct these malocclusions orthodontically. Past treatments have been to extracting lower premolars in order to retract the lower incisors to reduce the negative overjet. This is only possible in milder class 3 cases however, in most of these cases the patient's facial concavity will be emphasised and the potential for the patient to undergo a positive facial change with orthognathic surgery will be lost.

Case #2

This 17 year old female has a severe skeletal class 3 malocclusion Timing of treatment required her to wait until cessation of growth and her surgical treatment was delayed until age 17. Pre-surgical orthodontics was performed 12 months prior to surgery. Bimaxillary osteotomies involving advancement of the maxilla and a mandibular setback were performed to achieve a class 1 occlusal relationship together with a more harmonious facial profile.

Fig 7

Class 2

To orthodontically correct a skeletal class 2 malocclusion by orthodontics alone may often

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involve extraction of two upper premolar teeth followed by retraction of the upper anterior teeth to reduce the overjet. In some patients, this may result in reducing the upper lip and mid-face support with facial aesthetic compromise. On the other hand, the surgical-orthodontic option usually does not require upper arch extraction to reduce the overjet but rather involve surgery to advance the mandible. The result is that the patient's upper lip support is maintained and at the same time, there is aesthetic enhancement with a more defined jaw profile and greater chin projection.

Case# 3

This case is a young patient with a class 2 malocclusion. Options included orthodontic camouflage or surgery. The patient underwent extraction of 2 lower premolars, retraction of the lower incisors in preparation for mandibular advancement osteotomy. Prediction cephalometric planning indicated that an advancement genioplasty would be aesthetically beneficial and this was included in the surgical plan. Surgical correction of bilateral sagittal split mandibular advancement osteotomy with advancement genioplasty was performed.

Fig 8

Anterior Open Bite

It not possible to close a skeletal anterior open bite by traditional orthodontic mechanics for

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the correction to remain stable. Orthognathic surgery is usually required to correct the anterior open bite by differential movements of the maxillary and/or mandibular arches via osteotomies. For example, by impacting the posterior maxilla, the mandible then auto-rotates counterclockwise to achieve a positive overbite.

Case #4

This case illustrates the surgical closure of a skeletal anterior open bite with maxillary and mandibular osteotomies. A genioplasty was simultaneously performed for lip competence and aesthetics.

Fig 9

Vertical Maxillary Excess – “Gummy Smile”

Patients with Vertical Maxillary Excess often present with a “gummy” smile. These patients may present with or without an open bite. Usually, there is lip incompetence and these patients are habitual mouth breathers. Maxillary osteotomies with bone removal to impact the maxilla allows for reduction in gingival display, increased lip competence and in some cases, an improvement in breathing and airway.

Case #5

This patient presented with vertical maxillary excess and excess gingival display on smiling. Surgical management involved impaction

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of the maxilla by 4mm to hide the gummy smile and achieve lip competence.

Fig 10

Facial Asymmetry

The management of facial asymmetry requires orthognathic surgery that is usually a BSSO osteotomy of the mandible with rotation. In some patients, the mandibular asymmetry during growth has a more vertical dimension, and this results in a compensatory asymmetry of the maxilla with an occlusal cant of both mandibular and maxillary arches. These cases require both maxillary and mandibular osteotomies for correction and occasionally, a genioplasty is also required if the asymmetry extends to involve the chin.

Case #6

This case illustrates correction of mandibular asymmetry by performing an asymmetrical rotational mandibular osteotomy.

Fig 11

Maxillary Constriction

Maxillary constriction resulting in dental cross-bites is usually managed during growth with rapid maxillary expansion of the maxilla. Maxillary expansion is possible during adolescence as the maxillary sutures are not yet fused. In adults, maxillary expansion is achieved by 2 procedures as described below:

Surgically Assisted Maxillary Expansion (SARME).[17]

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1. To enable the expansion of a constricted maxilla in an adult, releasing osteotomies are performed and using a maxillary expansion device, gradual opening of the intermaxillary palatal suture is enabled. This procedure harnesses the principle of distraction osteogenesis to expand the hard and soft tissues. A hyrax device is secured in place across the maxillary arch or palate prior to surgery. The procedure usually involves a Le Fort I osteotomy with the addition of a vertical osteotomy in the midline of the maxilla. This osteotomy is made between the central incisor teeth and approached from the facial aspect of the maxilla. Postoperatively, the patient is instructed to activate the device 1- 2 turns per day (0.25 - 0.5mm per day). A midline diastema is anticipated during the activation period that is usually approximately 3 weeks. Following this, a retention period is required for maturation of bone and transverse stability and the device is left in placed for several months.

Fig 12

2. Segmental Maxillary Osteotomy
It is also possible to expand a narrow maxilla at the time of a Le Fort 1 maxillary procedure by making additional

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interdental osteotomies in the maxilla combined with palatal osteotomies to allow for immediate expansion of the segments. These segments are stabilized with rigid fixation. There is a limitation to the stretching of the soft tissues in this approach.

Conclusion

Facial osteotomies have evolved to be highly versatile and are a valuable treatment option for our dental patients with skeletal malocclusions. Benefits include improvements in masticatory function, speech, and facial aesthetics. Furthermore, maxillo-mandibular procedures have also been demonstrated to profoundly open narrow pharyngeal airways in the management of obstructive sleep apnoea.

Sophisticated surgical techniques and technological advancements have provided additional benefits in greater precision in planning and surgical execution as well as reduced recovery times and risks. In providing an overview of contemporary orthognathic surgical practice, it is hoped this will assist the general dental practitioner in their understanding of treatment options for their patients with skeletal malocclusions.

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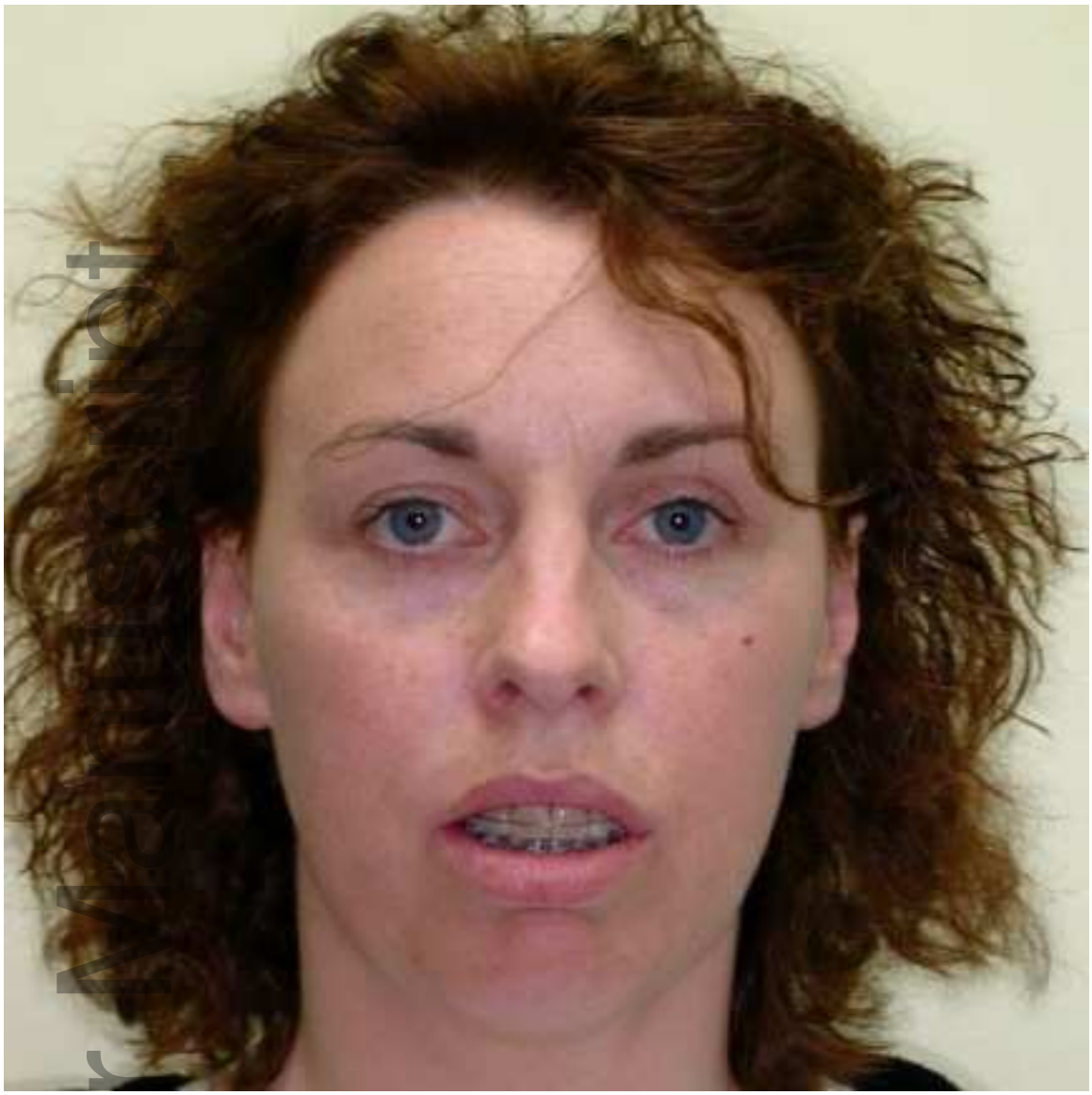
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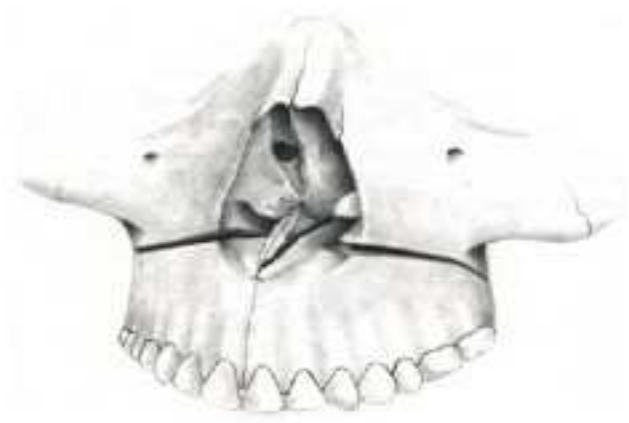
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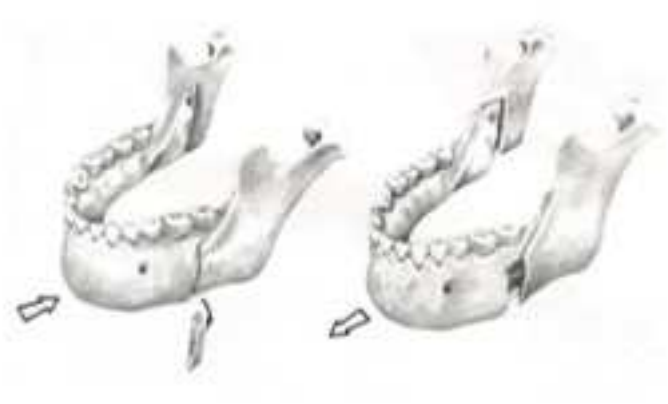
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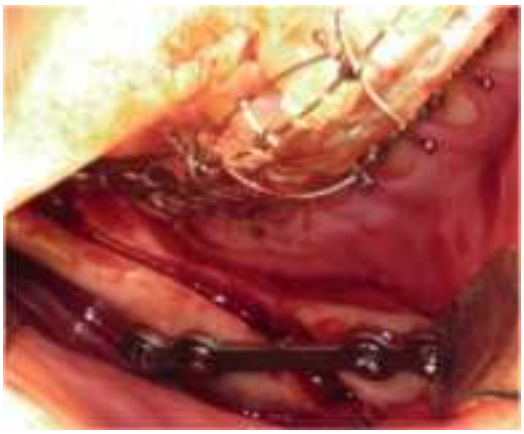
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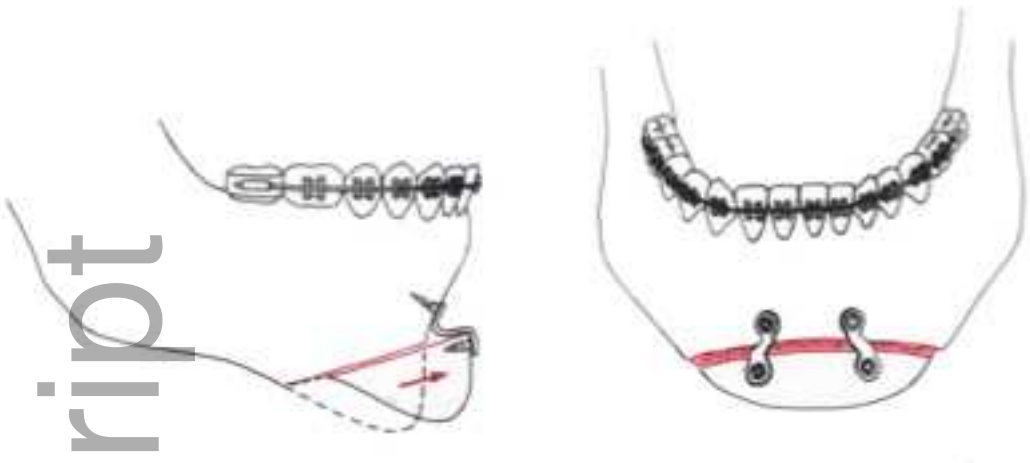
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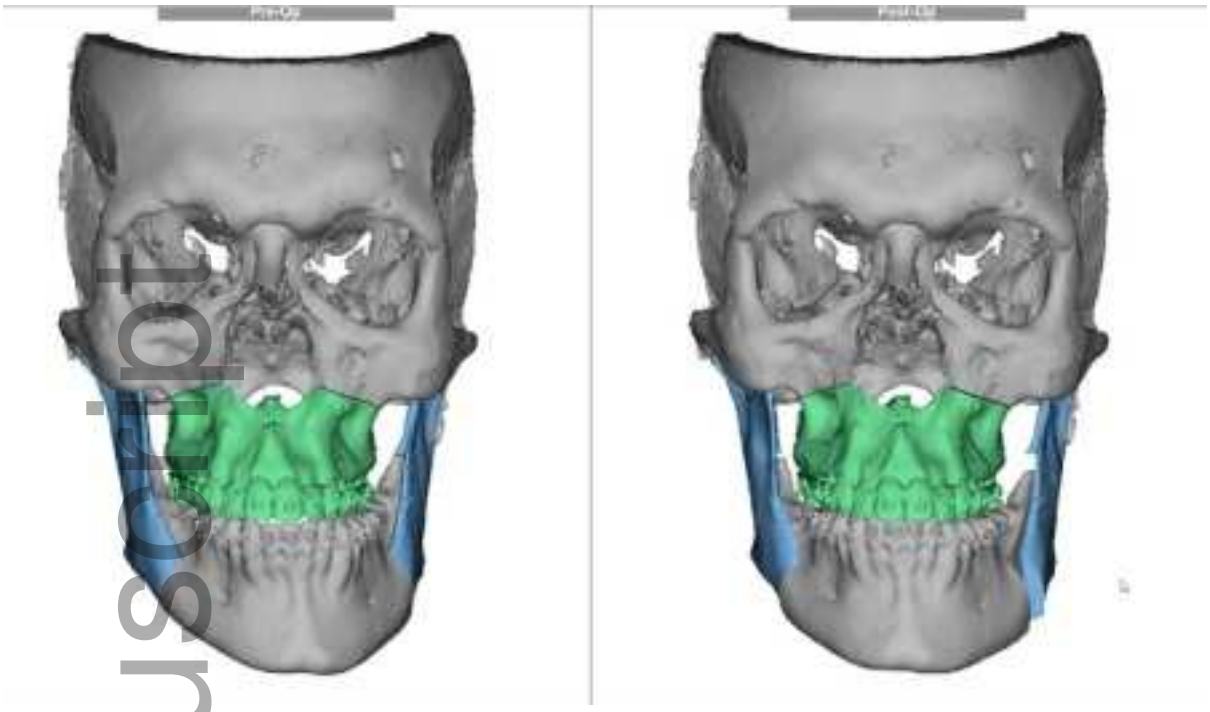
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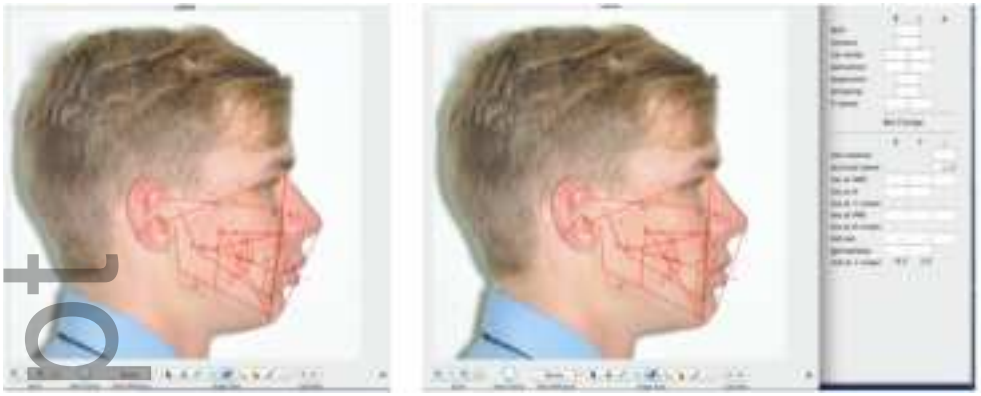
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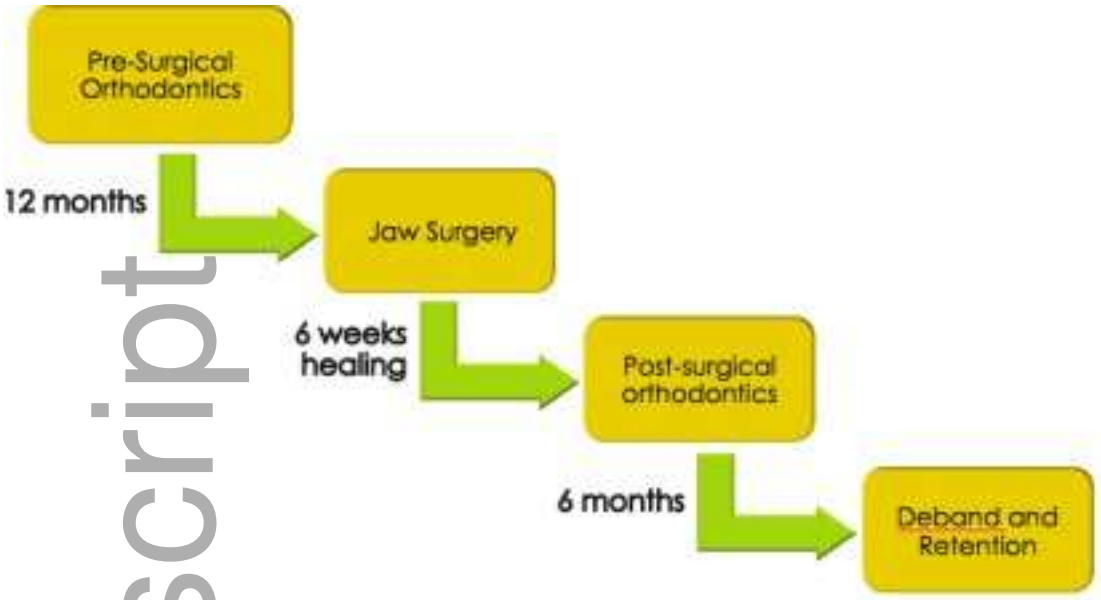
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