# Stability and Relapse in Orthognathic Surgery

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## INTRODUCTION

The long-term success of orthognathic reconstructive surgery is dependent upon long-term stability of the surgical correction. Stability is defined as the maintenance of the skeleton and associated dental structures in the intended position over time. Failure to achieve stability, also called surgical relapse, can result in a compromised final result. There are multiple reasons surgical relapse occurs. These reasons can be divided into both short and long-term causative factors. Short-term relapse occurs in the immediate post-operative period, and is most often due to surgical planning/model surgery errors, intra-operative surgical errors, or wound healing problems. Long-term relapse, on the other hand, is influenced by three major factors; growth, physiologic adaptation, and post-operative changes due to orthodontic or surgical relapse. Although equally critical, this article will not cover the role that orthodontic preparation, finishing, and maintenance of the orthognathic patient by the orthodontist play in contributing to post-operative stability.

## EARLY RELAPSE

Successful double-jaw orthognathic surgery requires methodical surgical accuracy, making it one of the most challenging surgical procedures provided within the scope of a modern maxillofacial surgery practice. Single jaw surgery, while less complex, also demands rigorous precision from start to finish. From the first consultation, the surgeon must begin to factor the aesthetic, functional, and stability related demands of the anticipated surgical correction. Failure to do so risks the introduction of errors that ultimately increase the likelihood of surgical relapse. Pre-operative planning/execution errors, intra-operative errors at the time of surgery, or post-operative wound healing errors all contribute to early surgical relapse.

## PRE-OPERATIVE ERRORS CONTRIBUTING TO EARLY RELAPSE

Success of the surgical plan depends on sound knowledge of the physiology and function of the jaws, including the limitations of any proposed surgical movements. Surgical planning that disregard the limitations, in both direction and magnitude of skeletal movement, increases the risk of early relapse.

When anterior-posterior movement of any one jaw exceeds one centimeter, the surgeon should consider an alternative surgical technique like distraction osteogenesis or concomitant bone grafting in addition to or instead of a standard Le Fort or BSSO to improve stability.

Treatment planning surgical movements that result in excessive counter-clockwise rotation of the facial skeleton should be avoided. Excessive counter-clockwise rotation contributes to early relapse and usually manifests as a newly developed anterior open bite on clinical examination. To limit excessive counter-clockwise rotation, the surgeon should employ techniques such as grafting to the posterior maxilla, changing the mandibular ramus osteotomy to lie outside the muscular sling (extra-oral inverted-L osteotomy), or incorporating a TMJ related procedure such as total alloplastic joint replacement. Patients diagnosed with short posterior face height are at particular risk for this type of relapse. Even with technique modification, this sub-group of patients should be approached with caution and deliberate planning.

## EXECUTION ERRORS

Accurate patient records are critical to surgical planning, therefore, obtaining surgical records and model surgery planning must be executed with attention to detail. Errors made while obtaining surgical records or during model surgery planning will translate into an error in the patient's final outcome. Consequently, errors of records collection or model surgery planning may ultimately become factors related to post-operative relapse, especially in complex two-jaw or bi-maxillary surgery.

An inaccurate centric bite is one example of a records collection error. The centric bite must be taken with care and confirmed several times to ensure that both of the patient's condyles are seated in their respective condylar fossa. If the centric bite is taken with the condyles not seated, an immediate change in the planned occlusion will occur intra-operatively as the condyle(s) return to the true centric position while the patient is under anesthesia and in the supine position.

Another example of a records collection error is an inaccurate face bow transfer. Care must be taken to ensure the acquisition of an accurate face bow transfer, otherwise, the model surgery and splint fabrication will be predicated on an erroneous dental and skeletal relationship. Other examples of records collection errors include alginate model inaccuracies or warped dental stone models.

Presently, surgical work ups assisted by computer-based planning are becoming more common. To prevent the introduction of treatment planning errors, digital planning with error-free models, an accurate centric bite and ideal transfer of natural head position must occur. Irrespective of whether the articulator or computer is used, the surgeon must accurately transfer the patient's records to eliminate the introduction of records collection errors that may affect post-surgical stability.

## EARLY RELAPSE DUE TO INTRA-OPERATIVE FACTORS

Also of importance to early surgical relapse are factors secondary to intra-operative errors that prevent passive and repeatable occlusion in the surgical splint. One such factor is failure to seat the patient's condyles into the condylar fossae during surgery. Whether one- or two-jaw surgery, the mandibular condyles must be seated passively in the most posterior-superior position of the fossa with good inter-maxillary fixation during stabilization of the surgical correction with plates and screws. Failure to do so will result in a post-operative occlusal relationship that is different from the one that was intended. Dislocation of the mandibular condyles, may occur during Le Fort I osteotomy if there is inadequate removal or relief of

posterior interferences. This leads to dislocation of the mandibular condyles as the maxillomandibular complex is rotated superiorly to the correct vertical position of the midface. Similarly, during mandibular surgery, the proximal (condylar) segment must be seated adequately to ensure the appropriate surgical correction. Some surgeons will employ clamps or plates that run from the maxilla to the proximal segment to limit this possibility. However, in the authors opinion, this is usually unnecessary. If the occlusion obtained immediately after rigid fixation is not passive and repeatable in the intermediate (maxillary) or final (mandibular) inter-occlusal splints, a rigidly fixed error has occurred. The surgeon must correct this error at the time of surgery; post-operative elastics will do little to correct this error post-operatively.

Finally, unintended intra-operative complications also may result in early relapse. One example is a "bad" split of the mandible during sagittal splitting. If inadvertent fractures of the skeleton occur during the osteotomy, the surgeon must first identify the complication and then use an appropriate and stable surgical technique to correct the mandible. If the rigid fixation employed either to correct an inadvertent fracture or during routine fixation is overcome by the function and physiologic demands of the jaws during convalescence, infection, mal-union, or non-union of the affected osteotomy site may result. This problem is classified as a wound healing related factor contributing to early relapse. Clinically, these issues will be readily visible as acute changes of the occlusal relationship and will require further surgery to correct.

## LATE RELAPSE

One of the most common causes of late post-operative instability is continued growth of the patient following surgical correction. Continued or late mandibular growth is the usual culprit in these situations. Proffit, Turvey, and Phillips have determined that growth affects post-operative stability by asymmetrically changing the untreated and treated areas of the facial skeleton.[1] The possibility of continued facial growth must be considered in both the pediatric and adult populations. Most, but not all patients will complete the majority of their craniofacial growth by the late teenage years, with the mandible finishing last in both genders. It is important to note that although craniofacial skeletal changes occur throughout adulthood, most of these changes are normal, symmetric physiologic changes, and do not contribute to observable post-operative relapse. In 1927, Milo Hellman termed "morphological differentiation" to describe these normal changes to the facial skeleton that occur throughout a patient's lifetime.[2] Pathologic conditions of the facial skeleton like unilateral condylar hyperplasia, on the other hand, differ from normal physiologic changes and can contribute to post-surgical relapse. Patients suspected of experiencing pathologic, hyperplastic growth should ideally not undergo surgical correction until after cessation of the growth has been verified. However a disadvantage of this philosophy is that as unremitting unilateral pathologic growth continues, compensatory changes occur in other unaffected bones of the skeleton and therefore increase the magnitude of surgical correction when finally performed. This obviously may also contribute to instability over the long-term. Consideration can be given by the surgeon to perform condylectomy or condylar shave as a first stage procedure where appropriate to limit this problem. Final surgical correction prior to cessation of pathologic or hyperplastic growth greatly increases the risk of late post-operative relapse.

# FUNCTIONAL MATRIX HYPOTHESIS

Over a half century ago, Melvin Moss postulated the Functional Matrix Hypothesis.[3] He presented a theory of growth which credited primarily epigenetic rather than genomic factors, as the primary contributor to the final form of the skeleton. Moss determined that "bones do not grow, they are grown," as the skeleton responds to the "functional matrix" surrounding them. Applying the functional matrix hypothesis, function and growth are primarily responsible for determining the form of bones like the angle of the mandible and the shape of the coronoid process. Orthognathic surgery changes the functional matrix as muscular and soft tissue tension is changed following surgical movements. Consequently, an understanding of Melvin Moss' functional matrix hypothesis is essential, particularly to aid the surgeon in determining which surgical movements will contribute to or prevent relapse.

Surgical movements that increase the stretch of a muscle or soft tissue change the functional matrix by introducing tension. Surgical movements that minimize soft tissue or muscle tension improve long-term post-operative stability. In contrast, surgical movements that increase the tension applied to the bone by soft tissue or muscle function also increase the chances of long-term post-operative relapse. The functional matrix hypothesis explains the well-documented high risk of long-term relapse following surgical maxillary expansion as the maxilla response to increased tension of the palatal soft tissue in the transverse dimension. In summary, the surgeon must take care to ensure that changes to the functional matrix are factored into the surgical plan to minimize the effect of these changes on the long-term stability of the case.

# OTHER FACTORS AFFECTING LONG-TERM STABILITY

For a period of time following surgery, neuromuscular adaptation to skeletal modification occurs. For example, when the position of the maxilla is changed, the postural position of the mandible adapts to the new maxillary position. The proprioceptors located in the periodontal ligament of maxillary posterior teeth, in coordination with the central nervous system, control the posture of the mandible to an independently determined normal position. As a result, the post-operative inter-occlusal space remains essentially unchanged from the pre-operative distance,[1]

Similarly, the functional position of the tongue changes following any direction of mandible or maxilla repositioning. Post-operatively, the tongue's position relative to the anterior teeth duplicates the exact pre-surgical contact with the palate and teeth post-operatively. Surgical changes that decrease the size of the oral cavity, such as inferior repositioning of the maxilla and mandibular setback can be affected by the function of the tongue. As the oral cavity decreases in size, pressure from tongue function on the structures in direct contact with the tongue will increase. The result may negatively impact post-operative stability. Surgical movements that increase the size of the oral cavity like superior repositioning of the maxilla, advancement of maxilla in anterior-posterior dimension, and mandibular advancement, result in less pressure from tongue function on the accompanying structures and consequently contribute to greater post-operative stability. Actual tongue position within the orofacial complex can change in response to surgical movements as well. Following a mandibular set back, the tongue and floor of mouth musculature potentially increase functional pressure against the anterior dentition. Over time, as the tongue repositions downward along with the hyoid

bone and adapts to the new oral cavity size, the impact of tongue function on post-operative relapse is minimized. The adaptation of the temporomandibular joint (TMJ) occurs in response to changes affecting condylar orientation, position, or arc of rotation around condylar axis following orthognathic surgery. Most patients respond to these changes with minimal difficulty, however the current literature regarding treatment and management of the TMJ is controversial regarding the effect of orthognathic surgery on stability. Clinical studies have demonstrated a reduction in pain and dysfunction following mandibular ramus osteotomies.[4] However, some authors also have demonstrated condylar changes following mandibular ramus osteotomies. Consequently, the recommendation of concomitant TMJ and orthognathic surgery may be elected to remove the risk of relapse or other problems associated with post-surgical condylar changes.[5,6]

Finally, patients presenting with Progressive Condylar Resorption (PCR) represent a unique and small group of patients with long term post-surgical relapse. PCR is associated with several factors including female sex selection, pre-existing TMJ disease, patients with a high mandibular plane angle, and patients requiring large magnitude mandibular advancement.[7] Although no specific etiology has been positively identified, PCR has been associated with both hormonal factors and avascular necrosis of the involved condyle.

It is important to recognize what role the type of skeletal fixation, either wire or rigid fixation, plays in the stability of orthognathic surgery. In the modern era of orthognathic surgery, titanium based rigid internal fixation has become the standard of care at most institutions and has been found to aid post-surgical stability in most cases. While wire fixation is still effective and utilized for specific scenarios, fixation that compromises post-operative stability is not recommended. Newer methods of fixation with resorbable materials have demonstrated similar favorable outcomes in terms of stability and should be considered affective options as well.[8]

# EVIDENCE

Until recently, the evidence of post-surgical stability has been based on two-dimensional lateral cephalogram analysis. The introduction of three-dimensional digital imaging promises the opportunity for more detailed data collection and a deeper understanding of craniofacial relationships. As three-dimensional craniofacial analyses are developed, changes in the craniofacial complex will be better understood. Relapse in multiple dimensions, as opposed to only those evident on a cephalometric x-ray, will certainly aid the surgeon in refining surgical techniques in the future.

Much of the scientific data currently available on the stability of orthognathic surgery has come from the analysis of patient records in the Dentofacial Deformities Program at the University of North Carolina. The lead investigators, William R. Proffit, Timothy A. Turvey and Ceib Phillips, have evaluated the stability of orthognathic surgery in the same group of patients for over four decades. A visual understanding of the implications for long-term stability in orthognathic surgery is gained by reviewing **Figure 1**, which summarizes the potential for relapse based on common patterns of dento-facial deformity and the associated directional movements.


*Figure 1: Hierarchy of Stability.*

# CORRECTION OF VERTICAL MAXILLARY EXCESS

The Le Fort I osteotomy came into common use in the late 1960s. For patients seeking correction of vertical maxillary excess, the Le Fort I osteotomy allows the maxilla to be superiorly repositioned (vertically impacted). After superior repositioning of the maxilla, the mandible autorotates to maintain dental occlusion. Despite early concerns that the maxilla would relapse back downward, superior repositioning of the maxilla has been found to be one of the most stable surgical movements available, regardless of the type of fixation used. A better than 90% chance of excellent post-operative skeletal stability following maxillary superior repositioning has been demonstrated.

For patients in which wire fixation is used, a "telescoping effect can result in a minimal continued superior movement that is on average only a one millimeter difference from the stability achieved with rigid fixation in the immediate post-surgical period."[9] Long-term studies examining patients over five years show that only about one-third of all patients undergoing maxillary superior repositioning experience a continuation of a downward movement of the maxilla. Fortunately in these cases, eruption of the incisors appear to compensate for the skeletal changes that may occur resulting in minimal clinically noticeable occlusal changes.[10,11]

# CORRECTION OF VERTICAL MAXILLARY DEFICIENCY

Vertical maxillary deficiency can be corrected with a Le Fort I osteotomy with inferior repositioning, however with far less predictability than surgical correction of vertical maxillary excess. Achieving post-operative stability following a LeFort I inferior repositioning is difficult. There is a strong tendency for the maxilla to return to the original superior position due to the significant upward occlusal forces applied by the mandibular teeth during function. Studies have found that up to 50% of patients experience greater than two millimeters of post-operative change, and up to 20% experience greater than four millimeters of change following surgical inferior repositioning of the maxilla. Furthermore, post-operative stability is highly dependent upon the type of fixation employed. Almost all vertical change is lost with wire fixation. Even with rigid fixation, there is a strong tendency for significant post-operative relapse. Although surgical correction of vertical maxillary deficiency is inherently far less stable than other surgical procedures, three approaches have been proposed to improve stability: (1) placement of heavy fixation plates from the zygomatic body to maxillary posterior segment; (2) interposition of a synthetic hydroxyapatite graft to provide mechanical rigidity; and (3) simultaneous ramus osteotomy to decrease occlusal forces.[12] Two additional techniques have also been employed by osteotomy modification. During Le Fort I osteotomy if the buttress osteotomy is placed at a higher level than the pyriform rim, as the maxilla is advanced it will be positioned inferiorly. This is described as "ramping". Another technique is to complete a "step" osteotomy in the region of the pyriform rim that accomplishes the same goal. It must be mentioned that

irrespective of the technique employed, stability of the correction is questionable over the long-term as a result of the change in facial height.

## CORRECTION OF MAXILLARY ANTERIOR-POSTERIOR DEFICIENCY

The Le Fort I osteotomy with advancement of the maxilla can predictably correct a maxillary anterior-posterior (Class III) deficiency. In fact, research has found that patients have an 80% chance of immediate post-operative stability, and only a 20% chance of two to four millimeters of relapse one year following surgery. If a larger magnitude advancement is planned (greater than 5 mm), heavier plates and screws with simultaneous autogenous bone grafting can aid the post-operative stability. Distraction osteogenesis, with either internal or externally placed distractors, may be considered for patients requiring maxillary advancements of greater than 10 mm. Patients with midface deficiency resulting from cleft lip and palate and other craniofacial anomalies present a unique challenge to achieving long-term post-operative stability. For these patients, even small magnitude surgical movements should be reinforced with the addition of bone grafts.

## CORRECTION OF MANDIBULAR DEFICIENCY

Since the late 1970s, the most common mandibular surgery has been the Bilateral Sagittal Split Osteotomy (BSSO), which allows the surgeon to move the mandible in either a more anterior or more posterior position. Trauner and Obwegeser first described the BSSO, which has undergone several subsequent modifications.[13,14] Studies have found good long term post-operative stability of the BSSO in cases of mandibular deficiency, demonstrating a better than 90% chance of less than 2 mm of change one year after surgical correction, regardless of the type of fixation used.[15] Other post-operative changes have been observed. The majority of patients experience greater than 2 mm of remodeling of the gonion in an upward direction during the first year after the BSSO advancement. Also, about 20% of patients experience condylar remodeling 1 to 5 years after surgery, resulting in decreased mandibular length and ramus height. These patients also experience long term post-operative dental adaptation. Lower incisor proclination occurs in about 50% of the cases, with the other half experiencing an increase in overjet.[1] **(Figure 2)**

*Figure 2A: Preoperative Occlusion. Demonstration of Relapse Due To Condylar Resorption One Year After Bilateral Sagittal Split Osteotomy To Correct Apertognathia and Mandibular Deficiency.*

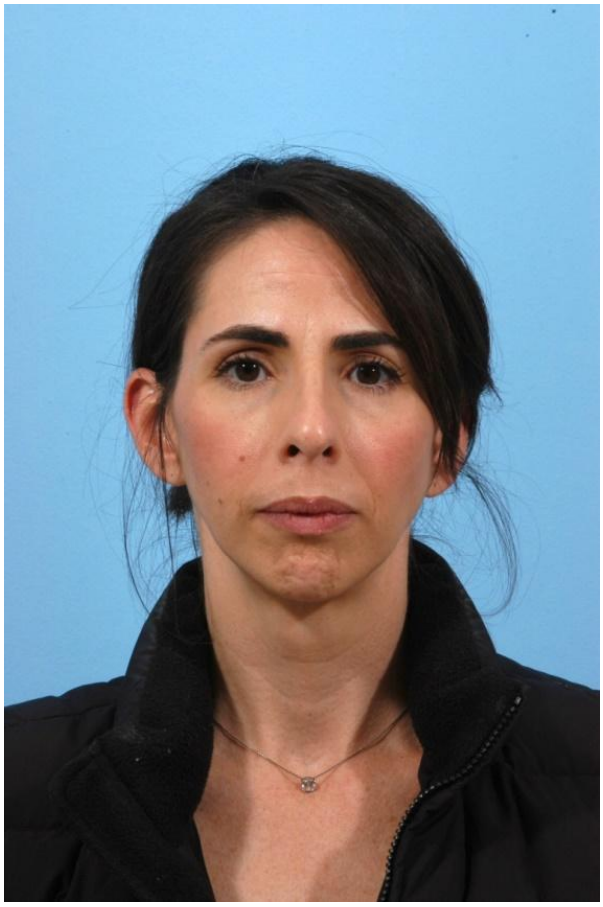

*Figure 2B: Preoperative Frontal Repose.*

*Figure 2C: Preoperative Frontal Smile.*

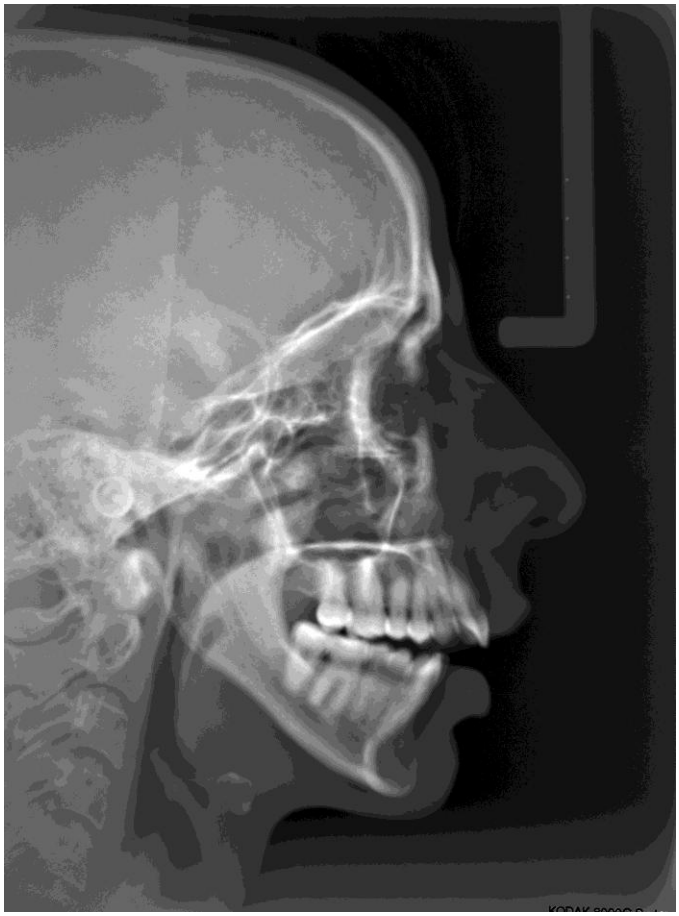

*Figure 2D: Preoperative Cephalometric Radiograph.*

*Figure 2E: 6-month Postoperative Occlusion.*

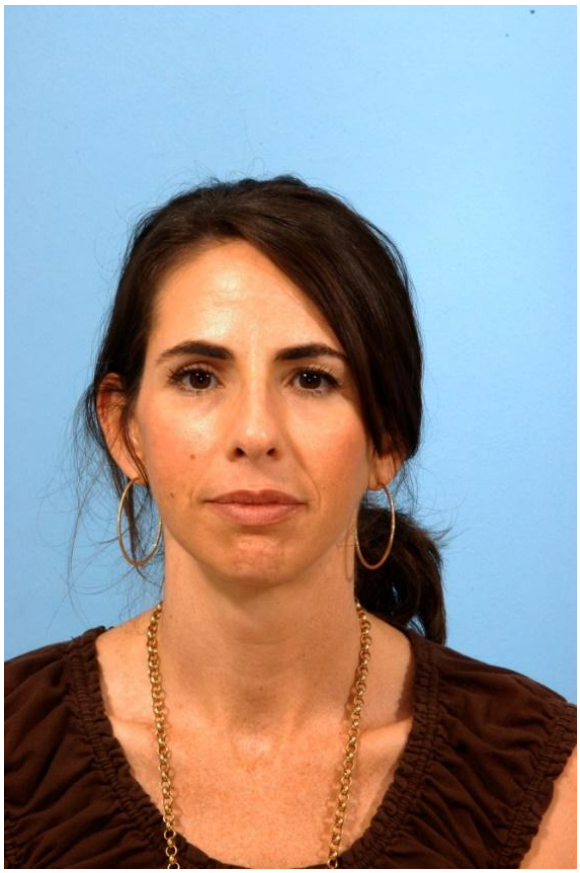

*Figure 2F: 6-month Postoperative Frontal Repose.*

*Figure 2G: 6-month Postoperative Frontal Smile.*

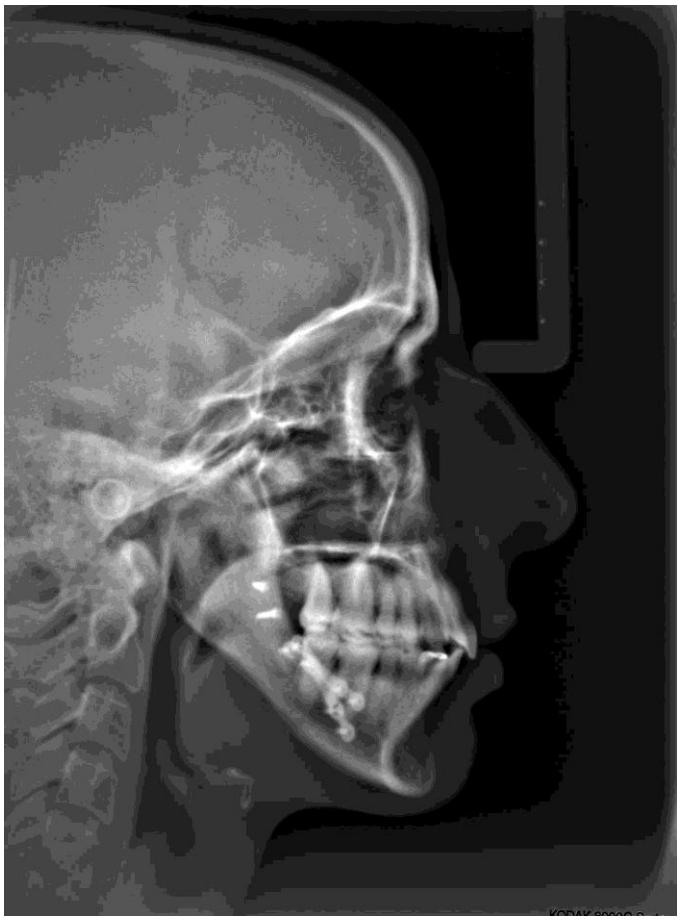

*Figure 2H: 6-month Postoperative Cephalometric Radiograph.*

*Figure 2I: 12-month Postoperative Occlusion.*

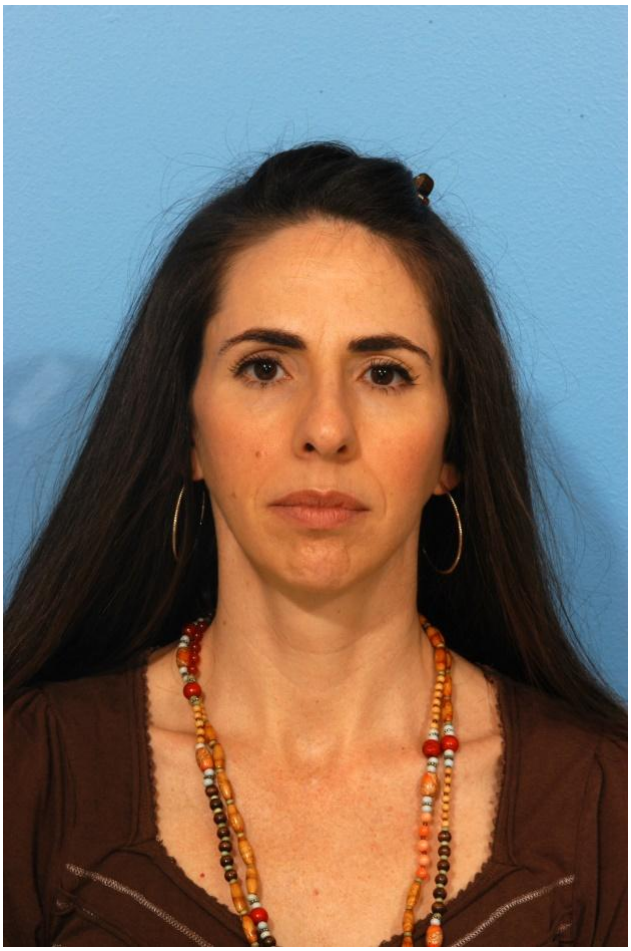

*Figure 2J: 12-month Postoperative Frontal Repose.*

*Figure 2K: 12-month Postoperative Frontal Smile.*

*Figure 2L: 12-month Postoperative Cephalometric Radiograph.*

# CORRECTION OF MANDIBULAR ANTERIOR-POSTERIOR EXCESS

Mandibular setback can be accomplished by either an Intraoral Vertical Ramus Osteotomy (IVRO) or BSSO with mandibular setback. Post-operative stability, while clinically acceptable in both cases, varies depending on which surgical technique is used. One year following IVRO, there is a chance of either forward or backward movement of the mandible. With a BSSO there is no post-surgical backward movement, but forward relapse is more frequent.

Regardless of surgical technique, up to 50% of patients experience more than two millimeters of post-operative change following a mandibular setback, with 20% of these patients experiencing change of more than four millimeters. For patients experiencing significant post-surgical relapse following a mandibular setback, the cause may be the result of a technical problem. During surgery, the position of the ramus (proximal segment with condyle) can inadvertently be pushed posteriorly into the condylar fossa. Following surgery, the ramus will return back to its original orientation.

# SIMULTANEOUS CORRECTION OF VERTICAL MAXILLARY EXCESS AND MANDIBULAR DEFICIENCY

Patients often present with complex dentofacial deformities that require double jaw surgery to correct. A Le Fort I maxillary osteotomy with superior repositioning and mandibular advancement with bilateral sagittal split osteotomy constitute the typical procedures used to correct both vertical maxillary excess and mandibular deficiency. For this particular type of surgery, the influence of the type of fixation used for long-term stability is significant. For patients stabilized with wire fixation, approximately 20% of patients experience a slight upward and rotational movement of the maxilla, while about 50% experience backward mandibular movement, six weeks after surgery. Furthermore, no return toward the original surgical position can be expected to occur, with nearly one-third of these patients experiencing continuing relapse. One year after surgery, only 60% of patients stabilized with wire fixation have an excellent clinical result. In contrast, patients stabilized with rigid fixation demonstrate greater stability in both the maxilla and mandible six weeks after surgery. One year after surgery, 90% of patients stabilized with rigid fixation are judged to have excellent post-surgical results. Consequently, rigid fixation provides significantly more stability for the simultaneous correction of vertical maxillary excess and mandibular deficiency.

# SIMULTANEOUS CORRECTION OF MAXILLARY ANTERIOR-POSTERIOR DEFICIENCY AND MANDIBULAR EXCESS

Some severe skeletal Class III dentofacial deformities can be corrected with a combined maxillary Le Fort I osteotomy with advancement, and mandibular intraoral vertical ramus osteotomy or bilateral sagittal split osteotomy. The data on stability for this particular surgical correction is limited, however it appears to be similar to the findings of post-operative stability seen in each jaw after maxillary advancement or mandibular setback alone. Of particular interest, the type of fixation used once again significantly affects post-operative stability. Ninety percent of patients with rigid fixation following double jaw correction of a Class III dentofacial deformity were judged to have an excellent clinical result compared to only

60% of patients with wire fixation one year following surgery. **(Figure 3)**

*Figure 3A: Preoperative Cephalometric Radiograph. Maintenance of Stability One Year After LeFort 1 Osteotomy with Maxillary Superior Repositioning and Advancement, Bilateral Sagittal Split Ramus Osteotomy with Mandibular Advancement and Genioplasty.*

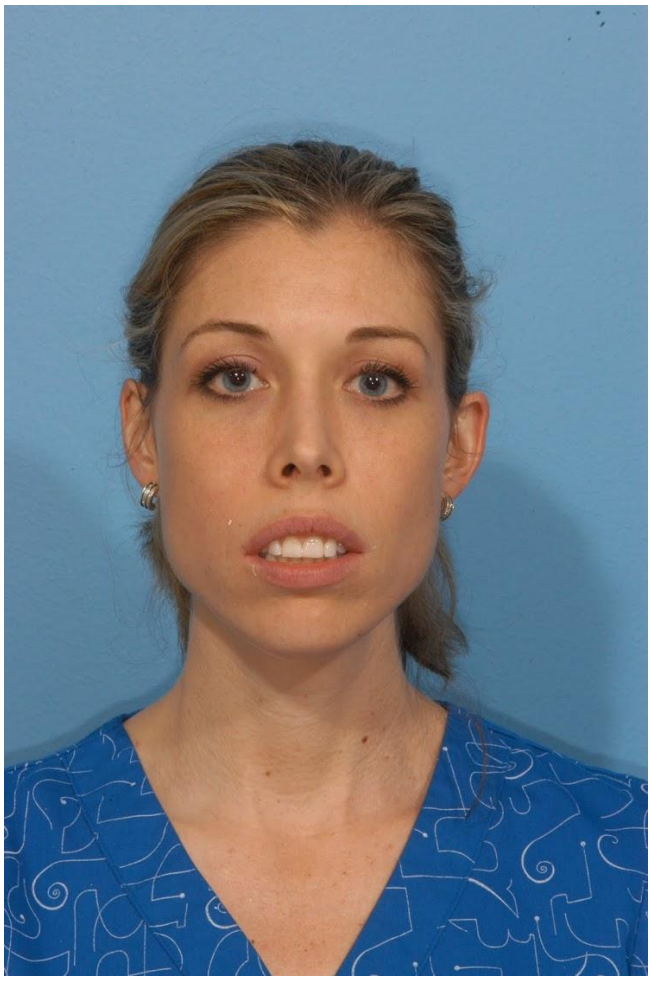

*Figure 3B: Preoperative Frontal Repose.*

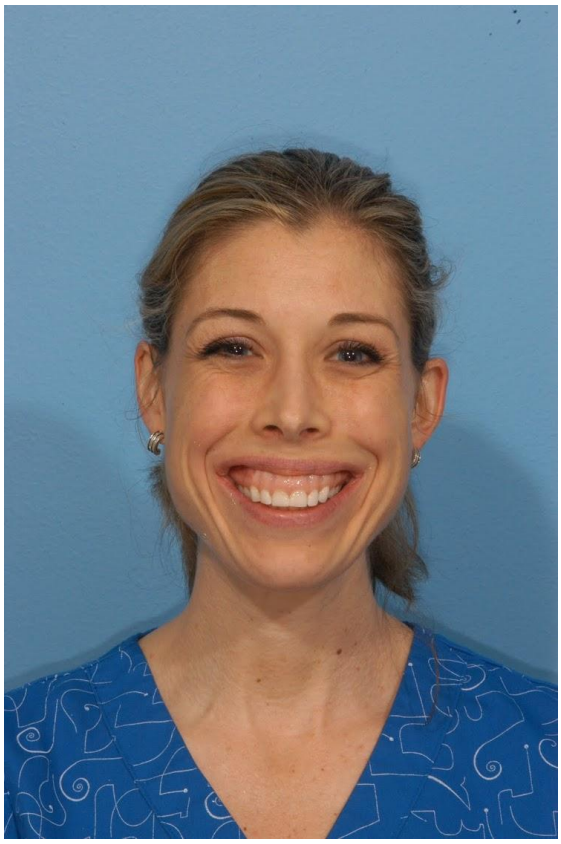

*Figure 3C: Preoperative Frontal Smile.*

*Figure 3D: Preoperative Lateral Repose.*

*Figure 3E: Preoperative Occlusion.*

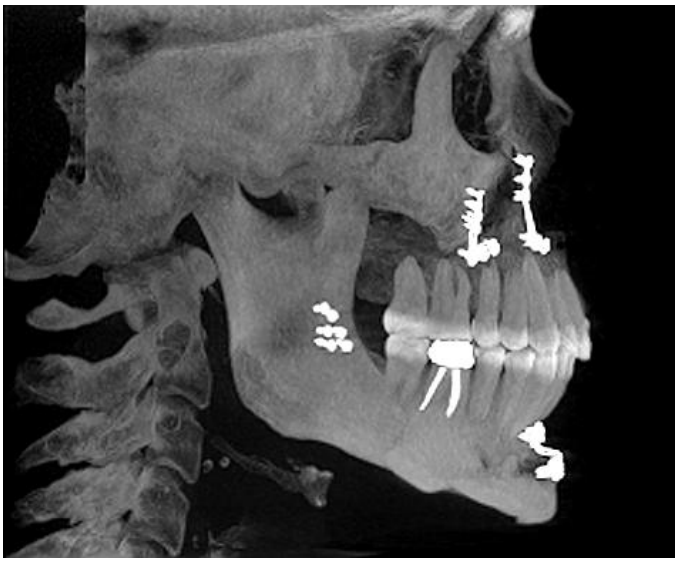

*Figure 3F: 12-month Postoperative Cephalometric Radiograph..*

*Figure 3G: 12-month Postoperative Frontal Repose.*

*Figure 3H: 12-month Postoperative Frontal Smile.*

*Figure 3I: 12-month Postoperative Lateral Repose.*

*Figure 3J: 12-month Postoperative Frontal Occlusion*.

# CORRECTION OF MAXILLARY TRANSVERSE DEFICIENCY

Surgical transverse widening of the maxilla can be accomplished with either a segmental Le Fort I osteotomy or Surgically Assisted Rapid Palatal Expansion (SARPE). The selection of surgical technique depends at least in part on the presenting dentofacial deformity of the patient. If only a transverse deficiency exists, then a SARPE is a reasonable alternative. If other accompanying maxillary deformities exist, for example, maxillary constriction and anterior open bite, then a segmental Le Fort I may be the best surgical option. Surgeon and/or orthodontist preference will also play a role in the selection of transverse surgical technique. Vanarssdall has documented a preference of SARPE over segmental Le Fort I on the basis of an improved periodontium.[16]

Post-operative stability must be considered in both cases as surgical maxillary expansion is the least stable of all orthognathic surgical procedures. As discussed earlier in this chapter, widening the maxilla causes a stretching of the palatal mucosa. As predicted by the functional matrix theory, the tension of the stretched palatal tissue applies a constricting force to the recently operated maxilla. The result is relapse of surgical expansion. In fact, studies have found that approximately 50% of the expansion in the 2nd molar area resulting from Le Fort I segmental surgery is lost within one year of surgery. Stability data on SARPE is similar to that of segmental Le Fort I osteotomy. It has been reported that about 60% of patients undergoing SARPE have dental relapse of greater than two millimeters of the posterior teeth with lingual movement of the teeth.[17]

Techniques to control transverse relapse following surgery include over-correction of the transverse deficiency, immediate post-surgical placement of a heavy orthodontic palatal bar and/or a palate covering retainer. Many authors recommend that

when the transverse expansion of the maxilla requires more than 6-7 mm of movement, a staged approach consisting of first stage SARPE followed by Le Fort I adds to the overall long-term stability of the correction.[18,19]
With different institutions advocating different techniques to manage transverse deficiency of the maxilla, the literature is controversial with regard to this particular area of stability in orthognathic surgery. Ultimately, the surgeon and orthodontist together must reconcile the surgical technique with the presenting maxillary deformity and decide which option to choose in concert with patient preference. In some healthcare systems, two separate procedures (SARPE followed by Le Fort I) is less feasible, while in others easily accommodated. In addition, two procedures require two separate recovery periods for the patient. If patient compliance is an issue, then this also may guide the choice of procedure. Lastly, irrespective of technique or philosophy employed, the most important factor is the consistency and length of post-operative orthodontic retention.

# CONCLUSION

The surgical correction of dentofacial deformities is both reliable and predictable. As with all surgical procedures, success demands of the surgeon an intimate knowledge and understanding of physiology and anatomy. Early relapse following orthognathic surgery often results from erroneous planning, intra-operative error, or wound healing problems. Late relapse frequently results in the presence of continued late, pathologic or asymmetric growth, failure of physiologic adaptation of supporting structures, or due to errors in the magnitude and/or direction of surgical movement. Inadequate orthodontic care also contributes to post-surgical relapse but has not been discussed in this article. The advent of rigid internal fixation (titanium or resorbable) has greatly increased the stability of certain orthognathic procedures like double jaw surgery.

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