Review Article aRTICLR

Stability of orthognathic surgery: a review of rigid fixation

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**Abstract**

The use of rigid fixation with orthognathic surgery was greeted by both excitement and healthy concern when it began to find its way into the literature approximately 10 years ago. The purpose of this paper is to review the literature and make comments based on the experience of the senior author on whether one of the early premises was true. Has rigid fixation improved stability with orthognathic surgery? The authors chose to examine mandibular advancements treated with a bilateral sagittal split osteotomy and maxillary osteotomies treated with a Le Fort I osteotomy. When compared to wire osteosynthesis, rigid fixation has improved stability; however, the individual move associated with the osteotomy must be considered. In some cases, auxiliary techniques should he used to ensure stability. Condylar resorption with mandibular advancement continues to be an area of concern.

**Keywords** : Maxilla, Mandible, Rigid fixation

Introduction

In a relatively short period of time, the use of rigid fixation of bony segments in orthognathic surgery has become a standard of care.’ There are several reasons for this change including shorter periods of hospital stay and patient convenience.’ Minimal or no immobilization of the jaws allows patients to function sooner, to resume their daily activities sooner, and return to work

earlier. Earlier function and airway management has changed hospital practiceProcedures which had once been done in anInpatient environment are now being done ****

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. as an outpatient.1 Complex procedures that would have been difficult with wire osteosynthesis are easier to execute with rigid fixation.1While rigid fixation has brought new possibilities to the treatment of dentofacial and craniofacial deformities, there are many questions that remain. Advocates of rigid fixation suggested that with rigid fixation one would change bone healing and eliminate relapse. The question remains, ‘With use of rigid fixation has stability of common orthognathic surgical procedures improved?’ The purpose of this paper is to review the existing data to determine if rigid fixation has improved stability with routinely used orthognathic surgical procedures for the mandible and maxilla. The surgical procedures that will be examined are advancement of the mandible by a bilateral sagittal split osteotomy (BSSO) and maxillary surgery with a Le Fort I osteotomy. These two procedures were chosen because they are the most frequently performed operations, and the literature has the most information regarding stability with their use.

MANDIBULAR ADVANCEMENT WITH A BSSO

A review of the literature on this topic is complicated by several factors. There is considerable variabilityin the way that surgery is done between one surgeonand another. Several techniques are considered under the broad term ‘wire osteosynthesis’. These include inferior border wire, circumferential wire, and superior border wire. For the sake of this paper these different stabilization techniques will be considered as one group. In a similar fashion, there are multiple techniques that are considered when the term ‘rigid fixation’ is used. These include the use of a lag screw technique, position screws, and plates.

**Short-term relapse**

Stability of mandibular advancements has been divided into short term and long term relapse.3 Several papers noted that relapse with wire osteosynthesis occurred during and soon after maxillomandibular fixation. Schendel and Epker,4 noted unacceptable postsurgical results occurred more frequently with large advancements. The adverse movement of osseous structures after surgery could be linear, rotary, or a combination of both. Most of the relapse they noted occurred soon after the surgical procedure. Relapse which occurs during the first 6-8 weeks is known as early relapse and is usually due to movement at the osteotomy site.’ Early relapse has also been seen with rigid fixation.Several studies with bicortical screws showed relapse is associated with larger advancements. In a paper by Gassmann, Van Sickels and Thrash 5, it was noted that early relapse occurred at the osteotomy site. They described linear and rotary changes occurring at the junction of the proximal and distal segments accounting for the relapse. The authors speculated that large advancements place increasing amounts of stretch on the surrounding soft tissue envelope. In addition, cases where there arelarger movements, have smaller amounts of bone at the interface between the segments. Mayo and Ellis8studied short term stability of the mandible following advancement surgery in two groups of animals, one with dental maxillomandibular fixation and the second with skeletal suspension wires plus dental maxillomandibular fixation with wire osteosynthesis. The study showed both horizontal and vertical movement was significantly better in the group with skeletal wires and maxillomandibular fixation.

**Long-term relapse**

Progressive condylar resorption resulting in late relapse has been noted by a series of authors.It has been defined as a change in shape of the condyle from normal to finger shaped with loss of height and later decrease in posterior facial height. Its incidence has been reported to be between 2.3% and 7.7% of patients treated by a BSSO to advance the mandible.8. Radiographic signs of condylar resorption were first noted at 6 months or more after surgery with a range of 6-17 months. Additional relapse has occurred following secondary surgeries.2 There are several theories as to why it occurs. Kerstens et suggested that surgery stimulates a process in the bone by increased load on the joint. They felt the process may be initiated by disk displacement and immobilization. Arnett et al 2suggested that mediolateral torquing or posterior displacement of the condyle with rigid fixation may be associated with condylar resorption and late relapse. Condylar resorption has been noted more frequently in females with high mandibular planes, preoperative temporomandibular dysfunction, large mandibular advancement and distal segment counter clockwise rotation. Scheerlinck et .noted progressive condylar resorption was four times greater for advancements greater than 10 mm than for those for advancements between 5 and 10 mm.

COMPARISON PAPERS

*Plates versus position screws*

Several authors have suggested that plates used to stabilize the fragments may have an advantage over bicortical screws because they may minimize rotation of mandibular condyles.8 Stability with plates has not been investigated to the same extent as bicortical screws. Blomqvist and Isaksson 6 compared shortterm stability seen when two groups of patients underwent mandibular advancement using either three bicortical position screws or monocortical screws and plates. They noted there was no difference in the stability between the two groups. Both showed instability the further the mandible was advanced.

MAXILLA-LE FORT I

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difference between maxilla stabilized by plates and those stabilized by wires. However, they included a variety of moves in both of their groups. Maxillary stability cannot be studied without examining the movement that was attempted with the initial surgery.

***Impaction***

Most surgeons agree that maxillary impaction is a very stable movement. Proffit et noted 7 that the vertical position of the maxilla was stable in approximately 80% of patients who underwent superior repositioning of the maxilla and were stabilized with wire fixation.In 1987, Carlotti and Schende8 studied 30 patients who underwent maxillary advancement stabilized by wire osteosynthesis. They had cases with both isolated maxillary surgery and two jaw procedures. Eight cases had larger than desired postoperative movement. They attributed the undesirable movement topreoperative orthodontic flaring of the central incisors. They concluded that suspension wires and bone grafting were sufficient to obtain skeletal stability in cases of maxillary advancement up to 11 mm. When surgery is more complex, they recommended rigid fixation. Luyk and Ward-Booth5 reviewed their results in 11 patients who underwent maxillary advancement with rigid fixation and intermaxillary fixation for 6 weeks. The mean maxillary advancement in a horizontal

direction was 3.7 mm. They noted there was

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patients who had 2 mm position screws while 14 had2 mm lag screw technique or with 3.5 mm compression screws. The wire group had 27 patients who were treated with a figure of eight superior border wire, 2 with circumferential wires and 6 with superior border wires. However, the large standard deviations indicate there were large advancements in both groups. While making overall comparisons easier, multiple previous studies have shown that early relapse is more prevalent with large advancements. Relapse in some of the sample in each group would obscure subtle differences between the groups. At 6 weeks postsurgery, the authors noted that some patients had the splints still in place while they were removed in others. Most likely the patients who had screws had their splints removed before 6 weeks while those with wires still had them in place. This would make the wire group look worse at 6 weeks but improved at 1 year. The forward movement in both groups was due to vertical settling when the splints were removed and some occlusal changes.This data suggests there is more long term relapse/ resorption in the rigid fixation group: however, due to the multiple problems in the study design, that conclusion can not be made with this paper.

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*Advancement*

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*Setback*

We did not find any papers in the literature which specifically addressed the stability of an isolated group of patients who underwent maxillary setbacks. In the senior author’s experience, this particular move is technically more difficult to execute; however, it is very stable when plates are used to stabilize the segments. Frequently, osseous gaps are present in the anterior maxilla which require bone grafts to fill the voids and give a scaffold for osseous regeneration. In contrast, with wire osteosynthesis, this type of move is prone to further upward movement.

***Inferior***

Inferior repositioning of the maxilla has been traditionally very unstable. Quejada et [11]noted that over 50% of the relapse of maxillary osteotomies stabilized with wire fixation occurred during the period of maxillomandibular fixation and the remainingrelapse occurred within the first 6 months aftersurgery. Ellis et al studied the stability of inferior movement of the maxilla using different techniques to fix the maxilla. One group had wire fixation of the maxilla and bone graft. The second had a similar procedure with the addition of myotomies of the masseter and temporalis muscles. The third had a bite opening appliance before down-grafting. The fourth group underwent down-grafting with rigid internal fixation. All of the groups had relapse; however, the animals who underwent rigid fixation had the most stable results, followed by the myotomy and bite opening group. The least stable group was the one with wire osteosynthesis and bone grafts.

*Open bite*

Open bite skeletal discrepancies can have a multitude of causes. Probably the most frequent correction of patients with open bites is done by surgery in the maxilla. Stability of open bite cases corrected by maxillary surgery is probably related more to the management of transverse problems of the dentition and tongue problems that it is to anterior-posterior or vertical discrepancies or the hardware used to fix the maxilla.6,7 Frohlich et studied tongue pressures in 21 children before and after surgical reduction of the tongue. Most of these subjects had either anterior or posterior open bites present. They noted that 12 months after surgery resting tongue pressures were lower than before the tongue reduction surgery, and were closer to those of a reference sample. A tongue reduction in selected cases may help close an open bite. The authors concluded that stable results can be achieved in treating skeletal open bite when small plate internal fixation is used and proper consideration given to the cause of skeletal open bite when planning.

DISCUSSION AND CONCLUSIONS

From the preceding review it is evident that there are many factors that need to be considered when examining the question of stability. There are cases where it makes no difference whether wires osteosynthesis or rigid fixation is used. There are others where it is clear that rigid fixation does improve stability. The factors which appear to have the most influence on stability are whether the upper or lower jaw is being moved, which direction they are being moved, and how much they are being moved. The following sections will discuss upper and lower jaw surgery. The first conclusion that can be drawn for all surgical procedures is that whether wires osteosynthesis or rigid fixation is used, relapse can occur.

*Mandibular advancement: early relapse*

Early relapse occurring with the use of wire osteosynthesis and a mandibular advancement has been well recognized with some authors reporting as much as 90% relapse occurring during maxillomandibular fixation.8 This lead to a variety of suggestions to minimize relapse including overcorrection of theocclusion, opening of the posterior bite, suprahyoid myotomy, using a sternal mandibular brace, and skeletal fixation in addition to maxillomandibular fixation.7

Mandibular advancement: long-term relapse

Progressive condylar resorption leading to long-term relapse is now recognized as a small but important cause of relapse in patients undergoing one or two jaw mandibular advancements. The association between pre-existing temporomandibular suggest the need to delay surgery on symptomatic patients. The association between large advancements and and condylar resorption suggests that early increased load leads to late condylar resorption/remodeling. Perhaps the same techniques used to prevent early term relapse. It is interesting that Van Sickels [7] did not see long-term relapse in his patients who had large advancements fixed by bicortical screws which were supplemented by skeletal wires and maxillomandibular fixation.

MAXILLARY OSTEOTOMIES

As the literature search reveals, the maxilla behaves very differently depending on how it is moved. For maxillary impaction, the surgical move is very stable,and very small hardware is necessary to stabilize the maxilla. There is sparse data on setbacks of the maxilla; however, as mentioned earlier it is ourimpression that this is also a very stable move. The size of the hardware is dependent on whether a bony gap exists after the surgical move. Advancement of the maxilla and especially inferior movement of the maxilla is not as stable as the two previous moves.It is with these two moves that rigid fixation has been shown to be superior to wire osteosynthesis. With both of these moves larger and stiffer plates need to be used.

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