The Skeletal Stability of Maxillary Advancement in Combination with Bilateral Sagittal Split Ramus Osteotomy

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Abstract: The aim of the current study is to assess the efficiency of poly-L- lactic acid (PLLA) plating system for LeFort I maxillary advancement stability in combination with bilateral sagittal split ramus osteotomy (BSSRO). The current study was conducted on 16 patients with age range 20-33 years old with skeletal class III. After preoperative workup, all patients were submitted for Le Fort I maxillary advancement and mandibular setback by BSSRO. The patients were divided into 2 equal groups. Titanium miniplates and monocortical screws were utilized for fixation in group I while, PLLA plating system was used for group II. Statistical significant differences were identified between the two groups in S-ANS perpendicular to SN, S-PNS perpendicular to SN, S-PNS parallel to SN and S-A point parallel to SN. Moreover, no statistical significant differences were identified in S-ANS parallel to SN and S- A point parallel to SN. In conclusion, these results suggested a slight tendency for vertical impaction after Le fort I osteotomy in group II, although difference in time course changes were not clinically apparent and normal occlusion was established in all patient.

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Key words: plating system, bilateral sagittal split ramus osteotomy, LeFort I osteotomy

1.Introduction:

LeFort I osteotomy is commonly used to correct jaw deformities. LeFort I osteotomy in combination with bilateral sagittal split ramus osteotomy (BSSRO) provide the most useful method for improving facial contours, eliminating asymmetries and establishing good occlusion, Ueki et al.,(2006). Several studies have documented the stability of these procedures when performed in isolation or in combination with each other. The achieved stability has been utilized by titanium plate and screws fixation, while others have used wire osteosynthesis, Skoczlas et al.,(1988); Law et al.,(1989); Carpenter et al.,(1989); Baker et al.,(1992).

Resorbable osteosynthesis materials have also been used for stabilization of surgical mandibular advancement with satisfactory outcome, Kallela et al.,(1998); Westermark et al.,(1998).

The biodegradable plate and screw offer reasonable stability for LeFort I osteotomy in the anteroposterior plane with tendency to relapse in the vertical dimension, Obwegeser et al.,(1994). In meanwhile, after emerging of LactoSorb L- plates (poly-L-lactic acid plate [PLLA]) satisfactory stability has been achieved for fixation of various maxillary osteotomies, Edwards and Kiely (1998); Shand and Heggie(2000); Edwards et al.,(2001).

Biomechanical properties of polymeric and titanium materials have been compared in vitro for maxillary osteotomies, Araujo et al.,(2001); Sittitavornwong et al.,(2006). Araujo et al.,(2001) reported lower elastic stiffness for biodegradable system than titanium but adequate to resist force of mastication. In vivo, the polymeric material is degraded over time. Therefore, elastic stiffness and maxillary stability might change after surgery which can lead to unclear characteristics of long term stability with polymeric material fixation, Landes et al.,(2003).

Potential skeletal relapse is a factor that should increasingly be taken into consideration in orthognathic surgery when deciding whether single jaw or double jaw surgery is necessary. Factors contributing to skeletal relapse are primarily the magnitude of mandibular advancement or setback, increasing amount of stretch of surrounding soft tissue and positioning of mandibular condyles outside the glenoid fossa, Eggensperger et al.,(2004).

To improve stability, many techniques have been advocated. These techniques include decreasing paramandibular connective tissues tension or increasing stability of osteotomy sites with different methods of fixation, Perrott et al.,(1994).

Rigid internal fixation has become the mainstay in both maxillomandibular trauma and orthognathic surgery. The bony fragments tend not to displace after they have been rigidly, internally fixed compared with wire osteosynthesis. At the present, the advantages of rigid internal fixation do not need to be emphasized furthermore. The questions that are still opened for discussion are; how rigid should it be

and what the best means to apply this fixation, Stoelinga and Borstlap (2003).

The purpose of the current study is to compare the time course changes in the maxillary stability after LeFort I osteotomy with titanium miniplates or polylactic acid ((poly-L-lactic acid) plate in combination with BSSRO.

2.Materials and Methods:

2.1.Materials:

2.1.1.Samples:

The current study was conducted on 16 patients with age range 20-33 years old presented with jaw deformities which were diagnosed as mandibular prognathism and maxillary deficiency.

The exclusion criteria consisted of: patients with:

(1) Great maxillary deficiency that mandates advancement more than 7 mm;

(2) Vertical maxillary deficiency that requires grafting procedures;

(3) Metabolic bone diseases;

(4) Cleft palate;

(5) Obstructive sleep apnea or revision osteotomies.

2.2.Methods:

2.2.1.Pre-operative work up:

All subjects were submitted to pre-operative frontal and profile photographs, as well as, lateral and postero-anterior cephlometric radiograph (figure 1). Preoperative orthopantograms were obtained, as well to get full diagnostic data. After obtaining face bow records, the upper and lower models were mounted on fully adjustable articulators. Orthodontic preparation was performed. The mock surgery was done on the mounted models and construction of the surgical stent will follow.

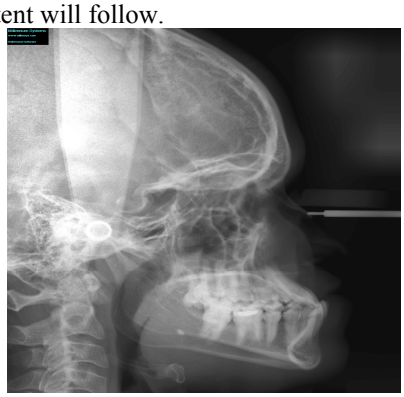

Figure 1: Preoperative cephalometric radiograph illustrating skeletal class III

2.2.2.Surgical procedures:

The patients were divided into two equal groups. All the patients in both groups were subjected to LeForte I osteotomy and BSSRO to advance the maxilla and setback the mandible (figure 2).

In group I patients, 2 L type titanium miniplates and 2 straight miniplates (4 holes with 4 screws [2mm diameter, 5mm length], Wurzburg, Leibinger Co, Freiburg, Germany) were used to fix the advanced maxilla and 2 titanium miniplates (4 holes with 4 screws [2mm diameter, 7mm length], Wurzburg, Leibinger Co, Freiburg, Germany) were used for bilateral internal fixation of the mandible.

In group II patients, 2 PLLA L type plates and 2 straight PLLA plates (4 screws for each [2mm diameter, 8 mm length], Inion Ltd, Finland) were used to fix the advanced maxilla. Another 2 PLLA plates with 4 screws (Inion Ltd, Finland,[2mm diameter, 8 mm length]) were utilized for bilateral internal fixation of the mandible.

All patients were subjected to maxillomandibular fixation (MMF) elastics to maintain ideal occlusion. All patients were received orthodontic treatment before and after surgery.

2.2.3.Cephalometric Assessment:

All patients underwent lateral cephalography to assess skeletal changes preoperatively, immediately after surgery, and 1, 3, 6, and 12 months post-operatively. To assess maxillary stability, arbitrary points for anterior nasal spine (ANS), posterior nasal spine (PNS), salla (S), nasion (N) and A point were defined and measured as follows from pre-operative images and subsequently transferred to all remaining radiographs (figure 3). One observer performed all digitization so that cephalometric method errors were small and acceptable for the purposes of this study.

2.2.4.Lateral Cephalometric Analysis:

**S-A parallel to SN*: distance between A point and sella parallel to SN plane.

**S-A perpendicular SN*: distance between A point and sella perpendicular to SN plane.

**S-PNS parallel to SN*: distance between arbitrary PNS and sella parallel to SN plane.

**S-PNS perpendicular to SN*: distance between arbitrary PNS and sella perpendicular to SN plane.

**S-ANS parallel to SN*: distance between arbitrary ANS and sella parallel to SN plane.

**S-ANS perpendicular to SN*: distance between arbitrary ANS and sella perpendicular to SN plane.

2.2.5.Statistical analysis:

The collected data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (SPSS 15.0 for windows; SPSS Inc, Chicago, IL, 2001). Data was presented and suitable analysis was done according to the type of data obtained for each parameter. (Table 1 & 2)

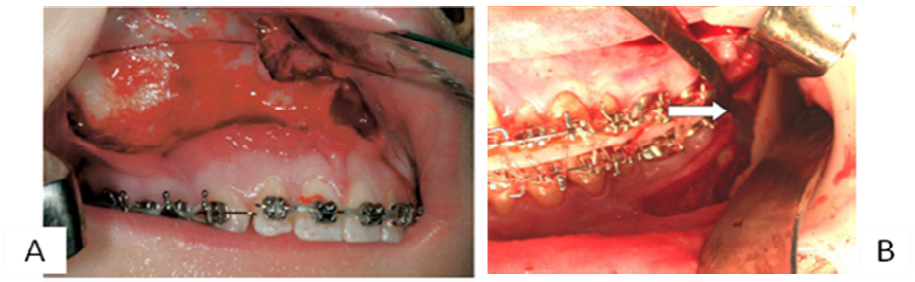

Figure 2: Surgical exposure for LeFort I osteotomy *(A), and BSSRO (B)*

Table 1: The cephalometric parameters of group I

	Initial		Immediately after		One month		Three month		Six month		One year	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
S-A parallel to SN	61.0	2.07	64.	1.71	63.6	1.75	64.2	1.76	63.4	1.74	63.6	1.81
S-A perpendicular SN	64.4	1.68	65.0	1.70	63.7	1.66	63.8	1.66	63.5	1.65	64.3	1.72
S-PNS parallel to SN	14.6	1.05	16.4	1.18	16.9	1.22	16.8	1.21	16.6	1.20	16.2	1.17
S-PNS perpendicular to SN	50.6	0.96	49.1	0.93	49.0	0.93	48.9	0.93	49.8	0.95	50.0	0.95
S-ANS parallel to SN	66.1	0.92	68.1	0.94	67.1	0.93	67.1	0.93	66.2	0.92	67.2	0.93
S-ANS perpendicular to SN	56.5	1.75	57.1	1.77	55.8	1.73	55.8	1.73	55.7	1.73	56.3	1.75

Table 2: The cephalometric parameters of group II

	Initial		Immediately after		One month		Three month		Six month		One year	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
S-A parallel to SN	58.1	2.37	61.0	2.49	60.5	2.46	61.0	2.49	59.8	2.43	59.8	2.43
S-A perpendicular SN	62.8	4.64	62.2	4.60	60.5	4.47	60.6	4.48	60.3	4.46	59.6	4.41
S-PNS parallel to SN	13.2	0.56	15.0	0.63	16.0	0.68	15.8	0.66	15.1	0.64	15.4	0.65
S-PNS perpendicular to SN	48.6	3.14	47.5	3.06	46.8	3.02	47.1	3.04	46.4	2.99	45.8	2.95
S-ANS parallel to SN	62.5	2.83	64.3	2.92	63.0	2.86	63.7	2.89	63.5	2.88	62.6	2.84
S-ANS perpendicular to SN	52.6	1.78	51.4	1.74	49.7	1.69	50.2	1.70	50.2	1.70	49.1	1.66

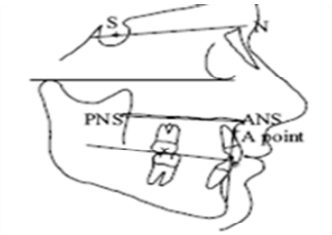

Figure 3: Measurements points on lateral cephalometric radiograph

3.Results:

After surgery, no patients experienced complications such as wound infection, dehiscence, bone instability or long term malocclusion. No obvious clinical relapse developed.

The total mean change of all parameters along the whole study period were calculated and tabulated. Statistical analysis utilizes the total mean for each parameter. The independent samples t test revealed a statistically significant difference between the two studied groups in Sella-ANS perpendicular SN, Sella-PNS perpendicular SN, Sella-PNS parallel SN and Sella-A point perpendicular SN parameters on lateral cephalometric radiograph. Meanwhile, there were no statistically significant differences between the two studied groups in Sella-ANS parallel SN and Sella-A point parallel SN (table 3).

Table (3): Comparison between the two studied groups regards change in measurements for lateral cephalometric analysis

Lateral Cephalometric analysis	Group	N	Mean	SD.	t.	P- Value	Sig.
Sella-ANS perpendicular SN	Group I	8	-1.2	0.05	13.8	0.000	HS.
	Group II	8	-1.6	0.06			
Sella-ANS parallel SN	Group I	8	-1.2	0.03	-1.9	0.09	NS.
	Group II	8	-1.1	0.06			
Sella-PNS perpendicular SN	Group I	8	0.3	0.02	59.7	0.000	HS.
	Group II	8	-1.0	0.06			
Sella-PNS parallel SN	Group I	8	0.3	0.03	-17.7	0.000	HS.
	Group II	8	0.6	0.04			
Sella-A point perpendicular SN	Group I	8	-1.2	0.06	13.2	0.000	HS.
	Group II	8	-1.9	0.15			
Sella-A point parallel SN	Group I	8	-0.9	0.23	-0.6	0.6	NS.
	Group II	8	-0.8	0.04			

4.Discussion:

Stability of Le Forte I osteotomy in conjunction with a mandibular procedure (BSSRO) has been well documented by numerous authors. Most studies have suggested that no appreciable difference exists between different types of fixation methods for single – piece maxillary impactions and / or advancements. However, inferior repositioning of the maxilla has been shown to be unstable move regardless of the fixation method used, Skoczlas et al.,(1988); Proffit et al.,(1991); Egbert et al.,(1995); Van Sickels and Richardson(1996), Proffit et al.,(1996).

This combination surgery was predicted to possibly result in heavier loading to maxillary segment which could result in some degree of impaction at molar region. These observations may suggest the slight tendency of PNS toward vertical impaction gradually. Nevertheless, the statistical significant difference between the two studied groups, as regard the lateral cephalometric parameters, could be attributed to the bending strength and anti-pull-out strength of PLLA plating system are higher than of the human cortex and lower than of titanium plates. In vitro, PLLA plating system can maintain 80% of early bending strength until 12 weeks post-operatively, Matsusue et al.,(1991; 1992).. The findings of the our current study are in accordance with Norholt and Pedersen (2004) who found a significant difference in vertical position of maxilla on lateral cephalometric analysis when compared with postoperative situation in study using PLLA plating system for internal fixation of fracture.

Ueki et al.,(2006) concluded that there was slight tendency of PNS toward gradual vertical impaction when using PLLA plating system and hence, weakening of segmental fixation at posterior part might occur after surgery. These findings give credibility to the results of our study.

Politi et al.,(2004) reported no difference in maxillary and mandibular skeletal stability regarding the type of fixation method except for the vertical posterior maxilla. Politi et al report support the findings of the present study which documents the existence of statistical significant difference between the two studied groups in the vertical position of ANS and PNS.

A point and ANS morphology can be changed during maxillary surgery. This might induce variability in the arbitrary ANS plane. Also, A point can be changed by post-operative orthodontic treatment so, the statistical analysis related to A point may be of little importance.

The clinical observations of the current study revealed no prolonged mobility, instability, non union at osteotomy sites in PLLA study group. These findings were in matching with Turvey et al ., (2002) report. Some surgeons clinically detected more mobility of the maxillary osteotomy segments fixed with PLLA plating systems than with titanium devices, but this didn't warrant surgical intervention. Turvey et al stated that minor mobility facilitated post surgical orthodontics and didn't interfere with bone healing.

The bulkness of the PLLA plating system and the technical manipulation can be considered, to some extent, as a drawback for PLLA plating system but the biodegradation capabilities and hence, no need for another surgery to remove the hardware can be advantageous.

Steolinga et al.,(2003) stated that there was no significant difference between mini-plate and bi-cortical position screws for fixation of BSSRO and moreover, the plate can accommodate the step and the

positional changes of the fragments leading to minimizing the torsion at the level of the condyle as much as possible. Also, miniplate with monocrtical screws fixation minimize the prevalence of inferior alveolar nerve damage. The findings of Steolinga et al.,(2003) support the design of our study in selection of miniplate fixation for mandibular osteotomy.

In conclusion, skeletal and occlusal stability with satisfactory results were obtained in both groups without complications. Further researches are needed to test the limits of resorbable fixation in large advancement cases.

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