Comparison of Rigid and Semirigid Fixation for Advancement Genioplasty

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Abstract To compare the skeletal stability of rigid versus semirigid fixation for advancement genioplasty by the assessment of vertical and horizontal measurements pre-operatively and post-operatively on lateral cephalometric radiographs. The study comprised of patients who underwent standard advancement genioplasty by inferior osteotomy of the chin with broadest musculoperiosteal pedicle with either rigid fixation or wire fixation. The displacements of vertical and horizontal measurements resulting following surgery was derived by calculating the difference between preoperative, immediate post-operative and 1 year post-operatively on lateral cephalometric radiographs. Preoperative measurements were marked as T1, immediate post-operative as T2, 1 year follow up post-operative as T3. In the semirigid group a mean horizontal advancement of 5.97 mm was accompanied by a relapse of 1.623 mm during a period of minimum 1 year. The mean superior repositioning of menton was 0.7 mm. This was

accompanied by a relapse of 0.325 mm during a period of 1 year. In the rigid group a mean horizontal advancement of 4.815 mm was accompanied by a relapse of 0.2 mm during a period of 1 year. The mean superior repositioning of menton was 0.975 mm. This was accompanied by a relapse of 0.1 mm during a period of 1 year. This study confirms the findings of several previous studies that contribute data specific towards the use of rigid fixation in advancement genioplasty. In our study we also observed that, in cases where large advancements are necessary, wire fixation may offer insufficient means of fixation particularly if the movement is complex and asymmetrical, in which case rigid fixation devices are more helpful.

Keywords Genioplasty · Rigid and semirigid fixation · Advancement · Resorption

Introduction

Genioplasty is a surgical procedure carried out to reshape or change the size of the chin that involves both bony and soft tissue components. The advanced genial segment has traditionally been stabilized with wire osteosynthesis. Studies have shown that this method affords good stability. Kirschner wires and Steinman pins have also been used and are also thought to produce good stability. Bone plate osteosynthesis and screw fixation are other stabilization methods now widely used. In all cases, the chin has to be rigidly fixed by either wires, miniplates or screws. A concern has been post-operative relapse, resorption, and remodeling. Initially, wiring procedures were used to stabilize the osteotomized segments. Rigid fixation techniques

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were introduced in an attempt to decrease the post-surgical relapse rate.

In this study patients who have undergone direct osseous genioplasty along with other orthognathic procedures were selected to compare the skeletal stability with rigid and semirigid fixation for advancement genioplasty by comparing the vertical and horizontal measurements on cephalometric radiographs followed-up to minimum 1 year.

Materials and Methods

The sample in this study was drawn from patients who reported to the Department of Oral and Maxillofacial Surgery, St. Joseph Dental College & Hospital, Eluru seeking for the correction of facial esthetics.

The study comprised a total of 20 subjects who were assigned into two groups. Each group comprising of ten subjects.

Group A (semirigid/wire fixation group) receiving transosseous wiring for advanced genial segment.

Group B (rigid fixation group) received a single paulus chin plate of 2 mm thickness and horizontal bar with 2 mm increments measuring 4–8 mm, for advanced genial segment.

All the subjects were followed-up for a minimum period of 1 year post-operatively. Three lateral cephalograms are obtained from each patient. The first lateral cephalogram is obtained before surgery, second lateral cephalogram immediate post-operatively and third lateral cephalogram after 1 year post-operatively.

All patients underwent standard advancement genioplasty by inferior osteotomy of the chin with broadest musculoperiosteal pedicle with either rigid fixation or wire fixation. The preoperative chin deficiency was assessed on lateral cephalograms using cephalometric analysis for orthognathic surgery (COGS) by Burstone et al. [1]. Treatment plan was made according to diagnosis. All patients underwent standard advancement genioplasty under general anesthesia along with other orthognathic procedures (Table 1).

The horizontal osteotomy was performed using 702 drilling bur. After sectioning the genial segment was advanced to planned position according to cephalometric analysis (Burstone's analysis), with minimal detachment of periosteum from anterior and inferior aspects of genial segment without detaching the geniohyoid and genioglossus muscle.

The repositioned segment was stabilized with either 0.018 stainless steel wire or a single chin plate (a single paulus chin plate of 2 mm thickness with horizontal bar measuring 4–8 mm) and screws.

Table 1 Type of surgery

Type of surgery	No. of subjects
Genioplasty + lefort 1	11
Genioplasty + AMO	5
Genioplasty + AMO + lower subapical	1
Genioplasty + lefort 1 + AMO	2
Genioplasty + rhinoplasty	1

The wound was closed in layers to reapproximate the margins of the periosteum, mucosa with 3/0 vicryl. A pressure dressing was applied externally and maintained in position for about 4 days to stabilise the repositioned soft tissue structures and prevent excessive swelling and hematoma formation (Fig. 1).

The patients were followed-up to 1 week post-operatively for the assessment of wound healing. A cephalogram was taken within 7–8 days after surgery.

Evaluation of Hard Tissue Changes After Advancement Genioplasty

Radiographic Techniques

Cephalometric analysis was done using Park et al. [2] method. Radiographs were taken preoperatively (T1) not more than 2 weeks before surgery, immediate post-operative i.e. before 7–8 days after surgery (T2), post-operatively after 1 year of surgery (T3).

- All the lateral cephalometric radiographs were taken on the same machine by the same operator.
- All the teeth should be in occlusion at the time of exposure and the lips in repose.
- Patients were positioned with ear rods of cephalostat placed in the ears and locking nasal positions against the bridge of patient's nose to eliminate rotation around the ear rods in sagittal plane.
- All cephalometric radiographs were taken a maximum of 2 weeks before surgery after which no further orthodontic movements of teeth were carried out.
- Post-operative radiographs were taken immediately (7–8 days) after surgery and another radiograph was taken a minimum of 1 year after surgery.

Cephalometric Analysis

Because most of the patients whose radiographs were analysed had undergone additional orthognathic procedures, it was not feasible to take reference planes based on cranial base super impositions.

Fig. 1 a Stabilization of the advanced genial segment using stainless steel wire, **b** Stabilization of the advanced genial segment using paulus chin plate

Park et al. [2] were unable to find a measuring method that applied to genioplasty and they developed their own measurements. This method was used in this study. Presence of plate may lead to error in marking point Pg and Me, especially when the difference between post-operative and 1 year follow-up is minimal. Hence unaltered mandibular landmarks must be precisely overlapped and bony outline at Pg considered and not the hardware.

The preoperative cephalograms were traced on 0.3 mm thick acetate tracing paper with black marker pen. It was then superimposed on the immediate post-operative lateral cephalogram using blue marking pen. These tracings were again superimposed on 1 year post-operative lateral cephalogram using red colour marking pen. This produced a single composite tracing for each patient that allowed serial observation and measurement of positional changes of hard tissues of chin. Unaltered mandibular landmarks considered while superimposing the tracings are, lingual border of symphysis, inferior border of the mandible, ramus, restorations or brackets (if any).

All lateral cephalometric films were traced on a transparent cellulose acetate sheet of 36 m (0.003 in.) thickness by the same technician. Similar conditions of the light box and general illumination were maintained during viewing

and tracing of all headfilms. All reference points were first identified, located, and marked. The reference planes were drawn, and, when the bilateral structures cast double shadows on the film, the technique of averaging the bilateral images was used. The magnification factor was considered when the measurements were recorded.

A reference line and special reference points were established.

Reference lines and reference points used in his study are

OPL (occlusal plane) a horizontal tangent to upper most convex area of mandibular first molar.

MePL (menton horizontal plane) a horizontal plane parallel to occlusal plane and at tangent to point menton (Me).

P point is (posterior reference point) posterior aspect of the inner cortex 25 mm below the OPL.

Pogonion (Pg) (hard tissue pogonion) most anterior point on the symphysis of the mandible in median plane.

Menton (Me) (hard tissue menton) most caudal point in the outline of the symphysis or the inferior-most point on mandible.

Fig. 2 Composite tracing with T1, T2, T3

The measurements analysed were as follows

1. Horizontal position of the hard tissue chin (P-Pg)—the distance from point P to Pg parallel to OPL.
2. Vertical position of inferior aspect of the hard tissue (OPL-MePL)—the perpendicular distance from the OPL to MePL.

The displacements of these points resulting following surgery was derived by calculating the difference between preoperative and immediate post-operative, 1 year post-operative positions. Preoperative measurements were marked as T1, immediate post-operative as T2, follow-up post-operative as T3 (Fig. 2).

Statistical Analysis

After collection of data, it was entered into microsoft excel 2007 and statistical analysis was done. The data were normally distributed and significance of differences between the groups was compared using paired Student *t* test; a probability of less than 0.05 was accepted as significant.

Results

The study was conducted with the aim to compare the skeletal stability of rigid versus non-rigid fixation for advancement genioplasty by the assessment of vertical and horizontal measurements preoperatively and post-operatively on lateral cephalometric radiographs.

The study comprised a total of 20 subjects. The subjects were assigned into two groups, $n = 10$ in each group. They are, Group A (wire fixation group); Group B (rigid fixation group).

Table 2 Group A (semirigid/wire fixation group) horizontal component; T2–T1 = advancement; T2–T3 = resorption

Case	T2–T1	T2–T3
1	6.1	2
2	6.5	2
3	6.5	2
4	7.5	1
5	6.5	1.5
6	5.5	1
7	6.5	1
8	4.5	1.5
9	5.1	2
10	5.0	2
Mean	5.97	1.6

Preoperative measurements, P-Pg; OPL-MePL—T1.

Immediate post-operative, P-Pg1; OPL1-MePL1—T2.

Six months post-operative, P-Pg2; OPL-MePL2—T3.

Immediate surgical changes of hard tissues—T2 to T1.

Follow up post operative changes of hard tissues—T3 to T1.

Relapse or resorption of hard tissues—T2 to T3.

In the semirigid group a mean horizontal advancement of 5.97 mm was accompanied by a relapse of 1.623 mm. The mean superior repositioning of menton was 0.7 mm. This was accompanied by a relapse of 0.3 mm during a period of 1 year (Tables 2, 3).

In the rigid group a mean horizontal advancement of 4.815 mm was accompanied by a relapse of 0.2 mm. The mean superior repositioning of menton was 0.975 mm. This was accompanied by a relapse of 0.1 mm during a period of 1 year (Tables 4, 5).

The two groups differed significantly ($P = 0.008505144$) in percentage horizontal change. The two groups did not differ significantly in the percentage vertical change ($P = 0.102416382$) (Table 6).

From the above data it can be analysed that rigid fixation was more stable when compared to non rigid fixation.

Discussion

Hofer [3] was the first to describe the anterior horizontal osteotomy of the mandible in 1942. He advocated extraoral, submental approach to the chin. Converse and Wood-Smith [4] popularized the procedure. Trauner and Obwegeser [5] in 1957 were the first to describe an intraoral approach to advance the chin and used circummandibular wires for stabilization. Since then many modifications have been suggested for genioplasty.

Table 3 Group A (semirigid/wire fixation group) vertical component; T2–T1 = advancement; T2–T3 = resorption

Case	T2–T1	T2–T3
1	0	0
2	–3	0
3	3.5	1
4	0	0
5	0	0
6	0	0
7	2	1
8	2.5	0
9	1	0
10	1	0
Mean	0.7	0.3

Table 4 Group B (rigid/plate fixation group) horizontal component; T2–T1 = advancement; T2–T3 = resorption

Case	T2–T1	T2–T3
1	6.5	0
2	3.5	0
3	5.1	0.5
4	5.0	0
5	5.0	1
6	4.5	0
7	5.0	0
8	4.5	0.5
9	3.5	0
10	5.5	0
Mean	4.81	0.2

Table 5 Group B (rigid/plate fixation group) vertical component; T2–T1 = advancement; T2–T3 = resorption

Case	T2–T1	T2–T3
1	0	0
2	1	0
3	0	1
4	2.5	0
5	3.5	0
6	0	0
7	0	0
8	0	0
9	2	0
10	0	0
Mean	0.9	0.1

After the genial segment has been advanced it must be rigidly fixed to avoid post-operative resorption and relapse. Hence the most reliable method is required for fixation. Generally the advanced segment is fixed by stainless steel wires or miniplates. Many studies were conducted to evaluate and compare the efficiency of different methods. Kirkpatrick and Woods [6] showed a mean horizontal relapse of 8 % after mandibular advancement using rigid fixation. But Reyneke et al. [7] compared the skeletal stability of wire and screw fixation after advancement genioplasty and demonstrated no difference between the two groups.

The main purpose of this study was to evaluate and compare the stability of advanced genial segment when a single bone plate is used for fixation versus wire osteosynthesis by means of cephalometric analysis. The amount of horizontal skeletal changes occurring at the pogonion and point P, the amount of vertical skeletal changes occurring at menton with reference to occlusion plane on preoperative and post-operative cephalometric radiographs after advancement genioplasty was evaluated.

Bone fragment fixation methods, mainly involve stainless steel wires or a miniplate. Both methods of fixation are effective, although the miniplate method is more reliable, easy to apply, and has been used more widely. Today, controversy remains between the two methods with each technique citing ease of use, predictability, low morbidity, and excellence of results.

Like any other maxillofacial osteotomy, osteotomy of the inferior border of the mandible can be adversely affected by two completely different mechanisms firstly the skeletal instability, where the advanced genial segment changes in position prior to osseous union, thereby rapidly altering the surgical outcome. The second being osseous remodeling, where the advanced genial segment is slowly recontoured during the remodeling process, by which the final result may differ from the immediate post surgical outcome.

The pattern of bone remodeling that occurs in the chin after advancement osteotomy of inferior border of the mandible is now a very well known phenomenon. The vascular supply to the osseous genioplasty pedicle has been proposed to be an important predictor of the relapse and resorption [8, 9].

Qualitative evaluation of bone remodeling showed that there were areas of bone deposition and resorption occurring simultaneously in the genioplasty sites [10]. Extensive bone deposition was observed along the anterior portion of the proximal segment, around and immediately above osteotomy site at the point B area. Another area of bone deposition was along the posterior edges of the distal segments bilaterally, where the proximal and distal segments interfaced. Such bone deposition was observed,

Table 6 Statistical analysis

	Vertical component		Horizontal component	
	T2–T1	T2–T3	T2–T1	T2–T3
Wire	0.7	0.3	5.97	1.6
Plate	0.9	0.1	4.81	0.2
	$P(T \leq t)$ one-tail	0.102416382	$P(T \leq t)$ one-tail	0.008505
	$P(T \leq t)$ two-tail	0.204832765	$P(T \leq t)$ two-tail	0.01701

leading to the rounding of the sharp edges resulting from the osteotomy. In all cases where a gap was present between the two segments of bone, new bone formation bridged this gap completely. But this remodeling pattern did not affect the horizontal stability of Pg. Hence the fixation devices for genioplasty must be placed on the areas of bone deposition [10]. In this study, plates used for fixation were placed in bone deposition areas. Palpation of the region intraorally and extraorally did not show any evidence of the hardware. None of the patients complained of pain or discomfort with and without palpation of the region.

The use of rigid fixation has certain technical advantages. It can be used for large advancements, in three dimensional repositioning with good adjustability. Plate can be selected depending on the required amount of advancement. If different amount of advancement is required it can be replaced with new plate.

Wire osteosynthesis is, however, less expensive; wire fixation is relatively less stable when compared to rigid fixation. Our study showed a post-operative resorption which is very less. Large advancements are not possible with wire fixation technique. The total amount of advancement possible with wire fixation is the total thickness of the cortex of the genium. Any advancement beyond this is not possible with wire fixation technique. The amount of advancement cannot be predicted. Wire fixation technique is not as simple as plate fixation. Plate becomes palpable in patients in less soft tissue, where wire fixation is of prime importance.

Conclusion

The results of our study and our clinical experience indicate that this single plate is an extremely simple and very useful method of stabilization. Although there are minor discrepancies with relation to vertical and horizontal components much resorption and remodeling was observed in case of wire fixation at bone resorption areas than at Pg. The plate offers considerable advantages over other methods of fixation.

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