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Original Research

Long Term Stability Following Genioplasty: A Cephalometric Study

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Abstract:

Background: A receding chin associated with an orthognathic mandible is a common situation and surgical changes in chin position are often required to improve the overall harmony of the face. Genioplasty is one such procedure. Stability of hard and soft tissue changes following genioplasty on a long term basis needs to be assessed. Studies on the stability of hard and soft tissue changes following genioplasty on a short term basis have revealed it as a procedure with good stability. This study is done to assess the stability of hard and soft tissue changes following genioplasty on a long term basis.

Materials and Methods: Pre-surgical, postsurgical and long term post-surgical cephalograms of 15 cases treated by vertical reduction augmentation genioplasty were obtained. Paired *t*-test was used to compare the changes between pre-surgical, postsurgical and long term postsurgical cephalograms.

Results: Findings of this study demonstrated that genioplasty is a stable procedure. After long term follow-up period, there was a relapse of 1.5 mm at the pogonion accounting for 24% of the surgical advancement. This is attributed to the remodeling that occurs at the surgical site, but not the instability due to the surgical procedure.

Conclusion: With the present study, it can be concluded that vertical reduction and advancement genioplasty can be considered as an adjunctive procedure that produces predictable results and the bony and soft tissue stability were generally very good.

Key Words: Genioplasty, hard tissue parameters, soft tissue parameters, stability

Introduction

The position of the chin is perhaps the baseline or foundation for harmony of the lips, nose and face. Dentofacial deformities are commonly associated with excessive protrusion or retrusion of chin and chin is one of the most variable areas in the entire mandible.

A receding chin associated with an orthognathic mandible is a congenital defect and in such patients teeth may or may not be in normal occlusion. In such cases, surgical changes in chin position are often required to improve the overall harmony of the face. Genioplasty is one such procedure. It is an operation which remodels the chin. Genioplasty allows three dimensional control of chin position, resulting in significant improvements in facial esthetics. Among all possible directions for repositioning the chin, advancement genioplasty to correct a receding chin is probably the most common procedure.

Many a times the presence of a deficient chin makes it perceive as proclined upper front teeth. Situations like these can be managed by a genioplasty. Studies on the stability of hard and soft tissue changes following genioplasty have been conducted by many research workers on a short term basis.[1-4]

However, the stability of hard and soft tissue changes following genioplasty has not been analyzed on a long term basis.

Objectives

1. To assess the long term bone and soft tissue stability following genioplasty.
2. To relate the changes in the bony architecture and soft tissues following genioplasty on a long term basis.
3. To develop predictive criteria for treatment planning.

Materials and Methods

Source of data

Pre-operative, post-operative and more than 2 year post-operative lateral cephalograms of 15 patients subjected to advancement genioplasty with or without vertical reduction and no concurrent mandibular procedure were obtained from Department of Orthodontics and Dentofacial Orthopedics, Bapuji Dental College and Hospital, Davangere, Karnataka, India.

The sample size consisted of 15 cases treated with genioplasty. The age of the patients ranged from 16 to 28 years with a mean age of 19.1 years.

The following cephalograms were used:
- Pre-surgical: T1
- Immediate post-surgical: T2
- Long term post-surgical: T3.

Criteria for selection of patients
The primary selection criteria were:
1. Lateral cephalograms taken under standardized conditions.
2. Pre-surgical, Immediate post-surgical and more than 2 years post-surgical radiographs. Immediate post-surgical radiographs were taken 1 month after the surgery to allow for the soft tissue edema to subside.
3. Patients who had undergone only a genioplasty procedure with no other osteotomy procedures.

The technique employed in taking the cephalograms was as follows:
1. Profile cephalograms were taken with patient's teeth in habitual occlusion and lips at rest position under standardized conditions with a cephalostat.

Analysis of lateral cephalograms
Tracings of the cephalograms are done on the tracing sheets with a 0.3 mm lead pencil. The necessary cephalometric landmarks were located.

Planes used in the study
1. Sella-Nasion plane: A line is drawn from Sella to Nasion.
2. Surrogate Frankfort plane (HP): The base line for comparisons of most of the data in this analysis is a constructed plane called Surrogate Frankfort plane (HP) which is constructed by drawing a line 7° from the line S to N. Most of the measurements will be made from projections either parallel to HP (II HP) or perpendicular to HP (⊥HP).

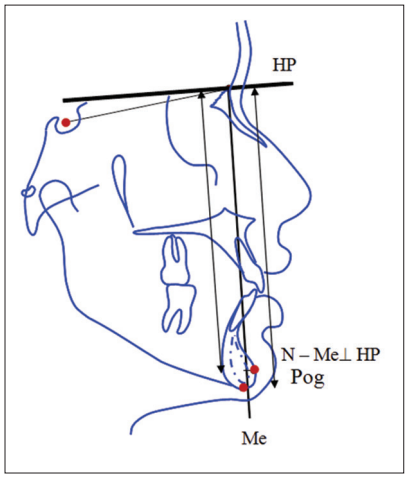


Figure 1: Linear parameters for hard tissue evaluation. Horizontal 1. N-Pog II HP, 2. N-Me II HP: Vertical, 1. N-Pog ⊥HP, 2. N-Me ⊥HP.

Hard tissue measurements used in the study (Figure 1)
Linear measurements
Horizontal:
- N-Pog II HP: It is the linear distance measured between Pogonion and a line drawn perpendicular to the surrogate Frankfort plane from Nasion parallel to the surrogate Frankfort plane.
- N-Me II HP: It is the linear distance measured between Menton and a line drawn perpendicular to the surrogate Frankfort plane from Nasion parallel to the surrogate Frankfort plane.

Vertical:
- N-Pog ⊥ HP: It is the linear distance measured between Pogonion and the surrogate Frankfort plane perpendicular to the surrogate Frankfort plane.
- N-Me ⊥ HP: It is the linear distance measured between Menton and the surrogate Frankfort plane perpendicular to the surrogate Frankfort plane.

Soft tissue measurements used in the study (Figure 2)
Linear measurements
Horizontal:
- N-Pog' II HP: It is the linear distance measured between soft tissue Pogonion and a line drawn perpendicular to the surrogate Frankfort plane from Nasion parallel to the surrogate Frankfort plane.
- N-Me' II HP: It is the linear distance measured between soft tissue Menton and a line drawn perpendicular to the surrogate Frankfort plane from Nasion parallel to the surrogate Frankfort plane.
- N-Si II HP: It is the linear distance measured between Si point and a line drawn perpendicular to the surrogate Frankfort plane from Nasion parallel to the surrogate Frankfort plane.

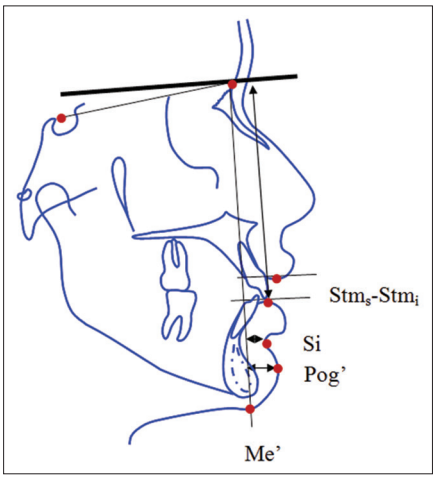


Figure 2: Linear parameters for soft tissue evaluation. Horizontal: 1. N-Pog'II HP, 2. N-Me' II HP, 3. N-Si II HP, 4. N-Stm_i II HP: Vertical 1. N-Pog' ⊥HP, 2. N-Me'⊥HP, 3. N-Si ⊥HP, 4. N-Stm_i ⊥HP, 5. Stm_s-Stm_i ⊥HP.

- N-Stm$_i$ II HP: It is the linear distance measured between Stm$_i$ point and a line drawn perpendicular to the surrogate Frankfort plane from Nasion parallel to the surrogate Frankfort plane.

Vertical:

- N-Pog' ⊥HP: It is the linear distance measured between soft tissue Pogonion and the surrogate Frankfort plane perpendicular to the surrogate Frankfort plane.
- N-Me' ⊥HP: It is the linear distance measured between soft tissue Menton and the surrogate Frankfort plane perpendicular to the surrogate Frankfort plane.
- N-Si ⊥ HP: It is the linear distance measured between Si and the surrogate Frankfort plane perpendicular to the surrogate Frankfort plane.
- N-Stm$_i$ ⊥ HP: It is the linear distance measured between Stmi and the surrogate Frankfort plane perpendicular to the surrogate Frankfort plane.
- Stm$_s$-Stm$_i$ ⊥ HP: It is the linear distance measured between Stms-Stmi perpendicular to the surrogate Frankfort plane.

Among the various cephalometric analysis for estimating the amount of hard and soft tissue changes, the LEGAN BURSTONE analysis was used.

Methodology

The presurgical, post-surgical and long term post-surgical values of the various parameters were compared to evaluate the changes that have occurred during and after genioplasty.

Statistical analysis

A paired *t*-test was used to analyze the paired observations i.e. difference from one time to another time of assessment.

Results

Hard tissue changes (Table 1)

Linear parameters

Horizontal changes:

- N-Pog II HP: The mean pre surgical value was – 13.1 mm (±8.5). It increased to – 6.9 mm (±8.9) post-surgically which was statistically significant. After long term observation, it was found to be reduced to – 8.4 mm (±9) which was statistically significant (Graph 1).
- N-Me II HP: The mean pre surgical value was – 20.1 mm (±8.2). It increased to – 14.7 mm (±8.6) post-surgically which was statistically significant. After long term observation, it was found to be reduced to – 14.8 mm (±8.5) which was statistically insignificant (Graph 2).

Vertical changes:

- N-Pog ⊥HP: The mean pre surgical value was 111.6 mm (±7). It decreased to 109.5 mm (±6.7) post-surgically which was statistically significant. After long term observation, it was found to be increased to 110.7 mm (±7.0) which was statistically significant (Graph 3).
- N-Me ⊥ HP: The mean pre surgical value was 119.5 mm (±7.2). It decreased to 117.9 mm (±6.9) post-surgically, which was statistically significant.

Table 1: Hard tissue parameters.

Linear parameters hard tissue	Pre-surgery (T1)	Post-surgery (T2)	Pre-post (T1-T2)	Long term (T3)	Pre-long term (T1-T3)	Post-long term (T2-T3)
Horizontal						
N-Pog II HP (mm)						
Mean	–13.1	–6.9	–6.2	–8.4	–4.7	1.5
SD	8.5	8.9	1.3	9.0	1.2	0.5
t value			–19.0		–14.6	11.5
P value			<0.001		<0.001	<0.001
N-Me II HP (mm)						
Mean	–20.1	–14.7	–5.4	–14.8	–5.3	0.1
SD	8.2	8.6	1.2	8.5	1.2	0.4
t value			–17.68		–16.68	1.47
P value			<0.001		<0.001	NS
Vertical						
N-Pog ⊥ og g (mm)						
Mean	111.6	109.5	2.1	110.7	0.9	–1.1
SD	7.0	6.7	1.5	7.0	1.2	0.6
t value			5.22		3.11	–6.86
P value			<0.001		<0.01	<0.001
N-Me ⊥ -Me ealH						
Mean	119.5	117.9	1.6	118.0	1.5	–0.1
SD	7.2	6.9	1.4	6.8	1.5	0.3
t value			4.41		3.94	–1.00
P value			<0.001		<0.01	NS

After long term observation, it was found to be increased to 118.0 mm (±6.8) which was statistically insignificant (Graph 4).

Soft tissue changes (Table 2)

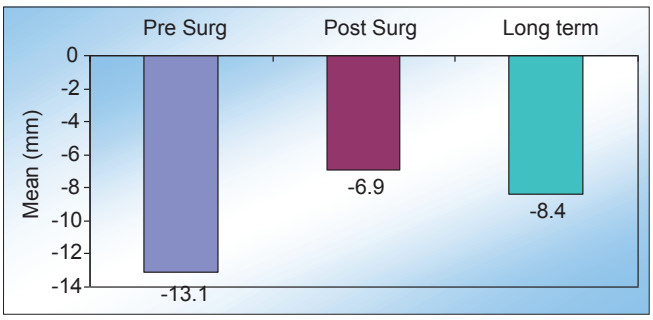
Linear parameters

Horizontal changes:

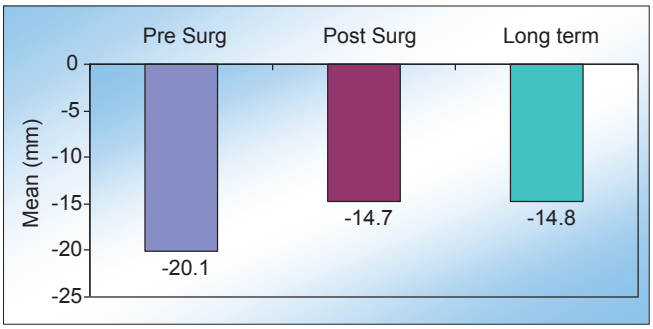
- N-Pog'II HP: The mean pre surgical value was – 1.1 mm (±9.2). It was increased to 3.7 mm (±9.4) post-surgically which was statistically significant. After long term observation, it was found to be decreased to 2.7 mm (±9.5) which was statistically significant (Graph 5).
- N-Me'II HP: The mean pre surgical value was – 20.6 mm (±8.7). It increased to – 17.0 mm (±8.9) post-surgically which was statistically significant. After long term observation, it was found to be increased to – 16.9 mm (±8.9) which was statistically insignificant (Graph 6).
- N-Si II HP: The mean pre surgical value was 0.2 mm (±8.5). It increased to 0.9 mm (±8.3) post-surgically, which was

Table 2: Soft tissue parameters.

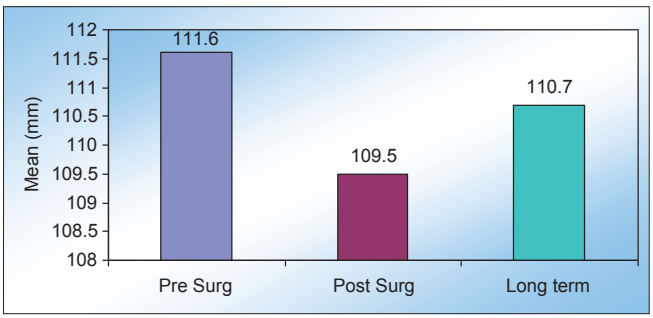
Linear parameters soft tissue	Pre-surgery (T1)	Post-surgery (T2)	Pre-post (T1-T2)	Long term (T3)	Pre-long term (T1-T3)	Post-long term (T2-T3)
Horizontal						
N-Pog' II HP (mm)						
Mean	–1.1	3.7	–4.8	2.7	–3.8	1.0
SD	9.2	9.4	1.1	9.5	1.1	0.4
t value			–16.22		–12.84	10.25
P value			<0.001		<0.001	<0.001
N-Me' II HP (mm)						
Mean	–20.6	–17.0	–3.6	–16.9	–3.7	–0.1
SD	8.7	8.9	1.0	8.9	1.0	0.3
t value			–14.15		–14.55	–1.00
P value			<0.001		<0.001	NS
N-Si II HP (mm)						
Mean	0.2	0.9	–0.6	0.7	–0.4	0.2
SD	8.5	8.3	0.6	8.4	0.6	0.4
t value			–4.01		–2.69	1.87
P value			<0.001		<0.05	NS
N-Stmi II HP (mm)						
Mean	6.4	6.0	0.4	5.9	0.4	0.1
SD	6.9	6.8	0.6	6.9	0.5	0.3
t value			2.32		3.39	1.00
P value			<0.05		<0.01	NS
Vertical						
N-Pog' ⊥ HP (mm)						
Mean	110.6	109.9	0.6	109.9	0.6	0.00
SD	7.2	7.1	0.5	7.1	0.5	0.00
t value			4.46		4.46	1.00
P value			<0.001		<0.001	NS
N-Me'⊥ HP (mm)						
Mean	125.2	124.9	0.3	124.9	0.3	0.00
SD	6.4	6.1	0.5	6.1	0.5	0.00
t value			2.26		2.26	1.00
P value						NS
N-Si ⊥ HP (mm)						
Mean	98.7	98.3	0.4	98.3	0.4	0.0
SD	6.3	6.1	0.6	6.2	0.5	0.4
t value			2.45		3.06	0.00
P value			<0.05		<0.05	NS
N-Stmi ⊥ HP (mm)						
Mean	82.7	81.7	1.1	81.7	1.1	0.0
SD	5.5	5.5	0.7	5.5	0.7	0.0
t value			5.87		5.87	1.00
P value			<0.001		<0.001	NS
Stms – Stmi ⊥ HP (mm)						
Mean	4.3	1.5	2.7	1.5	2.7	0.0
SD	2.5	1.4	1.7	1.4	1.7	0.0
t value			6.19		6.19	1.00
P value			<0.001		<0.001	NS



Graph 1: N-Pog II HP (mm).



Graph 2: N-Me II HP (mm).



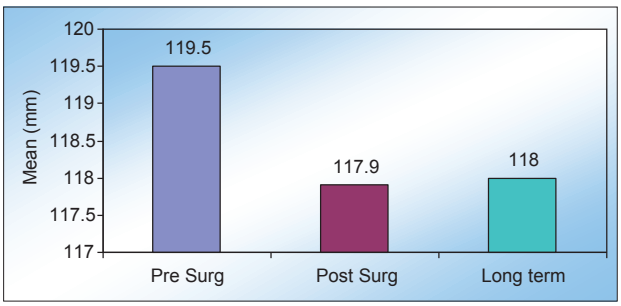
Graph 3: N-Pog' ⊥ HP (mm)

statistically significant. After long term observation, it was found to be decreased to 0.7 mm (±8.4) which was statistically insignificant.

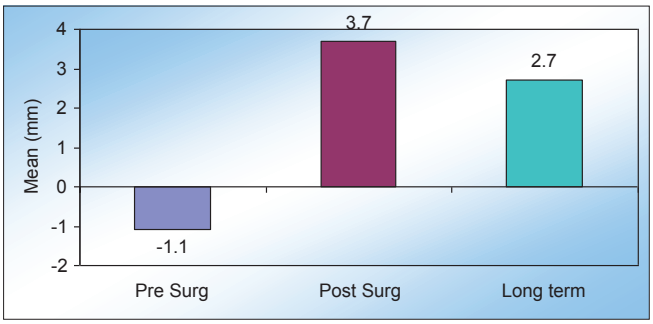
- N-Stmi II HP: The mean pre surgical value was 6.4 mm (±6.9). It decreased to 6.0 mm (±6.8) post-surgically which was statistically significant. After long term observation, it was found to be decreased to 5.9 mm (±6.9) which was statistically insignificant.

Vertical changes:

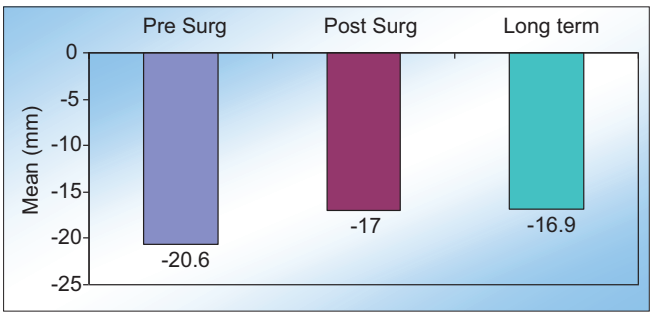
- N-Pog' ⊥HP: The mean pre surgical value was 110.6 mm (±7.2). It decreased to 109.9 mm (±7.1) post-surgically which was statistically significant. After long term observation, there was no change.
- N-Me' ⊥HP: The mean pre surgical value was 125.2 mm (±6.4). It decreased to 124.9 mm (±6.1) post-surgically which was statistically insignificant. After long term observation, there was no change.
- N-Si⊥HP: The mean pre surgical value was 98.7 mm (±6.3).



Graph 4: N-Me ⊥N-Me 4:m.



Graph 5: N-Pog' II HP (mm).



Graph 6: N-Me' II HP (mm).

It decreased to 98.3 mm (±6.1) post-surgically which was statistically significant. After long term observation, there was no change.

- N-Stmi ⊥ HP: The mean pre surgical value was 82.7 mm (±5.5). It decreased to 81.7 mm (±5.5) post-surgically which was statistically significant. After long term observation, there was no change.
- Stms-Stmi ⊥ HP: The mean pre surgical value was 4.3 mm (±2.5). It decreased to 1.5 mm (±1.4) post-surgically which was statistically significant. After long term observation, there was no change.

Discussion

To assess the changes produced by the genioplasty procedure several investigators used cranial base superimpositions. Dann and Epker used the mandibular plane to determine the changes due to genioplasty.[5] Hohl and Epker used mandibular superimpositions for their reduction genioplasty study.[6]

In the present study, the surrogate Frankfurt Horizontal plane of Burstone analysis was used as a reference plane based

on which all the measurements were done.[7] This reference plane was chosen as it does not alter by any surgery. In the present study to assess the changes that occur during and after genioplasty, cases that had undergone only genioplasty with no concomitant surgeries were chosen.

Bell and Dann observed that nonpedicled genioplasties had more significant resorption than pedicled genioplasties in their follow-up studies.[8] Edward showed experimentally that pedicled genial segments underwent significantly less resorption than free genial segments.[9] It is therefore recommended to maintain as much soft tissue attachment to the genial segment as possible. In the present study, cases that underwent genioplasty had minimum reflection of soft tissues labially, sufficient enough to provide access for placement of the cuts and had intact lingual soft tissues.

Since the configuration of the facial soft tissues can be altered by changing the architecture and position of the underlying hard tissues, it is essential to have predictive criteria for changes from hard to soft tissues not only after surgery but also during progressive periods after surgery.

Optimal treatment planning requires an understanding of the soft tissue response to advancement genioplasty. Information concerning the stability of such procedure and the relationship between osseous change and the net soft tissue change would be of predictive value.

Previous studies done on soft tissue changes after genioplasty found that the ratio of hard to soft tissue changes varied from 1:0.6 to 1:1.[10] In the present study, the ratio of hard to soft tissue changes in the sagittal plane is 1: 0.77.

The mean advancement found at hard tissue Pogonion during genioplasty was 6.2 mm. After long term follow-up period, it was found to be only 4.7 mm which indicates a relapse accounting for 24% of the surgical advancement. This finding is in accordance with the study done by Polido *et al.*[11] This relapse occurs because of remodeling changes occurring at the surgical site.

The mean superior movement found at hard tissue pogonion following genioplasty was 2.1 mm. After long term follow-up period, it moved down by 1.2 mm due to remodeling changes at the surgical site. This finding is in accordance with the study done by McDonnell, McNeill and West. The reason for this is that following genioplasty, the point designated as immediate post-surgical Pogonion turns out to be located at the interface between the surgical section and the anterior border of the symphysis. This leading edge is highly susceptible to resorption, more than likely because of the proximity of the overlying periosteum after closure of the wound.[12]

The mean advancement at the hard tissue menton was 5.4 mm following surgery. After long term follow-up period there was no significant change. The mean superior movement found at hard tissue menton following surgery was 1.6 mm. After a long term follow-up period there was no significant change in it. These findings are in accordance with the study done by DeFreitas *et al.*[13]

In the present study, the vertical position of the soft tissue did not correlate with the vertical osseous changes. This finding is in accordance with the study done by Park *et al.*[10]

The mean advancement found at soft tissue Pogonion following genioplasty was 4.8 mm. After long term follow-up period, it was found to be only 3.8 mm indicating the soft tissue pogonion moved back by 1mm indicating the relapse. So for long term prediction purpose the ratio of hard to soft tissue movement of 1:0.61 can be used.

The mean advancement found at mentolabial sulcus point following surgery was only 0.6 mm and after long term follow-up period there was no significant change at the mentolabial sulcus point. Study done by Davis, Davis and Daly found insignificant changes of mentolabial sulcus depth in their study.[14] Gallagher *et al.* also found insignificant changes of mentolabial sulcus depth in their study.[15]

The mean advancement found at stomion inferior point following surgery was 0.4 mm and after long term follow-up period there was no significant change.

The mean superior movement found at the stomion inferior following genioplasty was 1.1 mm and after long term follow up period there was no significant change.

The interlabial gap (Stms-Stmi) decreased by 2.7 mm following genioplasty. This occurs as the lower lip moves upward and forward along with the genial segment improving competency. After long term follow-up period, there was no significant change indicating stability.

Conclusion

With the present study, it can be concluded that vertical reduction and advancement genioplasty can be considered as an adjunctive procedure that produces predictable results and the bony and soft tissue stability were generally very good.

For long term prediction purpose a ratio of the ratio of hard to soft tissue movement of 1: 0.61 can be used.

Genioplasty can be a valuable adjunctive procedure in a borderline extraction case with a good nasolabial angle, protruding lower incisors and a deficient chin. A better esthetic result from non-extraction orthodontic treatment followed by

genioplasty can be achieved than from a treatment regimen involving extraction.

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