Original article

Comparison of the changes in facial profile after functional orthopedic and surgical orthodontic treatment – A cephalometric Study.

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Abstract: This study is an appraisal of benefits and perils of growth modification versus the surgical line of treatment. The present study was aimed at to study the facial profile changes following functional orthopedic and surgical orthodontic treatment and to determine the effects and efficacy of functional orthopedic versus surgical — orthodontic treatment of skeletal Class II malocclusion in non-growing patients and growing patients. The present study consists of 20 patients, 10 patients were treated using functional appliance for jumping the bite. The class II correction with functional mandibular bite jumping procedure and surgical mandibular advancement procedure occurs almost equally. Though there are some differences between the groups, it was not statistically significant.

Keywords: skeletal, mandibular, bite

Introduction: The application of combined surgical — orthodontic procedures to major dento-facial deformities and associated malocclusions is becoming increasingly prevalent. With severe dento-facial deformities, surgery improves the potential for achieving a satisfactory functional occlusion.

This study is an appraisal of benefits and perils of growth modification versus the surgical line of treatment.

Aims and Objectives: The present study was aimed at:

1. To study the facial profile changes following functional orthopedic and surgical orthodontic treatment.
2. To determine the effects and efficacy of functional orthopedic versus surgical — orthodontic treatment of skeletal Class II malocclusion in non-growing patients and growing patients.

Materials and Methods:

DATA COLLECTION: Pre treatment and post treatment lateral cephalogram of 10 growing patients and 10 non-growing patients who had been treated successfully in the Department of Orthodontics and Dentofacial Orthopedics, Bapuji Dental College and Hospital, Davangere were obtained. The age group of these patients ranged from 10 to 14 yrs for growing patients, with a mean age of 2 years and 18 to 24 years for non-growing patients, with a mean age of 21 years. Growing patients were treated by means of functional appliance like activator and twin block and non-growing patients treated by means of Bilateral Sagittal Split osteotomy for mandibular advancement procedure was carried out.

CRITERIA FOR SELECTION OF PATIENTS:

FUNCTIONAL APPLIANCE
1. Patient was a young growing individual in the peak growth spur
2. Patient had a dentition supporting lips
3. Patient demonstrated a severe class II skeletal malocclusion with an ANB of 6 to 10° and retrognathic mandible for which bite jumping appliance was necessary.

SURGICAL MANDIBULAR ADVANCEMENT
1. Patient was a non-growing adult.
2. Patient had a full complement of permanent dentition supporting lips.
3. Patient demonstrated a severe class II skeletal malocclusion with an ANB of 6 to 10° and retrognathic mandible for which surgical intervention was necessary.
4. Only mandibular advancement procedure by bilateral sagittal split technique was performed. Patient had required mandibular advancement with genioplasty are avoided in the study.

The technique employed in taking the cephalograms was as follows:
• All the radiographs of each subject were taken using the same machine.
• Each cephalograms was taken with the patients teeth in habitual occlusion and lips at rest position.

ANALYSIS OF LATERAL CEPHALOGRAMS:
Profile cephalograms were taken in occlusion under standardized conditions with a cephalostat. Among various analysis for estimating the amount of hard and soft tissue changes, the Legan & Burstone, Steiner, McNamara and Ricketts analysis were employed in this study. This analysis includes certain angular and linear measurements for both hard and soft tissues, which were easily applicable for the study.

ANGULAR PARAMETERS FOR HARD TISSUE EVALUATION:
1. SNA-Angle: It is the angle formed by the line drawn from sella-nasion to point-A. It relates antero-posterior position of maxilla to the cranial base.
2. SNB-Angle: It is the angle formed by the line drawn from sella-nasion to point-B. It relates antero-posterior position of mandible to the cranial base.
3. N-A-Pg-Angle (Angle of facial convexity): It is the angle formed by the N-A and a line from A to pogonion. It gives an indication of overall facial convexity.
4. MP-HP Angle: Angle formed between a line from gonion to gnathion and HP as its intersects gnathion. It indicates the divergence of the mandible.
5. Ar-Go-Gn Angle: A line drawn from articular to gonion and from gonion to gnathion makes up this angle. It represents the relationship between the ramal plane and mandibular plane.

LINEAR PARAMETERS FOR HARD TISSUE EVALUATION:
6. N-B (11HP): A perpendicular line from HP is dropped through nasion. The N-B line is measured in a plane parallel to HP from the perpendicular line dropped from N. This measurement describes the horizontal position of apical base of the mandible in relation to N. Therefore, a quantitative assessment of the antero-posterior position of the mandible and the degree of mandibular horizontal dysplasia can be evaluated.
7. N-Pg (11HP): similar measurements are made like those of N-A and N-B points. It indicates the prominence of the chin.
8. VERTICAL SKELETAL: Perpendicular line is drawn from HP and the measurement ANS to GN is evaluated. It indicates the lower third facial height, which may be helpful in evaluating the facial height pre-surgically and post-surgically.
9. MANDIBULAR MEASUREMENTS. Two measurements particularly relate to the mandible, a line from articulare to gonion establishes the length of the mandibular ramus and a line from gonion to pogonion establishes the length of the mandibular body.
10. N┴ to Pog: It is the linear distance measured from nasion perpendicular topogonion. Evaluates the relationship of the mandible to cranial base.
ANGULAR PARAMETERS FOR SOFT TISSUE EVALUATION:

11. G-Sn-Pg' (Angle of Facial Convexity): Angle formed by the line joined from subnasale to soft tissue pogonion, indicates a class II (or) Class III skeletal patterns.

12. Sn-Gn-C (Lower face throat angle): Formed by intersection of lines Sn-Gn and Gn-C. A critical angle which evaluates the treatment planning to correct the antero-posterior facial dysplasias. Based on these linear and angular parameters the surgical prediction is analysed to estimate the accuracy with that of the post-surgical results.


LINEAR PARAMETERS FOR SOFT -TISSUE EVALUATION:

14. G-Pg': It is measured by drawing a line perpendicular to glabella and parallel to HP and gives an indication of mandibular prognathism (or) retrognathism.

15. G-Sn and Sn-Me (HP): The ratio of middle third facial height to lower third facial height is measured perpendicular to HP. Ratio should be approximately 1:1.

16. Sn-Gn and C-Gn: Ratio of distances from subnasale to gnathion and cervical point to gnathion is measured. Ratio is little larger than 1. It explains the relation of the neck to the projection of the chin.

17. Li to (Sn to Pg'): A line is drawn from subnasale to soft tissue pogonion and measured perpendicular to the most prominent point of the lower lip. It indicates the lip position in antero-posterior direction.

18. Si to (Li-Pg'): The labio-mental sulcus is measured from the depth of the sulcus perpendicular to Li-Pg line, evaluates whether the sulcus is deep (or) shallow.

19. E-line: A line drawn from tip of the nose to the soft tissue pogonion, evaluates the position of upper lip and lower lip.

20. Pg-Pg': Measurement obtained from a line drawn from hard tissue pogonion to soft tissue pogonion, evaluates the thickness of the soft tissue chin.

Results: The present study consists of 20 patients, 10 patients were treated using functional appliance for jumping the bite. The magnitude of bite jumping was 5 to 10mm with mean of 8mm. The age of patients in functional group ranged from 10 - 14 yrs with a mean age of 12 yrs. Remaining 10 patients were treated by means of Orthognathic Surgical procedure. Surgical technique performed was bilateral sagittal split osteotomy for mandibular advancement with rigid internal fixation by screws. Age group of surgical patient ranged from 18 to 24 yrs with a mean age of 21 yrs. Lateral cephalograms prior to treatment and after treatment were taken in habitual occlusion with lips at rest position for both the groups. Cephalometric Analysis was carried out for functional and surgical orthodontic group. To compare the groups Mann - Whitney test was used. A p-value of < 0.05 was considered to be statistically significant, p-value < 0.001 highly significant and p-value > 0.05 to be non significant statistically.

HARD - TISSUE ANALYSIS:

SNA Angle: The mean functional pre treatment value was 81.3° ± 2.3° and mean post treatment
value was $82.2^\circ$ ($\pm 2.1^\circ$), with a mean difference of $-0.9^\circ$ ($\pm 0.9^\circ$). Surgical -orthodontic mean pre treatment value was $83.3^\circ$ ($\pm 3.2^\circ$) and mean post treatment value was $83.3^\circ$ ($\pm 2.9^\circ$), with a mean difference of $0.0^\circ$ ($\pm 0.5^\circ$). When the post treatment values were compared between the groups, it was found that functional group had a statistically significant value when compare to surgical group (p < 0.02).

**SNB Angle:** The mean pre treatment value of functional appliance was $77.0^\circ$ ($\pm 2.3^\circ$), with mean post treatment value of $79.8^\circ$ ($\pm 2.1^\circ$) with a mean difference of $-2.8^\circ$ ($\pm 0.8^\circ$). The mean surgical pre treatment value was $78.5^\circ$ ($\pm 2.5^\circ$), with mean post treatment value of $81.6^\circ$ ($\pm 2.4^\circ$) with a mean difference of $-3.1^\circ$ ($\pm 0.9^\circ$), which was found to be statistically non significant, though it is clinically significant.

**N-A-Pg Angle:** The mean surgical pre treatment value was $4.9^\circ$ ($\pm 1.7^\circ$), with a mean post treatment value of $2.6^\circ$ ($\pm 1.2^\circ$), with a mean difference of $2.4^\circ$ ($\pm 0.8^\circ$) and the mean functional appliance pre treatment value was $7.9^\circ$ ($\pm 2.9^\circ$), with a mean post treatment value of $5.5^\circ$ ($\pm 2.5^\circ$), with a mean difference of $2.4^\circ$ ($\pm 1.3^\circ$), which was found to be statistically non significant.

**MP-HP Angle:** Surgical mean pre treatment value was $23.6^\circ$ ($\pm 3.9^\circ$), with a mean post treatment value of $26.1^\circ$ ($\pm 3.7^\circ$), with a mean difference of $2.5^\circ$ ($\pm 1.2^\circ$) and the mean functional group shows $22.6^\circ$ ($\pm 2.5^\circ$), with a mean post treatment value of $24.4^\circ$ ($\pm 3.0^\circ$) shows a mean difference of $1.8^\circ$ ($\pm 0.6^\circ$) which was found to be statistically non significant.

**Ar-Go-Gn Angle:** The mean pre treatment value of surgical treatment was $120.9^\circ$ ($\pm 8.5^\circ$), with a mean post treatment value of $124.6^\circ$ ($\pm 7.5^\circ$) with a mean difference of $-3.7^\circ$ ($\pm 1.6^\circ$). In the functional appliance group mean pre treatment value was $122.5^\circ$ ($\pm 5.7^\circ$), and mean post treatment value was $124.5^\circ$ ($\pm 6.0^\circ$), with a mean difference of $-2.0^\circ$ ($\pm 0.9^\circ$). When the post treatment values were compared between the groups it showed a statistically significant increased values for surgical group. (p< 0.02)

**N-B(∥)HP:** The mean functional pre treatment value was $-10.6$ ($\pm 2.3$) and mean post treatment value was $-6.8$ ($\pm 2.3$), with a mean difference of $-3.8$ ($\pm 1.1$). Surgical -orthodontic mean pre treatment value was $-7.7$ ($\pm 3.6$) and mean post treatment value was $-3.1$ ($\pm 4.1$), with a mean difference of $-4.6$ ($\pm 1.6$) which was found to be statistically non significance.

**N-Pg(∥)HP:** The mean functional pre treatment value was $-8.0$ ($\pm 3.2$) and mean post treatment value was $-5.2$ ($\pm 2.9$), with a mean difference of $-2.8$ ($\pm 0.9$). Surgical -orthodontic mean pre treatment value was $-6.1$ ($\pm 3.0$) and mean post treatment value was $-2.1$ ($\pm 2.6$), with a mean difference of $-4.0$ ($\pm 3.6$) which was found to be statistically non significance.

**ANS-Gn (⊥ HP) (Vertical Skeletal):** The mean functional pre treatment value was $57.2$ ($\pm 4.7$) and mean post treatment value was $60.6$ ($\pm 4.4$), with a mean difference of $-3.6$ ($\pm 1.1$). Surgical -orthodontic mean pre treatment value was $61.3$ ($\pm 4.1$) and mean post treatment value was $65.7$ ($\pm 3.7$), with a mean difference of $-4.4$ ($\pm 1.4$). Comparing the post treatment value of functional appliance and surgical treatment was found to be statistically insignificant.

**Mandibular Measurement:** The mean functional pre treatment value was $0.62$ ($\pm 0.07$) and mean post treatment value was $0.60$ ($\pm 0.06$), with a mean difference of $0.02$ ($\pm 0.01$). Surgical -orthodontic pre treatment value was $0.62$ ($\pm 0.10$) and mean post treatment value was $0.60$ ($\pm 0.11$), with a mean difference of $0.02$ ($\pm 0.03$). Comparing the post treatment value of functional appliance and surgical treatment was found to be statistically insignificant.
**N┴ Pog** :- The mean functional pre treatment value was -7.1 (±1.9) and mean post treatment value was -4.3 (± 1.3), with a mean difference of -2.8 (± 0.9). Surgical-orthodontic mean pre treatment value was -7.9 (± 4.3) and mean post treatment value was -3.7 (± 3.9), with a mean difference of -1.9(± 4.0) which was found to be statistically non significance.

**SOFT TISSUE ANALYSIS : G-Sn-Pg’ Angle**:- The mean functional pre treatment value was 18.7 (±4.7) and mean post treatment value was 15.6 (±4.6), with a mean difference of 3.1 (± 1.5). Surgical-orthodontic mean pre treatment value was 18.0 (± 4.7) and mean post treatment value was 13.7 (± 4.7), with a mean difference of 4.3(±1.2) which was found to be statistical and clinical significance.( p < 0.05)

**Sn-Gn-C Angle**:- The mean functional pre treatment value was 108.2 (±9.6) and mean post treatment value was 105.7 (± 9.6), with a mean difference of 2.5 (± 2.0). Surgical-orthodontic mean pre treatment value was 110.6 (±13.6) and mean post treatment value was 106.0 (± 11.1), with a mean difference of 4.6(±2.5) which was found to be statistically non significance.

**Cm-Sn-Ls Angle**:- The mean functional pre treatment value was 104.3 (±12.5) and mean post treatment value was 105.7 (± 11.5), with a mean difference of 1.4 (± 2.9). Surgical-orthodontic mean pre treatment value was 100.6 (± 12.2) and mean post treatment value was 98.7 (±11.5), with a mean difference of 1.9(±4.8) which was found to be statistically non significance.

**G-Pg’ (HP)**:- The mean functional pre treatment value was -7.3 (±2.9) and mean post treatment value was -4.5 (± 2.5), with a mean difference of -2.8 (± 1.2). Surgical-orthodontic mean pre treatment value was -4.6 (± 1.3) and mean post treatment value was -2.6 (± 1.4), with a mean difference of -2.0(± 0.8) which was found to be statistically non significance.

**G-Sn & Sn-Me(HP)**:- The mean functional pre treatment value was 1.10 (±0.07) and mean post treatment value was 1.02 (± 0.04), with a mean difference of 0.08 (± 0.05). Surgical-orthodontic mean pre treatment value was 1.08 (± 0.06) and mean post treatment value was 1.05 (± 0.05), with a mean difference of 0.03 (± 0.06) which was found to be statistically non significance.

**Sn-Gn & C-Gn**:- The mean functional pre treatment value was 1.29 (±0.23) and mean post treatment value was 1.29 (± 0.26), with a mean difference of 0.00 (± 0.11). Surgical-orthodontic mean pre treatment value was 1.27 (± 0.14) and mean post treatment value was 1.24 (± 0.15), with a mean difference of 0.03 (± 0.05) which was found to be statistically non significance.

**Li-(Sn-Pg’)**:- The mean functional pre treatment value was 5.5 (±1.0) and mean post treatment value was 3.3 (± 0.9), with a mean difference of 2.2 (± 0.08). Surgical-orthodontic mean pre treatment value was 4.6 (± 1.6) and mean post treatment value was 2.5 (± 1.4), with a mean difference of 2.2 (± 1.1) which was found to be statistically non significance.

**Si-(Li-Pg’)**:- The mean functional pre treatment value was 5.5 (±1.5) and mean post treatment value was 3.9 (± 1.5), with a mean difference of 1.6 (± 0.7). Surgical-orthodontic mean pre treatment value was 6.3 (± 1.8) and mean post treatment value was 4.0 (± 1.2), with a mean difference of 2.3 (± 0.9) which was found to be statistically non significance.

**E-Line**:- The mean functional pre treatment value was -0.78 (±0.9) and mean post treatment value was -0.84 (± 0.67), with a mean difference of 0.06 (± 1.25). Surgical-orthodontic mean pre treatment value was -1.49 (± 1.37) and mean post treatment value was -1.31 (± 0.72), with a mean difference of -
0.18 (± 1.3) which was found to be statistically non significance.

Pg-Pg': The mean functional pre treatment value was 11.5 (±1.27) and mean post treatment value was 11.8 (± 1.69), with a mean difference of -0.30 (± 0.48). Surgical-orthodontic mean pre treatment value was 11.30 (± 1.06) and mean post treatment value was 11.60 (± 0.97), with a mean difference of -0.30 (± 0.95) which was found to be statistically non significance.

MANN - WHITNEY TEST Statistical analysis: Interval data are expressed as Mean ± SD. Since the data were found to be moderately skewed, a non parametric method, Mann - Whitney test was used to compare the post treatment changes between two groups. A "p" value of less than 0.05 was considered for statistical significance.

Discussion: The goal of early orthodontic treatment is to correct existing or developing skeletal, dento-alveolar and muscular imbalances to improve the maxillo-mandibular relationship before growth ceases. By initiating functional therapy in well selected growing individuals, the aim of getting a straight profile will be fulfilled which will minimize orthodontic treatment at a later date. Progressive improvements in surgical and orthodontic procedures over the last few years have brought significant gains in the quality and stability of combined surgical-orthodontic corrections. Continued experience with these procedures has brought increasing benefits from a team approach, resulting in finer end results.

The Correlation of sagittal jaw relationship can be achieved in several ways. The decision as to which technique is the most effective has long been a topic of considerable debate within the orthodontic literature. (Aelbers and Dermaut6, 7, Barton and Cook8 and Woodside8)

Functional appliances developed primarily in Europe have been used by many clinicians in an effort to stimulate mandibular growth. (Pancherz10, Frankel11)

In the present study the SNB angle showed variance between the functional mandibular bite jumping and surgical mandibular advancement. This can be attributed to the convenience of surgical procedure where we can advance the mandible to a larger extent. David Quast12 conducted a study on Bilateral sagittal split osteotomy with mandibular advancement procedure. They concluded that a significant increase in SNB angle were obtained at the end of surgical line of treatment. In the present study a significant increase in SNB angle following surgical line of treatment was found in accordance with the above mentioned study. In spite of changes in the antero-posterior direction of the mandible, in both surgical and functional line of treatment, the N-A-Pg angle remained unchanged.

The mandibular plane angle and the gonial angle showed statistical and clinical increase with the surgical procedure than with the functional orthodontic procedure. The main reason for this increase was the inferior movement of gnathion producing clockwise rotation of the distal segment. A more plausible explanation for the increase in mandibular plane angle and gonial angle is the continued antero-superior rotation of the proximal segment and continued resorption of the gonial angle, thereby altering both the angles post surgically. The above findings were in agreement with studies conducted by Singer and Bays13, McNamara and Carlson14 and Edward Ellis15.

A significant increase in the pre and post treatment SNA value was seen, in the functional appliance group. These findings are in contrast with studies conducted by Mills and McCulloch16 who stated that functional appliances will have a restraining effect on maxilla. However growth may have
attributed to the change in the SNA value in our study.

A significant correlation has been found between the N-B (I I HP) functional value and surgical value, since surgical lengthening of the mandible in few samples were primarily achieved by anterio-inferior advancement of the distal mandibular segment in order to open the bite surgically. This might have resulted in an anterior positioning of point-B and inferior positioning of pogonion, with an increase in anterior facial height. These findings were in confirmative with the previous studies by I ve and McNeill\textsuperscript{17}, White, Proffit & Kohn\textsuperscript{18}.

Reduction in the G-Sn-Pg value was found in both the groups. Comparing the surgical and functional group, there was a significant reduction in G-Sn-Pg value with the surgical group. This study showed that, there was a good co-relation in the angle of facial convexity with both functional and surgical line of treatment. No significant changes were found in the upper lip position and naso labial angle. These above findings were in accordance with previous studies of Mobarak, et al\textsuperscript{19}, Merkz and Van damme\textsuperscript{20}.

Results obtained in the study showed good correlation between the functional and surgical line of treatment soft tissue changes. Several authors, Cut Birth and Van Sickels\textsuperscript{21} commented on the high variability in lower lip position after mandibular advancement surgery. In this study the lower lip demonstrated a reduction in thickness, as well as lengthening and straightening with an accompanying decrease in mento labial fold as per the pre treatment and post- treatment outcome. In the studies carried out by, Quast, et al\textsuperscript{12}, and Mommaerts and Marxer\textsuperscript{22}, the horizontal change of the labrale inferius and mento labial fold was not significant, as was found in this study.

No variation existed in relation to chin thickness (Pg-Pg') between the functional and surgical values. This states that hard tissue pogonion move in 1:1 ratio with soft tissue pogonion, in correlation to studies of Mommaerts and Marxer\textsuperscript{22}.

**Summery and conclusion:** The purpose of this study was to assess quantitatively the amount and interrelationship between hard and soft tissue changes between the Functional mandibular bite jumping and surgical mandibular advancement. Lateral cephalograms prior to treatment and after treatment were taken in habitual occlusion with lips at rest position. Various hard and soft tissue angular and linear parameters from Legan-Burstone, Mc Namara, Steiner’s and Rickett’s analysis were employed in this study to compare the profile changes between the two groups.

The summery of this study is as follows:

- Surgical mandibular advancement showed variance in SNB angle when compared with the functional mandibular bite jumping, which may be attributed to the convenience of the surgical procedure where in we can advance the mandible to a larger extent.
- The mandibular plane angle and gonial angle increased statistically and clinically with the surgical procedure than when compared to functional orthodontic procedure.
- A significant reduction was in the pre and post treatment SNA value, in the functional appliance group. In case of surgical procedure there was no change seen since, the surgical mandibular advancement procedure involves only the mandible. In case of functional mandibular advancement procedure there was some restraining effect on the maxilla.
- Reduction in G-Sn-Pg value was found in both the groups. When compared between the groups, surgical group showed a significant reduction in G-Sn-Pg value.
From the analysis and discussion of the results, the following conclusions drawn from this study:

- The class II correction with functional mandibular bite jumping procedure and surgical mandibular advancement procedure occurs almost equally. Though there are some differences between the groups, it was not statistically significant.
- In terms of choosing a treatment modality between the two groups, diagnosis plays a key role.

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