Iranian Journal of Orthodontics
Summer 2006

# Hard tissue response to anterior tooth retraction

**Tahereh Hosseinzadeh Nik [a], Shahin Nourozi [b], Seyed Mehdi Hosseinizade [b]**

**Abstract:**

**Aim:** The purpose of this study was to investigate skeletal and dental changes during anterior tooth retraction as well as upper lip response to this orthodontic treatment.

**Materials and Methods:** Pretreatment and post treatment lateral cephalograms of 15 post-pubertal female patients (mean age 18.2) with class II division I malocclusion or bialveolar protrusion who required upper first premolar (P1) extraction were evaluated using a series of 5 linear and 9 angular measurements. All the cases were treated using combination edgewise technique. Point A displacement was then analyzed, and then the effect of orthodontic correction was determined using single variant regression analysis.

**Results:** On average, the maxillary incisors retraction was found to be 4.8mm which cause significant changes in SNA angle due to backward and downward movement of point A.

**Conclusion:** Preoral region hard tissue changes can be produced by surgical intervention, growth, orthopedic forces, and orthodontic movement of teeth. According to this study point A movement in post-pubertal patients is possible but it seems surgical intervention is inevitable in severe cases. Also palatal and occlusal plane rotation occur consequent to the tooth retraction. (IJO 2006; 1: 48 - 52 )

**Key words:** Anterior tooth retraction, Class II division I malocclusion, Bimaxillary protrusion, Point A, SNA angle

(Received: Sep17,2005; Revised and accepted Feb21,2005)

## Introduction

The hard tissue of face is a skeletal framework that is affected by dental and osseous changes, these changes in the Perioral region can be produced by surgical intervention, growth, orthopedic forces, and orthodontic movement of teeth. The younger a patient is the more opportunity available to correct his/her face profile by orthopedic interventions and vise versa as orthopedic therapy is able to change the direction and amount of growth in prepubertal patients [1].Björk and Helm found that, the average age of growth spurt in females is 10.5 years and 17 months later the maturation process happens, also no more height growth is considered in 16 years old girls [2]. Different methods investigated to judge a patient about his/her residual growth of jaws and consequently help clinician decides either surgical or non-surgical interventions should be taken [3-7].

One of the main goals in orthodontic treatment of patients with class II division I malocclusion is to move upper jaw backward and retract anterior teeth in order to help the patient improve his/her profile. This aim is more probable in prepubertal patients as a result of residual growth but is still questionable in post-pubertals.

Hasund and Ulstein [8] reported that point A position is affected by incisor inclination and is prone to change by incisor retraction.

King and Ricketts showed that orthopedic forces in prepubertal patients can prohibit forward growth of point A which is considered to be1mm per year.

Cephalometric study of Lew [9] in 18-24 year old patients with

[a] Associated professor, Tehran University of medical science, Dept of Orthodontics, Dental research center
[b] Dentist
Corresponding author: Dr.Hosseinzadeh Nik Dept of Orthodontics, Tehran University of medical science, Dept of Orthodontics.
e-mail:hoseinit @ tums.ac.ir.

maxillary protrusion problem after first or second upper premolar extraction revealed that although point A
response to orthodontic therapy was not statistically significant but, upper lip height
increase, results in improvement of gummy smile appearance patients. Dyer[10] studied skeletal response to orthodontic treatment and reported that midface length (A-CO) decrease in pre-pubertal patients is due to backward movement of point A but occlusal plane rotation is the main cause in post-pubertal.
SNA angle is another parameter which was studied by Bishara [11]; he reported that this angle is reducing after orthodontic treatment of class II division I patients.
The main aim of this study was to investigate "point A response to anterior tooth retraction".
Other supplementary goals of present study was to investigate
1. Comparison of point A changes in patients who underwent either tipping tooth movement or bodily tooth movement.
2. Anterior and posterior tooth response to orthodontic treatment
3. Occlusal and palatal plane probing during anterior tooth retraction

## Methods and Material

A sample of 15 patients who were clinically diagnosed with bimaxillary protrusion or class II division I malocclusion was chosen from the files of previously treated patients at Tehran university dental school, orthodontic department.
The subjects were selected based on the following criteria:
1. Post-pubertal females aged above 15 years at the beginning of treatment (mean age 18.2)
2. The availability of full records, including pre treatment and post treatment models, lateral cephalograms, and clearly documented orthodontic mechanics
3. class II division I malocclusion or bimaxillary protrusion
4. Extraction of maxillary first premolars
5. No impaction or missing tooth (apart from third molars)
6. Using combination edgewise technique for orthodontic treatment
7. No history of orthopedic treatment such as headgear

All cases were diagnosed and treated by one operator and the cephalograms were traced, and analyzed using angular and linear parameters. 9 angular and 5 linear measurements of hard tissue were computed from horizontal and constructed vertical axes. The horizontal axis was registered on sella-nasion (S-N) line. The vertical axis was constructed through sella perpendicular to the horizontal axis. Superimposition of the pretreatment and post treatment cephalograms were performed on the stable cranial base structures. (Table1, 2).

## Point A determination

Anthropologists determine point A as the deepest point between ANS and Prosthion on premaxilla, quite close to this description Björk determined it as the deepest point on the alveolar process between ANS and Prosthion. [12]
On the effort to make this description more quantifiable Jarabak brings out the determination that point A is located 2 mm anterior to upper incisor apex. By using xeroradiography Alex and Rick Jacobson proposed that this point is located 3mm labial to the point on 1/3 apical, 2/3 coronal of maxil-

**Table.1.** Hard and soft tissue landmarks

| | | |
|---|---|---|
| A | sub spinal | Most posterior point in concavity between ANS and prosthion |
| S | sella | Center of pituitary fossa of sphenoid bone, determined by inspection |
| Se | sella | Center of hypothesis gland fossa D, a constructed point on mid sagittal plane |
| N | nasion | Most anterior point of nasofrontal suture on midsagittal plane |
| Or | orbital | Most inferior point of optic fossa on radiograph |
| Por | porion | Most superior point of external earring fossa |
| Pog | pogonion | Most anterior point on the symphysis of the mandible |
| Go | gonion | Most posterior and inferior point on the angle formed by the junction of the ramus and body of the mandible |
| Me | menton | Most inferior point on the symphysis of the mandible |
| ANS | Anterior nasal spine | The process of the maxilla forming the most anterior projection of the floor of the nasal cavity |
| PNS | Posterior nasal spine | The process formed by the most posterior projection of the juncture of the palatine bones in the midline |
| ApU1 | Apical point 1 | Tip of root of most anterior maxillary incisor |
| IsU1 | Incisal upper1 | Incisal edge of crown of most anterior maxillary incisor |
| PPD6 | Posterior point distal 6 | Most posterior point at upper first molar crown |

**Table.2.** Hard tissue and dental measurements

| | |
|---|---|
| **Hard tissue measurements** | |
| SNA angle | Angle formed by intersection of sella-nasion and nasion point A lines |
| SN-PP angle | Angle formed by intersection of sella-nasion and palatal lines |
| OC-PP angle | Angle formed by intersection of occlusal and palatal planes |
| A-$S^{\perp}$ | Horizontal distance(mm) from point A to SN perpendicular line |
| A-N | Distance(mm) between points A and N |
| PNS-OC | Perpendicular distance(mm) between posterior nasal spine and occlusal plane |
| **Dental measurements** | |
| U1-SN angle | Angle formed by intersection of upper incisor axis and sella-nasion line |
| U1-N Pog angle | Angle formed by intersection of upper incisor axis and nasion-pogonion line |
| U1-PP angle | Angle formed by intersection of upper incisor axis and palatal plane |
| U1-NA angle | Angle formed by intersection of upper incisor axis and nasion-point A line |
| Ap1- $S^{\perp}$ | Distance(mm) between tip of maxillary incisor root and SN perpendicular |
| Iu1-SN angle | Angle formed by intersection of upper incisor axis and SN line |
| Iu1-PP angle | Angle formed by intersection of upper incisor axis and palatal plane |
| PPD U6- $S^{\perp}$ | Horizontal distance(mm) between most posterior point at upper first molar crown to SN perpendicular |

lary first incisor root [13]. In present study Björk determination of point A was used which was close to the Jarabaks'.hard tissue (point A) response to orthodontic treatment were compared in two groups; patients who experienced more tipping tooth movement and , patients who underwent more bodily tooth movement. For the purpose 4 angular and 1 linear measurements were issued (U1-SN, U1-N Pog, U1- PP and U1-NA angles as well as Ap1-$S^{\perp}$ measurement).

All Cephalometric measurements were made at least twice by orthodontic department professors. If there was a difference between the two measurements, a third measurement was made and the aberrant one was discarded. The mean of the 2 closest measurements was used in the calculation. The measurement error was calculated.

For the purpose of error testing, seven patients were selected, and pre and post -treatment radiographs were retraced by same professors, a minimum of two weeks later.

## Statistical analysis

Statistical evaluation was performed with SPSS 10.0 (SPSS, Chicago,Ill). The mean and standard deviation (SD) were determined for each of the pre and post treatment measurements and non parametric Wilcoxon was used to describe hard tissue changes. Single variant regression analysis was used to investigate the relation of point A distal movement to tipping or bodily tooth movement.

The relation of upper lip changes to incisor retraction was evaluated using correlation coefficient value. (table 1, 2)

## Results

Means and standard deviation (SD) in angular and linear variables, using cephalogram superimpositions, are shown in tables 3 and 4.

The average maxillary incisor retraction in subjects of this study was 4.8mm, other results categorize as follows:

1. point A repositioning during anterior tooth retraction
   SNA, the most important angular measurement in present study, showed a significant decrease (P=.0017) which is subjected to both horizontal and vertical repositioning of point A. Horizontal linear measurement of point A (A-$S^{\perp}$) reveals decreasing in this dimension (P=.09). Vertical investigation on this point (A-N and A -ANS) also showed increasing in the measurements (P=0.14 and P=0.32 respectively). (table3)

2. Anterior tooth response to orthodontic treatment
   As stated anterior tooth response was investigated through 4 angular and 1 linear measurements shown in table2. U1-SN, U1-N Pog, U1- PP and U1-NA angles showed significant decreasing (P=0.0059, 0.0031, 0.013 and 0.0032 respectively). The only linear measurement (Ap1-$S^{\perp}$) revealed a slight increasing which was not significant though (P=.0706). Through superimposition of pre and post treatment cephalograms of the patients they were categorized into tipping (7 cases) or bodily (8

**Table.3.** pre and post treatment mean and standard deviation for hard tissue variables

| | pretreatment | | Post treatment | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| U1-SN angle | 107.53 | 5.01 | 100 | 8.42 | 0.0059 * |
| U1-N Pog angle | 30.7 | 6.13 | 22 | 6.39 | 0.0031 * |
| U1- PP angle | 64.9 | 5.20 | 72.43 | 7.86 | 0.013 * |
| U1-NA angle | 28.56 | 4.78 | 19.43 | 8.55 | 0.0032 * |
| Ap1- $S^{\perp}$ | 54.83 | 5.40 | 55.3 | 4.64 | 0.706 |
| Iu1-SN | 86.86 | 4.24 | 86.03 | 3.82 | 0.16 |
| Iu1-PP | 33.36 | 2.60 | 32.9 | 2.46 | 0.3636 |
| PPD U6- $S^{\perp}$ | 23.8 | 5.35 | 25.5 | 5.62 | 0.0219 * |

**Table.4.** Pre and post treatment mean and standard deviation for dental variables

| | pretreatment | | Post treatment | | P.value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| A-$S^{\perp}$ | 60.26 | 4.208 | 59.833 | 4.366 | 0.09 |
| A-N | 59.93 | 3.076 | 60.966 | 3.66 | 0.14 |
| SN-PP angle | 8.47 | 3.838 | 9.866 | 2.99 | 0.23 |
| OC-PP angle | 11.06 | 3.140 | 10.666 | 6.099 | 0.23 |
| PNS-OC | 20.733 | 1.841 | 22.70 | 2.121 | 0.0052* |
| SNA angle | 81.166 | 4.782 | 79.066 | 3.955 | 0.0017* |

* P<.05

cases) tooth movement groups.

3. Posterior tooth response to orthodontic treatment
Horizontal movement of maxillary first molar was evaluated by 1 linear measurement (PPD6-$S^{\perp}$). This indicator showed a significant increase subsequent to anterior retraction (P=.0219), also occlusal plane rotation could be as well due to vertical changes of posterior teeth movement ( PNS-OC) explained in the following step.(table4).

4. Occlusal and palatal planes response.The results admit that during orthodontic therapy, clockwise palatal plane rotation compared to S-N line occurred, although not significantly (P=0.23). Palatal and occlusal plane angular measurements (OC-PP angle) showed an increase. PNS linear measurement to occlusal plane (PNS-OC) admits a significant increase (P=.0052).

## Discussion

When studying skeletal response to orthodontic treatment, full attention should be focused to residual growth of patients because it can influence the results. As Foly& Mamandras stated in female individuals the pubertal growth is nearly over 14 years [14]. The patients' average age in this study was 18.2 years so no residual growth was to influence the results. Beatty [15] through linear measurement proposed that in prepubertal class II patients, orthodontic treatment does not change point A position backward, but hold this point at place. In 1979 Baumrind [16] showed that point A distal movement happened in 37% of his post-pubertal patients.

Unfortunately, there is limited database of evidence of point A movement in post-pubertal patients subsequent to orthodontic treatment.

## Point A movement

This study corroborates the finding of Baumrind [16], as point A distal movement seen in 66% of patients but disagrees with those of Beatty [15]. As seen in table1, SNA angle showed a significant decrease (P=.0017) that admits changes in vertical or horizontal or either of the planes. A-$S^{\perp}$ linear measurement was applied to examine point A horizontal direction of repositioning. Decrease in this measurement approved a distal movement of 0.43mm at this point. Vertical linear measurement was applied by quantifying A-N distance, which

appeared to increase during orthodontic treatment although not significantly (P=0.14). These measurements approve distal and downward movement of point A, but more cases might be needed to reveals statistically significant linear changes to this point. Point A distance was also quantifies to ANS and palatal plane and the increasing results suggests clockwise rotation of this plane.

Anterior tooth response

As seen in table 2 upper first incisor inclination was assessed to SN, NPog, NA and palatal planes. The results showed that retro inclination of incisors significantly occurred as all these angles reduced, concerning that the reverse angle between incisors and palatal plane was measured. Linear measurement (Ap1-S?) also revealed an insignificant increase in quantity, this means during tipping tooth movement the apex of incisors slipped slightly forward. To probe the influence of type of tooth movement (tipping or bodily) on point A displacement, pre and post treatment cephalograms were superimposed and cases were categorized accordingly. 7 cases underwent tipping movement while 8 ones experienced bodily movement, but this study failed to show any relationship between these groups and point A displacement (P=0.55, 0.15 respectively) as mean point A movement in group1 was found to be 0.63mm and slightly higher 0.69mm in group 2.

Posterior tooth response

On horizontal plane, the most posterior point of upper first molar was evaluated to SN perpendicular plane. As expected, the distance increased significantly (P=0.0219) because the essential incisor retraction force was supplied by first molars. Evaluating posterior nasal spine distance to occlusal plane (PNS-OC) also revealed extrusion of maxillary first molar, as the measurement increased significantly (P=00.52).

Occlusal and palatal plane response

Palatal plane rotation was investigated to SN reference plane. The angle formed by intersection of these two lines was increased at about 2 degrees during tooth retraction so clockwise palatal plane rotation was anticipated. The non significant result (P=0.23) was due to light forces applied on teeth since no orthopedic instruments was used. Posterior nasal spine distance was then quantified to occlusal plane (PNS-OC). The linear measurement increased significantly (P=.0052) resulted in counter clockwise rotation of occlusal plane and posterior tooth extrusion. When both planes were investigated to each other (PP-OC), the intersected angle increased as was expected.

## Conclusion

Hard tissue responses to anterior tooth retraction were evaluated in a sample of 15 post-pubertal female patients. Although additional research is needed to better understand the relationship between tooth movement and hard tissue responses, the following conclusions can be made:

1. Anterior tooth retraction in post-pubertal patients with bimaxillry protrusion and class II division I malocclusion does affect hard tissue, reduce SNA angle and move point A backward and downward, but in severe cases surgical intervention is inevitable.
2. point A angular measurement showed significant changes on the contrary of linear measurements, as a result it seems angular measurements are more prone to declare minor changes and linear measurements needs either higher changes in quantities or more cases to involve in a study to reveal a reliable result.
3. Although bodily or tipping anterior tooth movement does not correlate to point A displacement in present study, a study with more cases involved might show different results.

## Reference

1. Lamastra S.J. Relationships between changes in skeletal and integumental points A and B followed by orthodontic treatment. Am J Orthod 1981; 79(4):416-23
2. Bj?rk A, Helm S. Prediction of the age of maximum pubertal growth in body height. Angle Orthod 1967; 37(2):134-43
3. Kluemper GT, Spalding PM. Realities of craniofacial growth modification. Atlas Oral Maxillofac Surg Clin North Am 2001; 9(1):23-51
4. Grave K, Townsend G. Cervical vertebral maturation as a predictor of the adolescent growth spurt. Aust Orthod J 2003; 19(1):25-32
5. Lewis AB, Roche AF, Wagner B. Pubertal spurt in cranial base and mandible comparisons within individuals. Angle Orthod 1985; 55(1):17-30
6. Hagg U, Taranger J. Maturation indicators and the pubertal growth spurt. Am J Orthod 1982; 82(4):299-309
7. Hagg U, Taranger J. Skeletal stages of the hand and wrist as indicators of the pubertal growth spurt. Acta Odontal Scand 1980; 38(8):187-200
8. Hasund A, Ulstein G. The position of the incisors in relation to the lines NA and NB in different facial types. Am J Orthod 1970; 57(1):1-14
9. Lew K. Profile changes following orthodontic treatment of bimaxillary protrusion in adults with the Begg appliance. Eur J Orthod 1989; 11(4):375-81
10. Dyer GS, Harris EF, Vaden JL. Age effects on orthodontic treatment: adolescents contrasted with adults. Am J Dentofacial Orthop 1991; 100(6):523-34
11. Bishara SE, Cummins DM, Jackobsen JR, Zaher AR. Dentofacial and soft tissue changes in class? division1 cases treated with and without extractions. Am J Orthod Dentofacial Orthop 1995; 107(1):28-37
12. Bj?rk A, Skidler V. Normal and abnormal growth of the mandible: a synthesis of longitudinal Cephalometric implant studies over a period of 25 years. Eur J Orthod 1983; 5(1):1-46
13. Jacobson RL, Jacobson A. Point A revised. Am J Orthod 1980;77(1):92-6
14. Foley TF, Mamandras AH. Facial growth in females 14 to 20 years of age. Am J Orthod Dentofacial Orthop 1992; 101(3):248-54
15. Beatty EJ. A modified technique for evaluating apical base relationships. Am J Orthod 1975;68(3):303-15
16. Baumrind S, Molthen R, West EE, Miller DM. Distal displacement of the maxilla and the upper first molar. Am J Orthod 1979; 75(6):630-40