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Soft tissue thickness changes after correcting Class III malocclusion with bimaxillar surgery

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SUMMARY

The aim of this study was to evaluate and analyse soft tissue thickness changes after bimaxillary orthognathic surgery.

Materials and methods. Eighty three consecutive patients (54 males and 29 females) with Class III malocclusion operated with bimaxillary orthognathic surgery were enrolled in this study. Standardized lateral cephalograms of adequate quality were analysed.

Results. The mean upper lip thickness decreased as a result of the surgery and statistically significant differences were recorded ($p<0.01$). The statistically significant difference in the post surgical tissue thickness of the lower lip also was recorded ($p<0.05$). Subjects with thick upper lips compared to patients with thin upper lips demonstrated greater (0.7 mm) and statistically significant ($p<0.01$) increase of vertical nasal projection. Vertical growth pattern had an influence only on B point to lower lip distance, which exhibited greater (2.2 mm; $p<0.01$) decrease during observation period.

Conclusion. It was found differences in the soft tissue responses between patients with thick or thin soft tissues after bimaxillary surgery and it should be taken into account while planning operation.

Key words: orthognathic surgery, soft tissue changes.

INTRODUCTION

Well balanced and harmonious soft tissue facial profile is a very important goal in orthognathic surgery. Sometimes it is difficult to predict the post surgical profile due to high variability of the thickness of the soft tissue overlying hard tissue structures which are subjected to surgical repositions. These variations result not only from imbalance of the dental and skeletal structures, but from individual variations in the thickness and tension of the soft tissues [1]. Some studies have indicated the influence of the gender on the soft tissue behavior [2]. Generally, the changes of the superior and inferior aspects of the profile, such as nasion and pogonion, have shown to have more predictable patterns than those of the midface areas, such as the nose and lips [3]. Soft tissue thickness and soft tissue adaptation of the lower lip and chin continue to occur up to 3 years post surgically [4]. There are only few articles focusing on the thickness of the soft tissue after orthognathic surgery, usually involving only one jaw procedures [3, 5, 6]. However precise and comprehensive data usable for planning bimaxillary procedures are lacking. The study of mandibular set back cases show thinning of the upper lip and minor thickness gain in chin and lower lip region [5, 6]. Maxillary advancement surgery gives minor thinning of the upper lip [7].The results of the studies suggest that in order to archive precise prediction of the postoperative profile the ratios of the soft tissue response to the hard tissue repositions should be calculated separately for thick or thin soft tissue patients.

The aim of this study was: 1) to describe and analyze soft tissue thickness changes after bimaxillary orthognathic surgery to correct Class III malocclusion. 2) to find if there is any differences in the soft tissue responses between patients with thin or thick soft tissues. 3) to find out differences in the soft tissue behavior among patients with different vertical growth pattern.

MATERIALS AND METHODS

The subjects enrolled in this study were 83 consecutive Caucasian patients (54 males and 29 females) with Class III malocclusion operated with bimaxillary orthognathic surgery. Age at the time of the surgery

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ranged from 16.2 to 52.2 years (mean age 25.8 years). LeFort I osteotomies with maxillary advancement were performed on the upper jaw and bilateral sagital split osteotomies were performed on the lower jaw. In the LeFort I osteotomies the incision was made from the zygomatic maxillary buttress region above the first molarto the midline of the maxilla above the central incisors. No dissection of tissue was done inferior to the incision. The nasal aperture was exposed with careful dissection along the piriform rim and lateral nasal wall under the inferior turbinate. Mucosa and periosteum from the floor of the nose are elevated as far the nasal crest of the maxilla in the midline. Forty one persons after surgery showed decrease of the facial height, 31 person did not changed their vertical facial dimensions and 11 persons showed increase of the facial height. The subjects were selected from the files at the Department of the Orthodontics, University of Oslo. Surgery was performed at the Department of Maxillofacial Surgery, Ullevaal University Hospital during the period from 1990 to 2003. No patient received any additional orthognathic surgical procedure and all patients had rigid internal fixation. A criterion for inclusion in the study was the availability of the standardized lateral cephalograms of adequate quality and resolution exposed according to a strict data collection protocol. X-rays were taken one week before surgery, within one week after surgery, 2 month, 6 month, 1year and 3years after surgery.

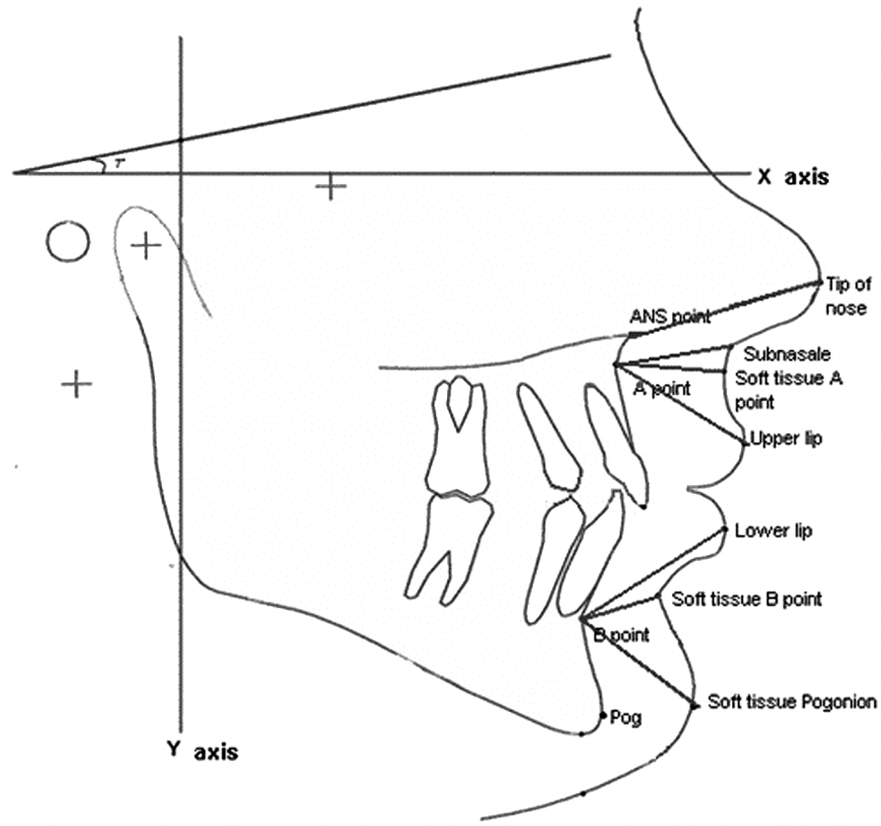

Fig. 1. ANS point – tip of anterior nasal spine; A point – deepest point between ANS and upper incisor alveolus; B point – deepest point between Pog and lower incisor alveolus; Pog – most anterior point on bony chin; Tip of nose – most prominent point of nose; Subnasale – transition between columella and philtrum; Soft tissue A point – deepest point of philtrum; Upper lip – most prominent point of upper lip; Lower lip – most prominent point of lower lip; Soft tissue B point – deepest point of labiomental area; Soft tissue pogonion – most prominent point of chin.

Depending on the local anatomy anterior nasal spine was recontoured in 16 patients. The nasal cinch

Table 1. Characteristics of the study groups

Measurement Study groups and subgroups	Number of patients	Gender		Mean age, years	Surgery	A to A soft tissue distance	B to B soft tissue distance	Nasal projection
		M	F					
Thick upper lip (2A)	40	34	6	26.6	14 maxilla up; 21 no vertical change; 5 maxilla down	20.0 mm	12.9 mm	33.1 mm
Thin upper lip (1A)	43	20	23	22.6	27 maxilla up; 10 no vertical change; 6 maxilla down	16.1 mm	12.1 mm	31.1 mm
Thick lower lip (2B)	41	30	11	24.8	20 maxilla up; 16 no vertical change; 5 maxilla down	18.7 mm	13.9 mm	32.3 mm
Thin lower lip (1B)	42	24	18	24.2	27 maxilla up; 10 no vertical change; 6 maxilla down	17.3 mm	11.1 mm	31.8 mm
Long nose (2C)	42	33	9	25.2	17 maxilla up; 17 no vertical change; 8 maxilla down	18.7 mm	12.7 mm	34.9 mm
Short nose (1C)	41	21	20	23.7	24 maxilla up; 14 no vertical change; 3 maxilla down	17.3 mm	12.3 mm	28.9 mm

was almost never performed, but the wound was always sutured with single V-Y suture.

The same cephalostat was used for all x-rays and all x-rays were performed in natural head position, teeth in maximal intercuspidation and lips relaxed. No adjustments were made for magnification (5.6%). Tracings were carried out on acetate paper by the same examiner (G. J.) for all the radiographs. The cephalogramm of the best quality was traced first and the consecutive radiographs were superimposed on sella, nasion, anterior and posterior cranial base using the "best fit" method. From the 6 month postoperative radiograph a template of the outline of the maxilla was constructed and superimposed on the presurgical radiograph on the outline of the bony palatal structures. This method of anatomic best fit was used to account for surgical alteration of the anterior nasal spina during surgery.

The cephalogramms were digitized with Dentofacial Planner software (Dentofacial Software, Toronto, Canada) on a computer with a digitizing screen (Numonics Cooperation, Montgomeryville, USA). A horizontal reference line (x-axis) was constructed through sella, rotated 7° from nasion-sella line. This line is approximation of the Frankfort horizontal plane. The y-axis was perpendicular to x-axis and passed through sella. The reference lines and points used in the analysis of the cephalogramms are given in Figure 1.

Statistical analysis

Statistical analyses were performed with SPSS for Windows software (SPSS, Chicago, Ill). Paired t-tests were used to analyze changes over time in cephalometric variables. Differences between groups were tested by independent samples t-test. For analysis of method error, 20 radiographs, chosen at random, were traced and digitized by the same investigator on 2 separate occasions at least 2 weeks apart. Dahlberg's [8] method was used to determine the error between the duplicate determinations. Systematic error was calculated by a paired t-test at the 10% level as recommended by Houston [9]. Lineal regression analysis was performed to test predictors for upper and lower lip thickness changes. Here are methods and results (data of measurements) mixed. There are 3 groups according to the soft tissue localization – upper lip, lower lip and nose. Every group has 2 subgroups.

The patients (group A, B, C) were divided in 2 subgroups (1A, 2A etc.) (Table 1) according to the preoperative upper lip thickness (represented as A-A` distance). The median of the A-A` distance was set as a bench mark (17.9 mm); thus similar numbers of patients (43 and 40 subjects respectively) were allocated in the groups. Mean upper lip thickness in the thin lip group1A was 16.1±1.4 mm in the range from 12.2 to 17.9 mm, mean thickness in the thick lip group 2A was 20.0±1.5 mm in the range 18.0 to 23.7 mm (Table 1).

The same procedure was performed for the lower lip thickness, represented as B-B` distance. Patient were divided into two groups (41 and 42). The mean value of the lower lip thickness in the group 1B was

Table 2. Surgical repositions in the groups

	1A	2A	P value	1B	2B	P value	1C	2C	P value
A point horizontally	3.3±2.5	4.0±1.9	0.13				3.5±2.5	3.8±2.0	0.63
A point vertically	0.1±3.3	-0.1±2.7	0.73				0.1±4.0	1.1±3.7	0.5
B point horizontally				-6.8±5.6	-6.9±5.5	0.54			
B point vertically				2.6±4.7	1.8±4.1	0.41			

"-"- in horizontal direction indicates backward movement and in vertical direction downward movement.

Table 3. Summary of the changes in pre and post operative soft tissue thickneses

Variable changes from T0 to T5	1A	2A	1A with 2A	1B	2B	1B with 2B	1C	2C	1C with 2C
ANS – Tip	-1.6±3.0**	-2.3±2.3**	-0.8				-1.4±3.1** (5%)	-2.5±2.0** (7%)	-1.1
A – A`	-1.4±1.8** (9%)	-2.8±1.7** (14%)	-1.3**						-0.9*
A – SN	-1.9±2.1**	-3.1±1.4**	-1.2**						-0.7
A – Upper lip	-0.9± 2.6**	-2.9±2.7**	-2.0**						-1.3*
B – lower lip				-1.1±2.6**	-1.8±2.2**	-0.7			
B – B`				0.4± 0.7** (4%)	-0.5±1.4** (4%)	-0.9**			
B – Pog`				-1.2± 1.8**	-1.1±1.9**	-0.1			

** – $p<0.01$, * – $p<0.05$. Negative values indicate decrease in thickness and vice versa.

11.1±0.7 mm with the range of 9.2-12.1 mm and in group 2B was 13.9±1.6 with the range of 12.4-19.0 mm.

The nose projection was measured as a horizontal distance from ANS to Tip of nose. The 41 patients with the shortest nasal projection of mean 28.9±2.6 mm (range 20.7-32.0) made up the short nose group 1C, while the 42 patients with the longest distance represented the long nose group (mean 34.9±2.0 mm in the range of 32.2-40.5 mm).

RESULTS

Soft tissue thickness change

The subgroups were tested with t-test for equality in the surgical repositions in the horizontal and vertical planes. Mean surgical movements in the groups are presented in Table 2

There were no statistically significant differences in surgical movements between groups so we can compare these groups. The upper lip thickness decreased in the both groups as a result of the surgery and statistically significant differences ($p \leq 0.01$) were recorded for A-Sn, A-A` and A-Ls. The statistically significant difference in the post surgical tissue thickness of the lower lip was recorded for B-Ll, B-Pog` and B-B` ($p \leq 0.05$) (Table 3).

Statistically significant were only some of the tested variables: vertical direction of movements of the maxilla during surgery (up, down and no vertical change), gender, amount of the horizontal movement of the maxilla during surgery, distance from ANS to the tip of the nose, amount of the horizontal movement of the B point during surgery, growth pattern (mandibular plane angle), vertical changes at B point during surgery. This equation explained 32% of the changes in the upper lip thickness and only 15% in the lower lip.

Vertical growth type and soft tissue thickness

The patients were divided into the subgroups according to the preoperative mandibular plane angle. Nine patients with the mandibular plane angle less than 27º represented horizontal growth type group, 45 patients with mandibular angle from 27º to 39º represented neutral growth type group and 29 patients with mandibular plane angle more than 39º were allocated in the vertical growth type group.

When the subgroups were tested for the differences in the surgical movements, no differences were found between the horizontal and neutral groups, but both groups differed from the vertical group for both horizontal and vertical movements. Horizontal and vertical groups were linked together and compared to vertical growth group. Results demonstrated that preoperatively all soft tissue thicknesses were similar, except distance from B point to lower lip ($p<0.01$) which was longer in vertical growth type patients. In the vertical growth type patients this distance exhibited greater (2.2 mm; $p<0.01$) decrease during surgery and post surgical observation period.

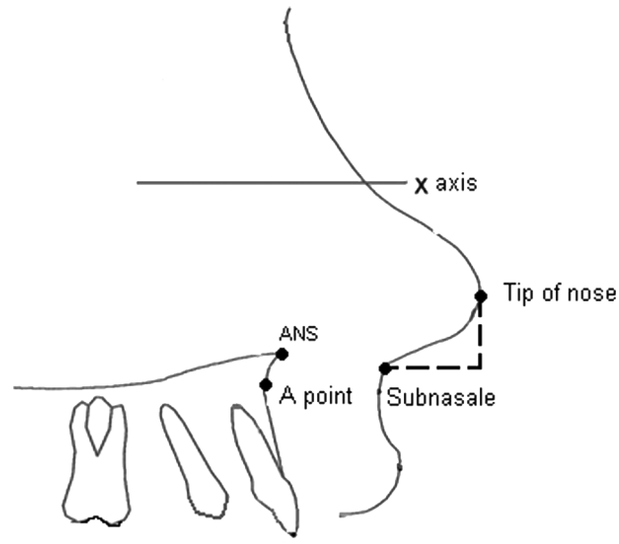

Fig. 2. Vertical and horizontal nasal projection (dotted lines)

Nasal projection change

Before surgery nasal projection values were similar in both groups (thin upper lip and thick upper lip) in both dimensions. Horizontal nasal projection showed no change comparing pre and 3 years postoperative values, while vertical nasal projection showed minor (0.3 mm), but statistically significant ($p=0.028$) increasing. Thick upper lip group demonstrated greater (0.7 mm) and statistically significant ($p<0.01$) increase of the vertical nasal projection.

The factors influencing the change of the tip of the nose were tested by multiple regression analysis. Several factors were tested and following independent variables were found to be statistically significant: preoperative nasal projection from Sn to Tip in the horizontal and vertical planes (Figure 2), horizontal movement at A, vertical movement at A, mandibular plane angle and distance from ANS to the tip of the nose. Linear regression equation explained 42% of horizontal and 35% of vertical changes.

DISCUSSION

The prevalence of the Class III malocclusion has been assessed in several epidemiological studies and some authors claim it is more frequent in males [10] while others did not observe noticeable gender differences [11], but noticeable differences in the craniofacial morphology were recorded [12]. Our sample has a prevalence of men (65% men, 35% women) and that distinguish it from other studies in bimaxillary sur-

gery [13-15]. Men on average have thicker soft tissues compared with women [2]. Most of the women in our study were in the thin soft tissue groups and most of the men felled in the thick tissue groups.

The major effect of maxillary advancement and V-Y lip closure is to cause the nose to become more pronounced, with the tip being elevated and moved forward [16]. We observed the mean increase of the upper lip which corresponds to other authors [13, 16]. In the present sample there was almost never performed alar base cinch since the maxillary advancements were moderate. The opinions about the alar base cinch on the response of the of the soft tissues are controversial [16-18]. Furthermore clear criteria for the indications of the procedure is lacking.

The focus of the present study was to evaluate long term changes in the soft tissue profile thickness after bimaxillar surgery to correct Class III skeletal malocclusion and investigate the factors influencing the changes on the nasal tip. Evaluation of the 3 year outcome demonstrated considerable improvements in the facial profile. Usually prognathic patients are characterized by rolled up upper lip contour, decreased nasolabial angle, excessive protrusion and fullness of the lower lip and poorly contoured mentolabial fold. In agreement with several other studies [3, 5, 19] maxillary advancement resulted in thinning of the upper lip by 1.3 mm. Difference between thin and thick group shows that thicker lip can tolerate more of surgical advancement. In contrary to expected, distance from B point to the lower lip decreased and it could be contributed to anticlockwise rotation of B point in most of the cases during surgery as the majority of the cases had increased facial height. The thin lower lip group represented tiny increase in the soft tissue thickness and it corresponds well to other research [5, 6]. Soft tissue thickness decrease in thick lower lip group recorded in mentolabial fold region does not correspond to the current literature data [5, 6] and it could be explained with decrease of the lower facial height during surgery and formation of more accented mentolabial fold. Distance from B point to the soft tissue pogonion increased and it is in agreement with the current literature [5, 6]. Nose projection demonstrates similar changes to maxilla, when longer nose group showed greater tolerance of the performed surgical advancement of the maxilla and vice versa.

The ratios of the soft tissue response to hard tissues should be calculated separately for thick and thin groups or for men and women [2]. Results of our study show that persons with thicker soft tissues are able to mask more of the hard tissues movements which corresponds to findings of Hu et al [2], but it is in opposite to the statements of the Mobarak et al [5].

It was found differences in the soft tissue responses between patients with thick or thin soft tissues after bimaxillary surgery and it should be taken into account while planning operation.

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