Evaluation of the facial soft tissues following surgically assisted maxillary expansion associated with the simple V-Y suture

Bone movement in orthognathic surgery gives rise to changes in the positions of the adjacent soft tissues, with such change varying according to the location, direction, and degree of movement. The behavior of the soft tissues, especially the labial tissues, can be influenced by the type of suture employed. This study sought to characterize alterations induced into the soft tissue, by the effect of different suturing techniques, on the upper lip in patients undergoing surgically assisted maxillary expansion. Twenty-three patients were divided into 2 groups and analyzed, with group 1 receiving conventional suturing and group 2 receiving the simple V-Y suture. The results were determined through cephalometric tracings conducted immediately preoperative and a minimum of 6 months postoperative. From these results, it was possible to detect a tendency toward more posterior positioning of the upper lip with this procedure, which can be compensated by the V-Y suture. Alterations in the vertical position of the soft tissues were not significant. (Int J Adult Orthod Orthognath Surg 2002;17:89–97)

Orthognathic surgeries that involve the maxilla invariably give rise to important alterations in the superjacent soft tissues, especially the upper lip and nose. In general, access utilized for maxillary osteotomies, such as Le Fort I, causes widening in the base of the nose, shortening of the upper lip, and inversion of lip vermilion. These effects result from the use of mucosal incisions, with ample periosteal shifting, in conjunction with muscular disinsertions and edema.

To control such alterations, some specific surgical techniques are employed in the nasal and labial regions.1 Lassus2 described the double V-Y suture for the aesthetic correction of thin lips, the principle of which was later applied by Schendel and Williamson3 during the closing of the vestibular incisions of the Le Fort I osteotomy. In spite of the fact that such procedures may reduce labial shortening by up to 10%,4,5 there is still doubt concerning their true clinical efficacy.6 It is also difficult to predict the response of the soft tissues before such procedures.

The many studies that have already been conducted sought to correlate soft tissue behavior with bone movement, especially that in the anteroposterior direction.7–16 Because of the emphasis given to this correlation, it is possible to verify the importance of the procedures in soft tissues, especially the choice of the location for the incision and the suturing method.17

Specifically to evaluate the effects of these procedures, the present research studied patients who underwent surgically assisted rapid maxillary expansion treatments. When compared to the Le Fort I osteotomy, which is generally used as a parameter in these studies, rapid maxillary expansion definitely does not induce great repercussions in the anteroposterior positioning of the maxilla. Using a cephalometer, one can detect little to no alteration in the positioning of the bone bases in the anterior or posterior direction, and even...
when they do occur, they are restricted to a few millimeters, and they relapse considerably during the postoperative period. Thus, this procedure can serve as an excellent means for observing the alterations of soft tissues due to suturing procedures, as for example the V-Y suture and the alar base suture. In the same way, this study shall try to characterize cephalometric alterations induced by this type of procedure, as well as the soft tissue response.

Methods

Patients and surgical procedures

This study used 23 patients from the Orthognathic Surgery Service of the Sagrado Coração University in Bauru, São Paulo, Brazil, who had undergone surgical orthodontic treatment. Leukodermal adult patients were included in the sample, presenting diverse types of malocclusion, but showing a common diagnosis of transverse maxillary deficiency.

All of the patients underwent surgical orthodontic treatment, which consisted of the expansion of the maxilla with the use of a Hyrax expander anchored in the dental elements or osseointegrated implants. The procedures were conducted by the same surgical team, using the technique described by Betts et al:

1. Circumferential mucoperiosteal incision of the upper maxilla, which extends from the area of the first molar on one side to the first molar of the other side.
2. Shifting of the mucoperiosteal flap and of the portion of nasal mucosa adhered to the lateral wall of the nasal fossa bilaterally.
3. Osteotomy of the maxilla’s anterior wall, extending from the piriform opening until the zygomatic pillar and tuber, finishing at the pterygoid fossa, bilaterally; an osteotomy that separates the perpendicular lamina of the pterygoid process from the sphenoid bone of the maxilla's tuber, bilaterally; and an osteotomy of the median palatine raphe and alveolar process of the maxilla at the median line.
4. Continuous spiral suture of the mucoperiosteal flap from the molar to the canine area bilaterally, with a suturing technique according to each group (conventional or V-Y).

Patients with major craniofacial deformities, cleft lip/palate, or syndromes were excluded, as were those with alterations in their general health. All patients accepted inclusion in the referred study.

Only those patients who had all of their radiograph documentation conducted with the same type of x-ray equipment and in the same cephalostat were selected. This assured adequate similarity in positioning and avoided major differences among radiographs. Cephalometric radiographs were obtained during the preoperative period and a minimum of 6 months postoperative, and they were divided into 2 groups as follows:

1. Group 1: 11 patients who received conventional suturing of the upper lip
2. Group 2: 12 patients who received the simple V-Y suture of the upper lip

Thus, an attempt was made to evaluate the influence of this type of suture over the final positioning of the lip without the use, in any patients, of the alar base suture.

Cephalometric analysis

Cephalograms constructed from the radiographs taken at the preoperative exam (T0) and the 6-month postoperative exam (T1) were used for both groups. With the goal to minimize mistakes in reproducing the referential cephalometric structures, 2 tracings were made of each radiograph, with these procedures based on the work by Gabrielli. The cephalometric points that were used are described in Fig 1.

Cephalometric tracing was used according to other works, standardizing 2 reference lines as follows:

1. A horizontal reference line (LHR), taken 12 degrees below Sn and passing through S
2. A vertical reference line (LVR), tracing a line perpendicular to the horizontal reference line, starting from S
With the cephalometric points and the reference lines determined, the horizontal and the vertical cephalometric measurements were conducted, starting from the cephalometric point in question until the perpendicular trace of the reference line, with results recorded in millimeters. With regard to the vertical cephalometric measurements, Sn-USt and Ls-USt, the distance between the referred points was measured. A single angular measurement was obtained, the nasolabial angle (NLA), and recorded in degrees.

Cephalometric measurements were made as follows:

- **Horizontal measurements**: distances between ANS, Pn, Sn, A', USt, Ls, and Is and the vertical reference line (LVR), with each characterized as a separate horizontal measurement
- **Vertical measurements**: distances between ANS, Pn, Sn, A', USt, Ls, and Is and the horizontal reference line (LHR)
- **Angular measurement**: observation of the NLA

Figure 2 portrays the entire cephalometric tracing taken from the radiographs, which were conducted in the same way preoperatively and postoperatively.

In addition to the cephalometric analysis, both groups were submitted to measurements of the alar base distance by means of a digital precision caliper, both during the preoperative exam (T0) and the postoperative (6-month minimum) exam (T1).

The mean changes between the cephalometric measurements found in the preoperative periods (T0) and the postoperative periods (T1) were analyzed statistically using a paired-samples test (Student t test). Before statistical tests were performed, however, an exploratory analysis of the data was conducted, using a “stem and leaf” display. This consists of the ordering of data in a programmed manner to show its approximate distribution, dispersion, asymmetry, value grouping, and especially the detection of outliers (discrepant data) and their spatial location. This alerts researchers to possible problems not observed during the experiment (for example, material that...
is unusual to the experiment during some time period or in a patient). Linear correlations were also conducted between the variables measured to verify whether the behavior of any 1 patient was linearly related to the behavior of any other patient. For this, Pearson’s linear correlation coefficient was used.

Results

The “stem and leaf” display showed that, although the sample was small, it presented good symmetry in almost all of the variables taken. Through the diagrams, we observed the occurrence of discrepancies in the data with regard to outliers in some of the variables.

• Pn-LVR. Two outliers and less: Group (G) 1 patient (P) 4 and G1P9
• Pn-LHR. Two outliers and less: G2P1 and G2P12; 2 outliers and up: G1P2 and G1P8
• Sn-LHR. Three outliers and less: G1P4, G2P1, and G2P12; 1 outlier and up: G1P8
• A’-LHR. Three outliers and up: G1P2, G1P8, and G2P7
• Ls-LHR. One outlier and less: G2P12
• Is-LHR. One outlier and less: G1P4

• NLA. One outlier and less: G1P4; 2 outliers and up: G2P8 and G2P12

This called attention to possible causes of variation that were not observed during the experiment in patients 4 and 8 of group 1 and patient 12 of group 2. Note, however, that the existence of those outliers did not violate the presupposition for the performance of the tests.

The average of the variables, obtained from patients in each group, in both periods (pre- and postoperative), as well as the average of the differences between both periods for both groups, the Student t test results, and the respective levels of significance, are presented in Table 1.

For the variable Pn-LVR, a significant difference was detected between the mean of the periods only within group 2 and between both groups (at the 1% level in both cases); no significant difference was detected between the mean of the periods within group 1. For Pn-LHR, no significant differences were detected within the groups or between them.

For the ANS-LVR variable, a significant difference between the mean of the periods was evident only within group 2 (at the 5% level), and no significant difference
was evident between the average of the periods within group 1 or between both groups. For ANS-LHR, no significant difference was detected within the groups or between them.

For the Sn-LVR and A’-LVR variables, there were significant differences between the mean of the periods within groups 1 and 2 (at the 5% level) and between groups (at the 1% level). For Sn-LVR and A’-LHR, no significant difference was evident, either within the groups or between them.

For the USt-LVR variable, a significant difference between the mean of the periods was detected only within group 1 and between the groups (at the 5% level), and no significant difference occurred between the mean of the periods within group 2 (at the 5% level).

For the Ls-LVR variable, a significant difference between the mean of the periods was evident only within group 1 (at the 5% level), and no significant difference was evident between the average of the periods within group 1 or between both groups. For Ls-LHR no significant difference was detected within the groups or between them.

For the Is-LVR variable, there was a significant difference between the average of the periods only within group 1 and between both groups (at the 5% level), and no significant difference occurred within group 2. For Is-LHR no significant difference was detected within the groups or between them.

For the Sn-USt variable, no significant difference between the mean of the periods within any of the groups was detected; however, a significant difference was evident between both groups. For the Ls-USt variable, no significant difference was detected within the groups or between them. For NLA, there was a significant difference between the mean of the periods only within group 2 and between both groups (at the 5% level in both cases), and

### Table 1: Means for each variable in each group at both time points and between-group comparison

<table>
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<th>Variable</th>
<th>Group 1</th>
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<th>Group 2</th>
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<td>T1</td>
<td>t</td>
<td>T0</td>
<td>T1</td>
<td>t</td>
<td>G1</td>
<td>G2</td>
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<td>105.1944</td>
<td>106.3611</td>
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<td>–0.7576</td>
<td>1.1667</td>
<td>–3.1178**</td>
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<td>76.4167</td>
<td>78.3333</td>
<td>–2.9596**</td>
<td>0.4242</td>
<td>1.9167</td>
<td>–1.4858**</td>
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<td>2.2012*</td>
<td>92.7222</td>
<td>93.2500</td>
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<td>–1.3030</td>
<td>0.5278</td>
<td>–2.4620*</td>
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<td>Ls-LVR</td>
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<td>0.2292</td>
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<td>86.8889</td>
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<td>–0.2727</td>
<td>0.5833</td>
<td>–0.7222**</td>
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<td>81.2222</td>
<td>81.1944</td>
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<td>–1.8485</td>
<td>0.0278</td>
<td>–2.9996**</td>
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<td>57.9091</td>
<td>0.0000</td>
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<td>24.6944</td>
<td>25.0833</td>
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<td>–0.9697</td>
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<td>Ls-USt</td>
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<td>0.5837</td>
<td>10.3056</td>
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<td>NLA (deg)</td>
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<td>102.7273</td>
<td>–0.0476</td>
<td>101.0833</td>
<td>104.8333</td>
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<td>Alar base</td>
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<td>32.7667</td>
<td>–3.3196**</td>
<td>29.8000</td>
<td>33.2727</td>
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<td>3.4727</td>
<td>0.6664</td>
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</table>

T0 = presurgical; T1 = postsurgical (minimum 6 months). ns = not significant, considering the minimum level of significance at 5% (α > .05); *significant at the 5% level (α ≤ .05); **significant at the 1% level (α ≤ .01) (t test for all values). The t values are associated with 9 degrees of freedom for comparison within group 1, 10 degrees of freedom for comparison within group 2, and 21 degrees of freedom for between-group comparison.
no significant difference was detected between the average of the periods within group 1. For the alar base, a significant difference between the mean of the periods was evident within group 1 and group 2 (at the 1% level in both cases), and no significant difference was detected between the mean between both groups.

There were statistical differences, whether within the groups or between them, for all the vertical variables, while only 1 statistical difference was found among the horizontal variables (UST within group 2).

From the coefficients of simple linear correlation (r) among the variables measured, the following were observed.


- When only group 2 was considered, significant linear correlation was evident between Pn-LVR and ANS-LVR, Sn-LVR, A'-LVR, USt-LVR, and Sn-USt; between ANS-LVR and A'-LVR and Ls-LVR; between Sn-LVR and A'-LVR, USt-LVR, and Sn-USt; between A'-LVR and USt-LVR, Is-LVR, and Sn-USt; between USt-LVR and Is-LVR; between Pn-LHR and ANS-LHR, Sn-LHR, USt-LHR, Ls-LHR, and Is-LHR; between ANS-LHR and Sn-LHR, USt-LHR, Ls-LHR, and Is-LHR; between Sn-LHR and USt-LHR, Is-LHR, and Ls-USt; between USt-LHR and Ls-LHR, and Is-LHR; and between Ls-LHR and Is-LHR.

Discussion

Orthodontic treatment and orthognathic surgery, which involve hard tissues, induce modifications in the soft tissues and consequently in the facial profile. The patient’s concern with esthetics is very important, thus obliging clinicians to predict as accurately as possible the alterations that will take place.10–12,25,26

For example, since 1981, various authors have evaluated the responses of the soft tissue profile to maxillary surgical procedures at the Le Fort I level, basing their findings on pre- and postoperative cephalometric analyses.5–8,10,12,14,15,17,26 Others proposed the same evaluation based on computerized tomography (CT).8,16 Gabrielli5 highlighted the difficulties of establishing these parameters for a final prediction of the soft tissues, including complex 3-dimensional movements, especially in the cases of maxillary repositioning.

Therefore, in this study, an attempt was made to evaluate only one variable of the surgical technique, the mucosal suture, in a specific type of surgery: maxillary expansion. As discussed beforehand, this analysis proposed in repositioning surgeries of bone bases, especially the maxilla, may be jeopardized by the influence that the movements themselves give toward tegument.5,17 According to Mansour et al,27 maxillary impaction causes vertical movement at all soft tissue points of the maxilla, and maxillary advancement progressively increases the movement of the soft tissues from the tip of the nose to the far end of
the upper lip. Using alar base sutures and V-Y sutures in vertical maxillary impactions, Jensen et al\textsuperscript{12} reported anterior movement of soft tissues in 90\% of hard tissue changes and demonstrated a 20\% shortening of the upper lip and changes in NLA proportional to the degree of maxillary rotation. McCance et al\textsuperscript{8} examining subjects who had undergone Le Fort I osteotomies, detected a proportional rate between common hard and soft tissue of 1:1 at the midline, which increased to 1.25:1 at the alar bases and the canine regions bilaterally. In 1993, they perceived a constant rate of involvement on the maxilla, with the central part of the upper lip having moved 1:1, increasing to 1.25:1 in the canine regions, and 1.5:1 in the paranasal area.\textsuperscript{13} Betts et al\textsuperscript{17} used age, sex, alar suture, V-Y suture, and ANS as variables in their study; they affirmed that the soft tissue changes associated with maxillary surgeries may be affected more by the position of the incision and the methods used in closing and suturing than by the hard tissue changes. Gabrielli\textsuperscript{26} affirmed in his retrospective study that in maxillary repositioning, alterations in length, area of the transverse section, thickness of the upper lip, and NLA did not present a significant correlation with alterations in the hard tissue. Among the soft tissue reference points that were studied, only the most anterior point Pn and USt presented a significant correlation with the alterations of the hard tissue. However, in the maxillary advancement, the alterations in the cutaneous portion and the length of the upper lip presented a significant correlation with all bone and dental reference points considered, and NLA and the area of the transverse section tended to decrease. Gabrielli\textsuperscript{6} evaluating the effect of the conventional suture, the double V-Y suture, and the simple V-Y suture, all with alar base suturing, in the morphology of the maxilla’s upper lip, verified that all points in the soft tissue considered in the study presented upper movement in all 3 groups. NLA had an average increase of 6.4 degrees with the simple V-Y suture, an increase of 3.4 degrees with the double V-Y suture, and a decrease of 2.0 degrees with the simple suture. The double V-Y suture resulted in an elevation in the position of the vermilion of the upper lip, when compared to the simple suture, and there was also an advancing of A, USt, and Ls in the patients that received simple V-Y sutures when compared with the patients that received double V-Y suturing. Jensen et al\textsuperscript{12} when using V-Y sutures in patients who underwent Le Fort I osteotomies with vertical maxillary impaction, reported the horizontal response of the upper lip to maxillary advancing as being 1:1 at the sulcus, 0.8:1 at Ls, and 0.9:1 at USt. An average increase of 1.2 degrees in NLA was strongly correlated with the anterior maxillary rotation, and there was a 1-mm maxillary advancement for every 0.65-degree increase in maxillary incisor angulation. Vertically, the rate of alteration of soft tissue to hard tissue was 0.21:1 from Pn and 0.18:1 of the upper labial and subnasal sulcus in relation to A. Furthermore, the rate of alteration of the upper labial sulcus to a supra dental point was 0.17:1.

Initially, an attempt was made to evaluate the accuracy of the values obtained in this study. From that point on, with the characterization of the validity and the strength of the sample, comparative statistical analysis was employed. In this study, one can clearly identify the fitness of this experimental model; that is, procedures of maxillary expansion lend themselves to comparative analyses of soft tissue alterations caused by the type of suture used. This is evident by the absence of any statistically significant difference between the groups in items ANS-LVR or ANS-LHR. The impression of the absence of maxillary bone movement in the upper or lower direction was confirmed. From then on, an analysis was made using the 2 employed parameters as a basis (the horizontal and the vertical reference lines). If the study is divided into 2 analysis points, interesting observations can be highlighted. With LHR as a basis for comparison, no statistically significant difference between the groups was observed in any of the measurements or points studied. Thus, one can infer that since there was no alteration in bone positioning in the vertical direction, the suturing procedures would have little or no influence on the positioning of the lip in the vertical direction. This
impression is validated by the observation of this tendency between the groups, as well as between the pre- and postoperative periods in each group separately.

In clinical practice, this type of suture is used not for the purpose of elongating or shortening the upper lip, as might be assumed when using the LHR as a basis, but to increase its thickness or even the corresponding area of vermilion. When transferring this clinical interest it seems important to make correlations using LVR as a basis, which in the final analysis refers to the anteroposterior positioning. However, in this evaluation, significant differences were found. With regard to the values encountered in relation to the Ls-LVR measurement, the type of suture did in fact influence the final positioning of the lip. An isolated analysis of the control group, in which the simple suture was employed, showed a very clear tendency for a more withdrawn positioning of the lip. In all values there was at least a 5% statistical difference. This behavior can be explained by the increase in space in the arch as a result of the maxillary expansion and consequent accommodation of the incisors, with a more palatine inclination. Thus, the soft tissues would accompany this inclination.

When the experimental group was analyzed, these differences were smaller. In the USt-LVR and Is-LVR values, no difference whatsoever was observed between the pre- and postoperative periods. In the remaining values, there were significant differences, although positive, at 5%, that is, there was a more anterior positioning of the lip at these points. It can be inferred that the V-Y suture compensated for the differences in positioning of the teeth (for the palatine) in expansion surgeries, preventing the loss of labial support and, in some parameters, even promoting an increase in labial support. Even the most prominent portion of the nose, which was not altered by the simple suture, revealed a more anterior projection in the patients who received the V-Y suture. On the other hand, there was an increase in NLA, a finding that was also verified by Gabrielli.5

Interesting data were also observed with regard to the clinical evaluation of the alar base distance. In both groups, there was a distinct increase in this distance between the pre- and postoperative periods. This fact may be attributed to the movement executed by the osseous base, which expands transversely, or even by the lack of sutures in this area. From the values obtained, and from the comparison between groups, apparently the type of suture did not exercise any influence over this transverse aspect, completing this analysis that sought to give a 3-dimensional emphasis to the study.

Conclusions
In patients who undergo surgically assisted maxillary expansion, there is a tendency to have a more posterior positioning of the upper lip, without important vertical alterations. The V-Y suture seems to minimize this effect by maintaining the anteroposterior positioning of the lip, or by allowing for a more anterior position in some points. Maxillary expansion without suturing of the alar bases invariably gives rise to a widening of the nasal base, regardless of the type of suture applied over the mucosa.

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References


