Soft Tissue Profile Changes After Bilateral Sagittal Split Osteotomy for Mandibular Setback: A Systematic Review

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Purpose: To evaluate the ratio of soft tissue to hard tissue in bilateral sagittal split setback osteotomy with rigid internal fixation or wire fixation.

Materials and Methods: A literature search was performed using PubMed, Medline, CINAHL, Web of Science, the Cochrane Library, and Google Scholar Beta. From the original 766 articles identified, 8 articles were included. Two articles were prospective and 6 retrospective. The follow-up period ranged from 1 year to 12.7 years for rigid internal fixation. Two articles on wire fixation were found to be appropriate for inclusion.

Results: The differences between short- and long-term ratios of the lower lip to lower incisors for bilateral sagittal split setback osteotomy with rigid internal fixation or wire fixation were quite small. The ratio was 1:1 in the long term and by trend slightly lower in the short term. No distinction was seen between the short- and long-term ratios for mentolabial fold. The ratio was found to be 1:1 for the mentolabial fold to point B. In the short term, the ratio of the soft tissue pogonion to the pogonion showed a 1:1 ratio, with a trend to be lower in the long term. The upper lip showed mainly protrusion, but the amount was highly variable.

Conclusions: This systematic review shows that evidence-based conclusions on soft tissue changes are difficult to draw. This is mostly because of inherent problems of retrospective studies, inferior study designs, and the lack of standardized outcome measurements. Well-designed prospective studies with sufficient samples and excluding additional surgery, ie, genioplasty or maxillary surgery, are needed.

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An accurate prediction of the postoperative facial profile is an essential step in the treatment planning process for combined surgical orthodontic therapy. In addition to the popular conventional lateral cephalogram for 2-dimensional analysis, newer methods to quantify the soft tissue profile, such as optical laser surface scanners,1,2 stereophotogrammetry with 2 or more cameras,3 or computer tomography-assisted imaging4,5 exist for 3-dimensional analysis.

However, most clinicians in daily practice still use the 2-dimensional approach to predict the effect of maxillofacial surgery on the soft tissue profile. Possible problems that evolve when using prediction software based on data from research are the large individual variabilities in soft tissue response or differences in skeletal stability among patients undergoing the same procedure, technical or operator inaccuracies when generating the prediction, and differences in age and gender between groups.6

Surgical correction used to have as the primary objective the restoration of normal occlusion and the
resulting change in the soft tissue profile was secondary. Modern approaches initiate their maxillofacial treatment by the newly defined endpoints of a patient’s soft tissue profile and derive from that the necessary dental and skeletal movements. This with the reflection that different methods for (segment) osteotomies currently exist to achieve more perfect esthetic results, and wrongly angulated teeth should not dictate the final surgical positioning of the jaws. In a Class III jaw relation, the maxillary incisors are often proclined and mandibular incisors retroclined, which makes it necessary to remove dental compensations with extraction of premolars or the addition of other surgical procedures (ie, distraction of the anterior alveolar segment in combination with a Le Fort I procedure) to achieve normal inclined incisors.

However, accurate prediction of the postoperative facial profile remains an essential step in the treatment planning of combined surgical-orthodontic therapy and increases a patient’s understanding and acceptance of the recommended treatment. Prediction procedures are mainly based on ratios representing soft tissue profile changes relative to the surgical movement of the underlying bone. Studies evaluating these ratios or regression equations represent the database for manual and computerized surgical predictions.

Clinical trends for fixing the proximal to the distal segment intraoperatively show an increased use of rigid internal fixation (RIF) instead of wire fixation (WF), but data on patients treated by WF continue to be published. However, no systematically reviewed data are yet available on the soft tissue outcome in patients with bilateral sagittal split setback osteotomy (BSSO) for mandibular setback. Furthermore, a separate analysis and direct comparison between RIF or WF in the short and long term are still missing.

The aim of this study was to systematically review the literature on the soft tissue profile after BSSO setback with different types of RIF and WF. The specific research questions were:

1. What is the relation between the soft tissue and skeletal movements in BSSO setback surgery?
2. Is there a difference between short- and long-term results?
3. Is there any difference between RIF and WF?

Materials and Methods

LITERATURE SEARCH

A literature search to identify articles reporting BSSO advancement with surgical-orthodontic treatment with RIF or WF and ratios of soft to hard tissue was performed using the following databases.

- PubMed (from 1966 to week 3 of August 2009)
- Medline (from 1966 to week 3 of August 2009)
- Google Scholar Beta (to week 3 of August 2009)
- EMBASE Excerpta Medica (from 1980 to week 3 of August 2009)
- CINAHL (from 1982 to week 3 of August 2009)
- Web of Science (from 1945 to week 3 of August 2009)
- CENTRAL of the Cochrane Library (to week 3 of August 2009)

Free text words and Medical Subject Heading terms were used. The heading sequence ("BSSO" OR “bilateral sagittal split osteotomy” OR “sagittal split osteotomy” OR “mandibular osteotomy” OR “orthognathic surgery”) AND [“soft tissue” OR “soft tissue profile” OR “soft tissue relapse” OR “relapse” OR “stability”] AND “cephalometry” [Medical Subject Heading] NOT “distraction”) was selected. No exclusion of articles based on language was performed. To complete the search, references of each selected publication on soft tissue profile after BSSO setback surgical-orthodontic treatment were hand-searched.

SELECTION CRITERIA

The following inclusion criteria were chosen initially to select potential articles from the published abstract results:

1. Human clinical trials
2. Sample with at least 10 subjects
3. Lateral cephalograms used for horizontal soft tissue stability, which was measured on the pogonion (Pg) and/or point B and/or lower incisor to their corresponding soft tissue points
4. BSSO for mandibular setback with RIF or WF; genioplasty was accepted

Exclusion criteria were:

1. Syndromic or medically compromised patients
2. No case reports, case series of fewer than 10 patients, descriptive studies, review articles, opinion articles
3. No surgical intervention (ie, Le Fort I, other types of mandibular surgery, etc) other than BSSO for mandibular setback with RIF or WF

Articles that met the final inclusion criteria were divided into 2 groups according to the RIF or WF method used. The cutoff value of less than 2 years was chosen to separate short- from long-term studies. If more than 1 publication on the same patient group for the same postoperative follow-up was present, the most informative and relevant article was included.
Personal communication took place with 5 investigators\textsuperscript{16-20} to complete information on RIF material, mean age, and genioplasties.

DATA EXTRACTION

Data were extracted and methodologic quality was assessed by 2 observers (C.J., I.J.V.) independently. Data were recorded on specially designed data extraction forms. First, abstracts were reviewed without considering the number of patients reported. Articles that apparently fulfilled the inclusion criteria and articles whose title or abstract did not present enough relevant information were obtained in full text. Second, full-text articles were extracted on the following items: year of publication; study design; follow-up period; number and mean age of patients; ethnic background of patients; number of surgeons operating; type of RIF or WF; presence of orthodontic treatment; intermaxillary fixation; genioplasty; splint; mean skeletal advancement; mean ratio between the lower incisor, point B, and Pg and their corresponding soft tissue points in the lower lip (labrale inferior), mentolabial fold (Mlf), and soft tissue Pg (Pg'); ratios for the labrale superior to the lower incisor, point B, or Pg when present; and correlations between soft tissue points and different variables such as age, gender, and relapse, etc. Missing ratios between soft and hard tissue points were calculated by published data.

In addition, to document the methodologic soundness of each article, a quality evaluation modified by the methods described by Jadad et al\textsuperscript{21} and Petrén et al\textsuperscript{22} was performed with respect to pre-established characteristics. The following characteristics were used: study design; sample size and prior estimate of sample size; selection descriptions; withdrawals (dropouts); valid methods; confounding factors considered, eg, genioplasty; presence of a splint on the immediate postsurgical radiographs and brackets bonded on teeth in the follow-ups; method of error analysis; blinding in measurements; and adequate statistics. The quality was categorized as low, medium, or high. In case of discrepancy regarding inclusion criteria, quality evaluation, or extracted data between the observers, a consensus decision was taken.

Results

RESULTS OF SEARCH

The search strategy resulted in 766 articles and the number of abstracts selected was 168 (Table 1). The hand-search disclosed 24 studies. The Quality of Reporting of Meta-Analyses flow diagram provides an overview of the final selection process (Fig 1). Eight suitable studies (7 articles from the electronic search and 1 from the hand-search) were identified after consideration of all inclusion criteria (Table 2). Six articles that met the first inclusion criteria were rejected because of final selection criteria. Reasons for final rejection were that patients had other types of setback surgery or the exact surgical procedure was not described in 3 studies\textsuperscript{23-25} or insufficient patient and/or surgical outcome data in 3 studies.\textsuperscript{26-28}

QUALITY ANALYSIS

Most studies (6)\textsuperscript{17-19,29-31} were retrospective, and only 2\textsuperscript{16,20} were prospective. The ethnic background of the treated patients in all reviewed studies was mainly white. Only 1 article\textsuperscript{31} on Asian subjects was found in the literature reviewed.

Methodologic quality assessment revealed that the research quality or methodologic soundness was low in 6 studies and of medium quality in 2 studies (Table 2). The most obvious findings were small samples implying low power, lack of error analysis, no blinding of measurements, and deficient or lack of statistical analysis. Furthermore, no study declared any power analysis. Four studies\textsuperscript{16,19,30,31} were judged to have an adequate sample, ranging from 29 to more than 80.

In all studies, the methods used to detect and analyze the postoperative ratios between soft and hard tissue were valid and well known. However, 1 study\textsuperscript{17} did not include a method error analysis and none of the studies used blinding in measurements.

Considering the confounding variable genioplasty, 1 study stated that additional genioplasty was carried out in only 2 patients, but points Pg, Pg', menton (Me), and soft tissue menton (Me') in these patients were excluded from data analysis.\textsuperscript{16} And in 1 study it was not clear if patients with genioplasty were included or not.\textsuperscript{29} None of the studies analyzed the presence of bonded brackets and their influence on follow-up cephalograms.
Another confounding variable was the presence of a splint on the immediate postsurgical radiographs. Surgical splints were not used in 3 studies. In 3 patients in a study by Mobarak et al., splints were present on the postsurgical radiographs but the immediate postsurgical data of these patients were excluded. One study probably using surgical splints did not comment on the presence of a splint on the immediate postsurgical radiographs or compensate for its presence.

**FOLLOW-UP PERIOD**

The follow-up period ranged from 1 year to 12.7 years for RIF (Tables 3 and 4). Six studies were short term and 2 were long term. The follow-up for the studies using WF (Table 5) was 12 to 16 months.

**SHORT-TERM SOFT TISSUE RATIOS**

Short-term ratios for RIF without genioplasty (Table 3) were –1% to 23% for the upper lip to the inferior incisor, point B, or Pg. It was 73% to 90% for the lower lip to the inferior incisor. The Mlf followed point B at 106% to 108%. The Pg’ followed the Pg at 88% to 128%.

**LONG-TERM SOFT TISSUE RATIOS**

Long-term ratios for RIF without genioplasty (Table 4) were 29% to 78% for the upper lip to the inferior incisor, point B, or Pg and 100% for the lower lip to the inferior incisor. The Mlf followed point B at 99% to 106%. The Pg’ followed the Pg at 79% to 94%.

**FIGURE 1. Quality of Reporting of Meta-Analyses flow diagram.**

CORRELATIONS

Correlation statistics for other variables, such as gender, age, etc, were used in only 2 studies. Another study used correlation statistics only to assess the relation between change in hard and soft tissue structures.

GENDER

Effects of gender on soft tissue changes were reported by 3 studies. The findings of Mobarak et al indicated that soft tissue movement in response to skeletal repositioning is somewhat greater in women than in men for the upper lip and the chin. Joss et al showed that women in contrast to men were more likely to have more backward movement of the soft tissue instead of forward movement seen for the labrale inferior, Mlf, and Pg in the long term.

AMOUNT OF SETBACK

Mobarak et al showed that soft tissue changes after small setbacks were less predictable compared with large setbacks. Greater mandibular setback resulted in more retrusion and lengthening of the upper lip.

SOFT TISSUE MORPHOLOGY

Soft tissue thickness and preoperative morphology were investigated by Mobarak et al. Their results revealed associations between the preoperative thickness of the upper and lower lips and the net change in thickness in the sense that the greater the preoperative soft tissue thickness, the greater the expected change. However, the correlations between preoperative soft tissue thickness and the net change in soft tissue thickness were too weak to provide clinically useful predictions.

Table 2. ARTICLES (N = 8) INCLUDED IN REVIEW

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Country</th>
<th>Study Design</th>
<th>Judged Quality Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alves et al</td>
<td>2008</td>
<td>Brazil</td>
<td>CT, R</td>
<td>Low</td>
</tr>
<tr>
<td>Joss et al</td>
<td>2008</td>
<td>Switzerland</td>
<td>CT, P</td>
<td>Medium</td>
</tr>
<tr>
<td>Chou et al</td>
<td>2005</td>
<td>Taiwan</td>
<td>CT, R</td>
<td>Low</td>
</tr>
<tr>
<td>Mobarak et al</td>
<td>2001</td>
<td>Norway</td>
<td>CT, R</td>
<td>Low</td>
</tr>
<tr>
<td>Enacar et al</td>
<td>1999</td>
<td>Turkey</td>
<td>CT, R</td>
<td>Low</td>
</tr>
<tr>
<td>Gaggl et al</td>
<td>1999</td>
<td>Austria</td>
<td>CT, R</td>
<td>Low</td>
</tr>
<tr>
<td>Ingervall et al</td>
<td>1995</td>
<td>Switzerland</td>
<td>CT, P</td>
<td>Medium</td>
</tr>
<tr>
<td>Schatz and Tsimas</td>
<td>1995</td>
<td>Switzerland</td>
<td>CT, R</td>
<td>Low</td>
</tr>
</tbody>
</table>

Abbreviations: CT, clinical trial; P, prospective study; R, retrospective study.


Table 3. SUMMARIZED DATA OF 4 SHORT-TERM STUDIES WITH BSSO SETBACK SURGERY WITH RIF

<table>
<thead>
<tr>
<th>Study</th>
<th>Type of Surgery (RIF, IMF, Genioplasty, etc)</th>
<th>No. of Patients</th>
<th>Type of RIF</th>
<th>Design</th>
<th>No. of Surgeons</th>
<th>No. of Patients in Follow-Up</th>
<th>Mean Age (Range)</th>
<th>Ls</th>
<th>Li</th>
<th>Ii</th>
<th>Mlf : Pg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alves et al</td>
<td>BSSO with RIF (2 titanium bicortical screws), no genioplasty, no IMF</td>
<td>41</td>
<td>1</td>
<td>CT</td>
<td>1</td>
<td>13.2 mo</td>
<td>23 yr</td>
<td>-1% (Ls:Li), -1% (Ls:Pg)</td>
<td>73% - 94%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chou et al</td>
<td>BSSO with RIF (5 bicortical screws), no genioplasty, IMF</td>
<td>64</td>
<td>3</td>
<td>CT</td>
<td>20.0 ± 1.6 yr</td>
<td>20 yr (17–54)</td>
<td>0% (Ls:Pg)</td>
<td>88%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingervall et al</td>
<td>BSSO with RIF (5 titanium lag screws), genioplasty in 2 patients, no IMF</td>
<td>29</td>
<td>4</td>
<td>CT</td>
<td>20 yr (17–54)</td>
<td>1 yr</td>
<td>22% (Ls:Pg), 23% (Ls:Pg)</td>
<td>107%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schatz and Tsimas</td>
<td>BSSO with RIF (bicortical screws), no genioplasty, IMF</td>
<td>13</td>
<td>-</td>
<td>CT</td>
<td>23.1 yr (16.7–38.4)</td>
<td>1 yr</td>
<td>90%</td>
<td>108%</td>
<td>128%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: —, not reported; B, point B; BSSO, bilateral sagittal split setback osteotomy; Ii, incision inferior; IMF, intermaxillary fixation; Li, labrale inferior; Ls, labrale superior; Mlf, mentolabial fold; Pg, pogonion; Pg = soft tissue pogonion; RIF, rigid internal fixation; ss, stainless steel.

### Table 4. SUMMARIZED DATA OF 2 LONG-TERM STUDIES WITH BSSO SETBACK SURGERY WITH RIF

<table>
<thead>
<tr>
<th>Study</th>
<th>Type of Surgery (RIF, IMF, Genioplasty, etc)</th>
<th>Number of Surgeons</th>
<th>Number of Patients</th>
<th>Mean Age (Range)</th>
<th>Follow-Up</th>
<th>Ls</th>
<th>Li:li</th>
<th>Mlf:B</th>
<th>Pg:Pg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joss et al. 2008</td>
<td>BSSO with RIF (3 titanium lag bicortical screws, diameter 3.5 mm), no splint, no genioplasty, IMF for 4-8 d</td>
<td>4</td>
<td>17</td>
<td>27.1 yr (18.9-40.5)</td>
<td>12.7 yr</td>
<td>78%</td>
<td>77%</td>
<td>75%</td>
<td>100%</td>
</tr>
<tr>
<td>Mobarak et al. 2001</td>
<td>BSSO and RIF (3 bicortical screws with washers), IMF (d?), no genioplasty and other surgery, splint</td>
<td>7</td>
<td>80</td>
<td>24.5 ± 7.6 yr</td>
<td>3 yr</td>
<td>35%</td>
<td>29%</td>
<td>35%</td>
<td>100%</td>
</tr>
</tbody>
</table>

NOTE. Negative values imply a posterior movement, positive values an anterior movement.

Abbreviations: B, point B; li, incision inferior; IMF, intermaxillary fixation; Li, labrale inferior; Ls, labrale superior; Mlf, mentolabial fold; Pg, pogonion; Pg', soft tissue pogonion; RIF, rigid internal fixation.


### Table 5. SUMMARIZED DATA OF 2 SHORT-TERM STUDIES WITH BSSO SETBACK SURGERY WITH WF

<table>
<thead>
<tr>
<th>Study</th>
<th>Type of Surgery (Genioplasty, IMF, etc)</th>
<th>Number of Surgeons</th>
<th>Number of Patients</th>
<th>Mean Age (Range)</th>
<th>Follow-Up</th>
<th>Ls</th>
<th>Li:li</th>
<th>Mlf:B</th>
<th>Pg:Pg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enacar et al. 1999</td>
<td>BSSO with WF or RIF (bicortical screws and miniplates), IMF (wk?), splints, no genioplasty</td>
<td>—</td>
<td>12</td>
<td>21.5 ± 1.4 yr</td>
<td>1 yr</td>
<td>1%</td>
<td>—</td>
<td>—</td>
<td>59%</td>
</tr>
<tr>
<td>Gaggl et al. 1999</td>
<td>BSSO with WF, IMF for 6 wk, genioplasty?</td>
<td>—</td>
<td>60</td>
<td>22 yr (19-26)</td>
<td>12-16 wk</td>
<td>33%</td>
<td>28%</td>
<td>52%</td>
<td>83%</td>
</tr>
</tbody>
</table>

NOTE. Negative values indicate a posterior movement, positive values an anterior movement.

Abbreviations: —, not reported; B, point B; li, incision inferior; IMF, intermaxillary fixation; Li, labrale inferior; Ls, labrale superior; Pg, pogonion; Pg', soft tissue pogonion; RIF, rigid internal fixation; WF, wire fixation.

Discussion

This systematic review was designed to process ratios of 1 specific maxillofacial surgical procedure, in the sense that the more surgical procedures one adds, the more complex soft tissue prediction becomes. The Quality of Reporting of Meta-Analyses statement was used as a basis to improve the completion of this systematic review. A lack of quality in the reviewed studies was found, which makes drawing conclusions difficult. Therefore, at present, a meta-analysis of the data is impossible. To increase the power of this systematic review, it would be necessary to include only randomized clinical trials, prospective multicenter articles, or prospective clinical trials.

Calculating ratios between the movement of the hard tissue and soft tissue is a simple and effective method to quantify soft tissue profile changes after surgery. These ratios are the basis of prediction software programs used to guide the surgeon, orthodontist, and patient in their decision-making process. Another interesting question is whether one should use linear or nonlinear ratios of soft to hard tissue because it has been proposed and adopted by some software programs and evaluated in Class III patients receiving a combination of Le Fort I and BSSO setback. There was evidence for a linear relation between hard and soft tissue changes. However, the nonlinear hypothesis could not be supported by any of the reviewed articles, probably because this research question was not addressed.

An interesting question would be the role of lip thickness and its correlation to the amount of hard tissue movement and soft tissue change. Stella et al found that increased lip thickness produced a less predictable correlation between hard and soft tissue changes compared with thin lips in patients with Le Fort I advancement. A thick upper lip may have a tendency to absorb a large amount of maxillary advancement without a perceptible change in soft tissue contour. However, no clear association was found between soft tissue thickness and ratios of soft to hard tissue changes after mandibular setback surgery with vertical ramus osteotomy. The findings of Hu et al in Class III patients showed that a greater thickness of soft tissue in men compared with women resulted in a smaller ratio of soft to hard tissue change 1 year after intraoral oblique or vertical ramus osteotomy. Others showed that soft tissue movements and ratios in women were greater than in men after vertical ramus osteotomy for mandibular setback. Differences for soft tissue profile prediction between men and women were found in 3 reviewed studies and have to be accounted for in BSSO for mandibular setback. Differences in soft tissue ratios between male and female patients were related to the preoperative soft tissue thickness, and soft tissue movement was greater in women compared with men for the upper lip and the chin. In the opinion of Mobarak et al, the use of ratios instead of absolute measurements eliminates the effect of size differences between men and women. They showed that soft tissue changes after small setbacks were less predictable compared with large setbacks, and accredited the poor predictability to the possible greater rotation of the distal segment with a greater component of vertical repositioning in cases with small setbacks. However, correlation statistics were used in only 3 of the studies reviewed.

SHORT-TERM COMPARED WITH LONG-TERM RATIOS

Bailey et al postulated that 3 possibilities for long-term soft tissue relapse exist: 1) resolution of edema or other soft tissue change related to the surgery; 2) postsurgical growth and remodeling of hard tissue landmarks, which would be reflected in changes of the overlying soft tissue; and 3) soft tissue changes as a result of maturation and aging.

The cutoff value of less than 2 years was chosen to separate short- from long-term studies in this review. The differences between short- and long-term ratios of the lower lip to the lower incisors for BSSO with RIF or WF were quite small. It was 1:1 in the long term and by trend slightly lower in the short term. No distinction was seen between the short-term and long-term ratios for Mlf. The ratio was 1:1 ratio for Mlf to point B. In the short term the ratio of Pg’ to Pg was 1:1 and in the long term showed a tendency to be lower (Fig 2). A 3-dimensional analysis using computed tomograms in 17 patients with BSSO for mandibular setback showed anteroposterior ratios of 1:0.78 for point B to Mlf and 1:0.86 for the Pg to Pg’ 6 months postoperatively. In addition to the new soft tissue position of the lower face, an important short-term effect of maxillofacial surgery is postoperative swelling (edema from retraction, irritations, and inflammation). Thus, the immediate short-term soft tissue profile changes measured on lateral cephalogram are always in addition to the surgery, swelling, and thickness of the orthodontic brackets. A more anterior soft tissue location would result in smaller ratios for soft tissue points immediately after surgery. Therefore, it is advisable to consider an adequate healing period of several months for follow-up measurements. In a 3-dimensional laser-scanned sample of 3 surgical patients, it was shown that facial morphology recovers to approximately 90% of the 6-month postsurgical baseline within 3 months after bimaxillary surgery. Dolce et al showed that the swelling caused by BSSO for
mandibular advancement began to resolve by 8 weeks and was fully resolved by 6 months.

The effects of aging and changes in soft tissue elasticity were analyzed by Behrents. In his longitudinal and long-term survey on nontreated subjects, he found that the distance between the sella and labrale superior increased in adulthood and that the labrale superior moved downward. He also described a forward and downward movement of the Pg =\textsuperscript{1} and soft tissue menton for both genders in adulthood. Menton achieved a more prominent Pg =\textsuperscript{1}, a less accented Mlf, more retrusive lower lip, and a larger and more angular nose compared with women. Forsberg carried out a longitudinal study of facial growth over a 10-year period in 49 subjects 24 to 34 years of age. In this period, the nose moved forward, and a retrusion of the lips and a posterior movement of the Pg =\textsuperscript{1} were seen. He pointed out that a close relation between the changes of the soft tissue and the underlying hard tissue could not be expected. The soft tissues are also subject to the influence of the tension of the oral musculature and the amount of subcutaneous fat present at different ages.

BSSO for mandibular setback surgery affects the upper lip in horizontal and vertical directions, although no concomitant maxillary surgery is done. Effects on the upper lip are seen as lengthening and more retrusive\textsuperscript{16} at a mean of 1 to 2 mm in the short term. In the long term, a continuous lengthening of the labrale superior of about 2 mm and a retrusion of 4 mm are seen.\textsuperscript{20} The abnormal incisal relation before surgery is likely to be the reason the upper lip was kept in a more protruded “pseudo-position” as a form of adaptation and compensation.\textsuperscript{16,20,43} An increase of upper lip retrusion and part of its lengthening from short to long term could be due to bracket removal. Retrusion and lengthening of the labrale superior were also attributed to the lack of soft tissue strength with increased age.\textsuperscript{20}

The lower lip was more variable.\textsuperscript{16} It was pointed out that there is a tendency of the lower lip length to decrease in the short term after mandibular setback surgery.\textsuperscript{16} From the short to the long term, only little lip length diminution and retrusion of the lower lip were seen.\textsuperscript{20}

The initial increase in lower lip inclination was not maintained and the original inclination was regained 1 year postoperatively, probably related to the resolution of edema. The lower lip reached a state of equilibrium within the first 6 months after surgery. Why the lower lip was not similarly affected by skeletal changes could be partly explained by the retroclination of the lower incisors as compensation for skeletal relapse. The increase in Mlf depth is most probably related to the decrease in soft tissue thickness in that area.\textsuperscript{30}

In the long term, the Pg =\textsuperscript{1} and Mlf showed only little forward movement in the horizontal direction, probably due to sagittal relapse of the underlying skeletal tissue. In the vertical direction, downward movement of the Pg =\textsuperscript{1} was seen mostly in the long term, although interindividual variation was quite high.\textsuperscript{20}

DIFFERENCE BETWEEN SETBACK AND ADVANCEMENT

A comparison between soft tissue ratios in patients systematically reviewed with BSSO for mandibular advancement \textsuperscript{12} and the present systematic review shows differences in the behavior of the labrale superior and inferior. In mandibular advancement the labrale inferior follows the lower incisors in general to 50% and in mandibular setback to 100%. Predictability of the upper lip after BSSO for mandibular setback and advancement is poor and highly variable in both directions. The upper lip demonstrates a forward movement of about 30% in setback and a backward movement of around 30% in patients with advancement. The Mlf and Pg =\textsuperscript{1} behave similarly in a 1:1 ratio for patients with BSSO mandibular advancement and setback. However, the ratio of the Pg =\textsuperscript{1} to the Pg in the long term showed a tendency to be lower in BSSO with RIF for setback and higher in advancement.

Another important difference between BSSO for mandibular advancement and setback is that mandibular advancement has a “lifting effect” of the soft...
tissue on the profile because of stretching. In contrast, mandibular setback leads to a compression of soft tissue due to shortening of mandibular bone length by unchanged soft tissue volume. This relative increase of soft tissue could lead to a double chin, relative deepening of the Mlf, loss of tissue strength, and, in consequence, premature aging of the face. The decrease in the size of the oropharynx due to mandibular setback surgery also could lead to a prominence of the tongue mass in the floor of the mouth. A probable increase in pressure in a forward direction of the mandible could be an explanation for the relapse. To overcome this compromising esthetic result of a double chin; submental fullness; or cervical skin laxity, the “turkey gobbler” deformity; Le Fort I result of a double chin; submental fullness; or cervical

References

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