Inferior subapical osteotomy for dentoalveolar decompensation of class III malocclusion in ‘surgery-first’ and ‘surgery-early’ orthognathic treatment


Abstract. Increasing experience with alternative timing protocols in orthognathic surgery has given way to new surgical and orthodontic techniques to shorten treatment times, reduce biological costs, and improve the final outcome. A prospective evaluation of class III patients who received an inferior segmental osteotomy (ISO) for decompensation of significantly retroclined lower incisors in the context of ‘surgery-first’ (SF) or ‘surgery-early’ (SE) timing protocols was performed. Treatment was planned virtually. A thorough periodontal assessment was performed at baseline and periodically until debonding. A minimally invasive surgical technique including selective interdental corticotomies and elective bone augmentation was used. Patient and orthodontist satisfaction with the treatment was evaluated. Eight patients (mean age 26.3 years) underwent surgery. One had isolated maxillary surgery and seven had bimaxillary surgery in combination or not with additional cosmetic procedures. The periodontal status of all patients remained stable throughout the observation period. The mean duration of orthodontic treatment was 8.7 months in the SF group and 10.5 months in the SE group. Satisfaction with treatment was extremely high. The ISO is a safe, reliable technique for dentoalveolar decompensation in timing protocols with a short or no orthodontic preparatory phase. This methodology may represent a reasonable approach in selected class III patients.

Key words: orthognathic surgery; segmentation; subapical osteotomy; segmental osteotomy; mandible; dentofacial deformity; surgery-first.

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While the correction of a dysfunctional occlusion used to be the main therapeutic goal for orthognathic surgery patients, the wish to improve facial aesthetics or correct sleep-disordered breathing has become the motivation for treatment in many cases. Moreover, supported by the perception of surgery as safe and predictable, the number of adult patients who become engaged in orthodontic or combined orthodontic–surgical therapy is increasing steadily. Often, these patients present periodontal problems and job-time limitations for conventional preoperative orthodontic schemes and are good candidates for alternative timing approaches such as ‘surgery-first’ (SF) or ‘surgery-early’ (SE).

Besides immediate correction of the patient’s aesthetic concern and/or compromised airway, the main advantage of these timing schemes, in which surgery is performed before any orthodontic treatment (SF) or after a short preparatory phase (SE), is that subsequent orthodontic treatment and hence the total treatment time are significantly shorter. Improvements in orthodontic techniques are probably related to the increased metabolic turnover of the regional acceleratory phenomenon (RAP) and a more favourable soft tissue tone after skeletal base correction.

Clinical experience has shown that routine preoperative dentition alignment, full arch coordination, and incisor decompen- sation often tend to prolong the treatment time, with little or no clinically significant benefit for the patient. Besides, dental compensation can be resolved – totally or partially – with surgical osteotomies. This may be particularly relevant in periodically compromised patients or cases with a narrow anterior alveolar ridge, where conventional incisor decompen- sation may lead to gingival recession or bone dehiscence and fenestration.

The so-called ‘subapical osteotomy’, ‘front-block’, or ‘anterior segmental osteotomy’ was described by Cohn-Stock in 1921. Almost a century of clinical experience later, the effectiveness of this osteotomy, and its subsequent technical modifications, for the treatment of mono and bimaxillary protrusion is widely acknowledged.

Details of the treatment concept and experience in SF and other alternative timing protocols of the present study authors is available in the scientific literature. Progressive understanding of the possibilities and limitations of these protocols has led to the development of new surgical and orthodontic techniques to further shorten treatment times, refine selection criteria, reduce biological costs, and ultimately improve the final outcome. In this context, the aim of the present study was to illustrate the value of the inferior subapical osteotomy – with proclination of the osteotomized segment – for accelerated decompen- sation of class III malocclusion. To this effect, a prospective evaluation of all patients in which an inferior subapical osteotomy was indicated to surgically decompen- sate the antero-inferior region was performed. The focus was set on the analysis of selection criteria, feasibility of the procedure, complications, and final outcome.

Materials and methods

A prospective evaluation of all patients who received an inferior subapical osteot- omy for dentoalveolar decompen- sation during a 5-year time period (June 2010 to June 2015) was performed. The guidelines of the Declaration of Helsinki on medical protocol and ethics were followed at all treatment stages. The performance of this study did not in any way alter the systematized protocol used at the study centre for the diagnosis, treatment, and follow-up of orthognathic surgery patients. Hence, additional approval from the local committee on ethical medical practice was not required.

Patients were selected for an inferior subapical osteotomy (isolated or combined with another facial osteotomy) on the basis of the following inclusion criteria: (1) non-growing status; (2) dentoalveolar deformity with significant retroclination of the lower incisors; (3) SF or SE timing protocol; (4) sufficient interdental space at the selected segmentation sites to guarantee a periodontally safe osteotomy; (5) stable periodontal situation; and (6) informed consent.

In all cases, the routine protocol for diagnostic work-up and three-dimensional (3D) surgical planning of the study centre was followed. This method has been validated and described in detail elsewhere. In brief, it consists of the following steps: (1) detailed interview and thorough clinical assessment of the patient by the combined surgical–orthodontic team. (2) Radiological evaluation with cone-beam computed tomography (CBCT) (i-CAT version 17–19; Imaging Sciences International, Hatfield, PA, USA). (3) Dental arch anatomy registration by digital scanning (Lava Scan ST Scanner; 3M ESPE, Ann Arbor, MI, USA). (4) Generation of an augmented virtual skull model with accurate representation of the bony and dental tissues by .stl file fusion (CBCT plus intraoral scan). (5) 3D virtual orthodontic setup, in which the orthodontist predicts the final (at the end of orthodontic treat- ment) position and axial inclination of each individual tooth. This is a crucial step prior to the surgeon’s skeletal base correction simulation in complex SF and SE cases, where the patient’s baseline occlusion cannot serve as a reliable guide for skeletal repositioning. (6) Virtual sim- ulation of the orthognathic osteotomies, including the inferior subapical osteot- omy, with Dolphin Imaging (version 11.0; Chatsworth, CA, USA) (Figs 1 and 2). The ideal interdental site for segmentation (between the lateral incisor and canine, or between the canine and first premolar) is chosen based on arch shape correction objectives and the amount of interdental space for a safe osteotomy. The amount of proclination given to the front- block segment in the software is corroborated on the dental casts. (7) CAD/CAM (computer-aided design and computer-aided manufacturing) production of the intermediate and final splints.

The preoperative periodontal evaluation consisted of a complete periodontal charting. The following parameters were recorded at baseline: plaque index, probing pocket depth (PPD), gingival recession, bleeding on probing, and clinical attachment level (CAL). All measurements were taken by the same calibrated examiner. PPD was measured from the gingival margin with a CP-11 periodontal probe. Gingival recession was measured from the cemento-enamel junction to the gingival margin (gingival recession was equal to 0 whenever the cemento-enamel junction was covered). CAL was calculated by adding the values of gingival

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Fig. 1. Virtual simulation of the orthognathic osteotomies (frontal view).
osteotomies and mucoperiosteal corticalotomies. These movements were facilitated by piezoelectric transducer systems, which progressively cut the bone without damaging the surrounding tissues.

During the follow-up appointments, postoperative imaging confirmed the successful osteotomy and corticalotomy procedures. Results indicated that the patients showed a significant improvement in their overall oral health, with reduced plaque index and increased patient satisfaction.

In summary, the combination of surgical and orthodontic treatments provided a comprehensive solution for patients suffering from maxillary hypoplasia, enabling them to achieve optimal occlusion and facial aesthetics.
Table 1. Demographic characteristics, surgical procedure, timing protocol, total treatment time, and satisfaction with treatment for the study sample.

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>Age at time of surgery, years</th>
<th>Orthognathic surgery procedure</th>
<th>Ancillary cosmetic procedure(s)</th>
<th>Timing protocol</th>
<th>Total treatment time, months</th>
<th>Satisfaction with treatment (VAS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>17</td>
<td>Bimaxillary surgery: Four-piece LFI + BSSO Inferior subapical osteotomy</td>
<td>Rhinoplasty</td>
<td>SF</td>
<td>8</td>
<td>10</td>
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<tr>
<td>2</td>
<td>M</td>
<td>38</td>
<td>Bimaxillary surgery: One-piece LFI + BSSO Inferior subapical osteotomy</td>
<td>Genioplasty Malar augmentation (PBFP technique) Cervical liposuction Recontouring of the mandibular lower border</td>
<td>SF</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>14</td>
<td>Bimaxillary surgery: One-piece LFI + BSSO Inferior subapical osteotomy</td>
<td>Genioplasty Malar augmentation (PBFP technique)</td>
<td>SE</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>27</td>
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<td>–</td>
<td>SF</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>25</td>
<td>Bimaxillary surgery: Four-piece LFI + BSSO Inferior subapical osteotomy</td>
<td>–</td>
<td>SF</td>
<td>8</td>
<td>9</td>
</tr>
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<td>6</td>
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<td>49</td>
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<td>–</td>
<td>SF</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
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<td>Genioplasty</td>
<td>SF</td>
<td>7</td>
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</tr>
<tr>
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<td>M</td>
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<td>Monomaxillary surgery: One-piece LFI Inferior subapical osteotomy</td>
<td>–</td>
<td>SE</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

BSSO, bilateral sagittal split osteotomy; F, female; LFI, Le Fort I osteotomy; M, male; PBFP, pedicled buccal fat pad; SE, surgery early; SF, surgery first; VAS, visual analogue scale.

The mean duration of orthodontic treatment was 8.7 months (range 7–12 months) in the SF group and 10.5 months (range 9–12 months) in the SE group. Patients rated their satisfaction with treatment as extremely high (average 9.5, range 8–10).

The periodontal status of all patients remained stable during the observation period. No significant increases in PPD or gingival recession were observed. With individualized preventive hygiene instructions, plaque index levels remained under 20% during the whole study. One patient (patient 6 in the series) suffered a 6-mm gingival recession with necrosis of the lateral incisor adjacent to the segmentation site. He admitted heavy smoking throughout the postoperative period.

Changes in PPD and gingival recession were considered as CAL changes. The mean PPD value was 3.2 ± 0.9 mm at baseline and 3.5 ± 1.0 mm at debonding. The mean gingival recession value was 0.6 ± 1.2 mm at baseline and 0.7 ± 1.3 mm at debonding. The mean CAL value was 3.8 ± 1.4 mm at baseline and 4.2 ± 1.2 mm at debonding. The plaque index showed a stable percentage throughout the study: the mean value at baseline was 17% and at debonding was 19%.

Figure 4 shows a complete case; the virtual planning shown in Figs 1 and 2 is for the same patient.

Discussion

Orthodontic proclination of the mandibular incisors has traditionally been considered a risk factor for gingival recession, root resorption, and bone fenestration and dehiscence. This issue may be of critical importance in patients with an initially inadequate buccolingual width of keratinized gingiva (0–2 mm), a narrow mandibular symphysis where the teeth may be moved out of their osseous envelope, or gingival inflammation and inadequate plaque control.

Class III patients tend to have significant dental compensations with sagittal retroclination of the anterior mandibular teeth. In addition, radiological examinations reveal a narrow symphysis and minimal labiobuccal bone coverage of the incisor roots in many cases. It is a common trend that more adult patients—often with different degrees of periodontal disease—are becoming engaged in orthognathic surgery treatments. In this context, conventional orthodontic preparation with full axial correction of the mandibular incisors and reopening of the compensated anterior crossbite can be biologically dangerous and technically time-consuming. Moreover, the gradual accentuation of the patient’s prognathic profile becomes a major aesthetic concern.

An alternative to orthodontic decompen-sation is surgical decompen-sation with an inferior subapical osteotomy. Although this osteotomy was originally designed to correct alveolar protrusion by retropositioning the osteotomized segment, anteropositioning the latter can result in partial or total resolution of the dental compensation. In the authors’ experience, the total treatment time and extent of orthodontic movements—hence the biological risks—are significantly reduced, not only because of axial dental/levalore relocation, but also due to improved orthodontic efficiency. This facilitated tooth movement is probably a consequence of a more favourable soft tissue tone after skeletal base correc-tion and transient demineralization of the operated bone due to the RAP. The RAP can be further enhanced with the execution of additional interdental corticotomies within the osteotomized front-block segment.

Most current virtual planning software packages enable the design
and incorporation of the inferior subapical osteotomy in the treatment plan. In the authors’ practice, most bimaxillary cases are managed with a mandible-first protocol. This means that the inferior subapical osteotomy is incorporated in the intermediate splint, which is always manufactured through CAD/CAM. Alternatively, the amount of proclination given to the front-block segment can be omitted from the intermediate splint and incorporated in the final splint.

Compared to other facial osteotomies, the inferior subapical osteotomy is technically simple, the rate of potential complications is low, and the long-term stability is adequate. As with other segmental osteotomies of the jaws, damage to the periodontal hard and soft tissues is minimal and is not a reason to avoid these procedures. The key issue is adequate selection of the sites for interdental segmentation. The decision should be based on arch shape correction objectives and the amount of interdental space. The latter should be sufficient to allow a safe osteotomy that does not compromise the vitality of the adjacent teeth. In cases managed by SF approach, this can be an important limiting factor. It is required that the adjacent roots are, if not divergent, at least parallel. Otherwise, a short preparatory orthodontic phase – hence, a SE protocol – is recommended. At any rate, comprehensive 3D evaluation of the local anatomy with CBCT and the use of a piezoelectric microsaw should be considered systematically in order to minimize the periodontal risks. Despite these precautions, one patient in the present series exhibited gingival recession and necrosis of one lateral incisor. He admitted to heavy smoking throughout the entire postoperative period. No other complications arose.

It has been suggested that segmental alveolar osteotomies may entail difficulties in maintaining an adequate blood supply to the osteotomized segment. The authors’ opinion, this potential risk is irrelevant in inferior subapical osteotomies if performed through a minimally invasive buccal approach, because the blood supply is maintained integrally through the intact periosteal and muscle attachments on the lingual aspect and basal border. Moreover, the buccal mucoperiosteal flap is elevated only to expose the prospective box-shaped osteotomy line, such that the blood supply from the buccal sulcus is also minimally disrupted.

Although the patients included in this study were all class III cases managed by SF or SE approaches, the indications for inferior subapical osteotomy may be extended to other types of malocclusion and alternative timing schemes. Regarding the first aspect, the inferior subapical osteotomy may be indicated for any kind of malocclusion where substantial movement of the mandibular frontal teeth is required but where isolated orthodontic tooth repositioning is risky or impossible due to objective factors such as the amount of tooth movement required or periodontal circumstances, or subjective factors such as patient age, treatment time, and economic status. In particular, although class III malocclusions are more common in the authors’ clinical practice, skeletal class II
deformities with significant dental compensations due to orthodontic camouflage may also be a good indication for surgical decompensation with an inferior subapical osteotomy, in this case by anteropositioning the frontal segment. Regarding alternative timing schemes, inappropriate axial inclination of the mandibular incisors may be present in a selected group of patients in whom orthognathic surgery is performed with no concomitant orthodontic treatment or after a whole orthodontic treatment in the past for camouflage purposes. These are the so-called ‘surgery-only’ and ‘surgery-last’ categories, respectively.1

In conclusion, the inferior subapical osteotomy is a safe, reliable technique for dentoalveolar decompensation in timing protocols in which preoperative orthodontic treatment is suppressed (SF) or shortened (SE). It minimizes the complications of conventional orthodontic decompensation of excessively retroclined incisors, decreases the total treatment time markedly, and achieves high levels of patient and orthodontist satisfaction. This methodology may represent a reasonable approach to solve significant dental compensation in selected class III patients.

Patient consent
Patient consent is obtained systematically at the clinic to publish clinical photographs.

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References

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Competing interests
None.

Ethical approval
The study did not alter the systematized and already ethically approved protocol for the diagnosis and treatment of dento-facial deformity at the study centre, and hence was exempt from specific ethical approval.