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Technical Note
Orthognathic Surgery

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

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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).[1–3]

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.[1–5] Improved orthodontic efficiency is probably related to the increased metabolic turnover of the regional acceleratory phenomenon (RAP)[2,5,6] and a more favourable soft tissue tone after skeletal base correction.[3–5]

Clinical experience has shown that routine preoperative dental alignment, full arch coordination, and incisor decompensation often tend to prolong the treatment time, with little or no clinically significant benefit for the patient.[4] Besides, dental compensation can be resolved – totally or partially – with surgical osteotomies. This may be particularly relevant in periodontally compromised patients or cases with a narrow anterior alveolar ridge, where conventional incisor decompensation 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.[7] 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.[1–3] 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 decompensation of class III malocclusion. To this effect, a prospective evaluation of cases in which an inferior subapical osteotomy was indicated to surgically decompensate 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 osteotomy for dentoalveolar decompensation 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) dentofacial 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.[8] 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 treatment) 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 simulation of the orthognathic osteotomies, including the inferior subapical osteotomy, 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

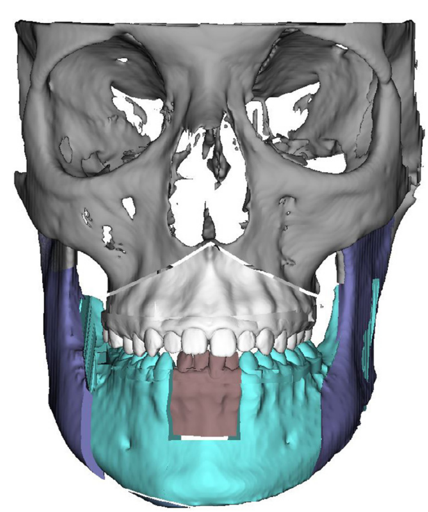

Fig. 1. Virtual simulation of the orthognathic osteotomies (frontal view).

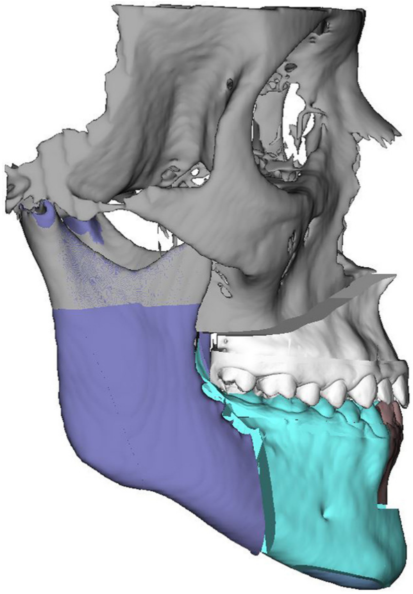

Fig. 2. Virtual simulation of the orthognathic osteotomies (profile view).

recession and PPD. All measurements were made at six sites per tooth: mesiovestibular (mv), central-vestibular (cv), distovestibular (dv), mesiolingual (ml), central-lingual (cl), and distolingual (dl). Two weeks prior to treatment, all patients were scheduled for oral hygiene instructions as well as for professional supragingival debridement according to individual needs, and the patient's ability to maintain optimal oral hygiene standards was checked.

In cases managed with SF, no preoperative orthodontic preparation apart from bracket bonding 2–7 days before surgery was implemented. In this group of patients, the first soft archwire was not placed until 24 h before surgery in order to avoid dental movements that could render the CAD/CAM splint inaccurate.

All patients were operated on under general anesthesia by the same surgeon (FHA). Monomaxillary cases (mandibular bilateral sagittal split osteotomy and or inferior subapical osteotomy) were treated in an outpatient context. Bimaxillary cases were discharged after 24 h.

The surgical approach for the inferior subapical osteotomy consisted of a horizontal incision between the two lateral incisors at a level below the attached gingiva and above the buccal sulcus. The mucoperiosteal flap was elevated carefully to expose the prospective box-shaped osteotomy line. A piezoelectric microsaw (Implant Center 2; Satelec-Acteon Group, Tuttlingen, Germany) was used to design the osteotomy and to perform additional interdental corticotomies at selected sites, with the aim of further enhancing the RAP and facilitating orthodontic decrowding. While corticotomies were interrupted when the superficial spongiosa was reached, and hence light bleeding was detected, the boundaries of the inferior subapical osteotomy were deepened towards the lingual cortex (Fig. 3). At the vertical interdental segmentation sites, the attached gingiva of the papilla was only slightly elevated and the piezoelectric abutment was tunnelled upwards towards, but not reaching, the inter-alveolar crest. The osteotomy was completed with gentle rotation manoeuvres of a 6-mm straight osteotome (Epker DO-181; Bontempi, Tuttlingen, Germany). Once repositioned, no rigid fixation system, besides the adapted archwire itself, was used to fix the segment in its final position. Additionally, interdental gaps greater than 3 mm were grafted (Apatos, OsteoBiol; Tecnoss, Giaveno, Italy). Likewise, horizontal osteotomy gaps greater than 3 mm were grafted in order to smooth the transition between the chin and the repositioned front-block segment.

Postoperative orthodontic treatment was started no later than 2 weeks postoperatively in order to benefit from the RAP. At this point, the composite bridges were removed and the archwire was substituted with expanding coils. If necessary, the inclination of the intermediate mandibular fragment was further modified with elastic mechanics.

Postoperative CBCT imaging was performed 1 month and 1 year after surgery. Periodontal checkups were scheduled on a monthly basis during the first two postoperative months and then every 3 months. A final check-up was performed after orthodontic debonding. The following parameters were evaluated: plaque index, PPD, gingival recession, bleeding on probing, and CAL.

Patient satisfaction with treatment was evaluated on a 0–10 visual analogue scale (VAS) at the 6-month follow-up appointment.

Results

During the 5-year study period, a total of eight patients (three female, five male) underwent an inferior subapical osteotomy for dentoalveolar decompensation purposes at the study centre (Table 1). Their mean age at the time of surgery was 26.3 years (range 14–49 years). For all patients, the preoperative malocclusion was skeletal class III with combined sagittal-transverse maxillary hypoplasia and severely compensated mandibular incisors.

The inferior subapical osteotomy was performed between lateral incisors and canines. In seven cases, interdental corticotomies were executed within the front-block segment and in any additional location indicated by the orthodontist. One patient underwent isolated maxillary surgery and seven patients underwent bimaxillary surgery (one-piece or segmented Le Fort I osteotomy plus mandibular bilateral sagittal split) in combination or not with additional cosmetic procedures. Six patients were operated on according to the SF protocol. A SE approach was followed in the remaining two.

Postoperative recovery was uneventful in all patients. Bimaxillary cases were discharged 24 h after surgery, and the so-called 'monomaxillary' case (Le Fort I plus inferior subapical osteotomy) was operated on in the morning and discharged in the late afternoon.

Fig. 3. Inferior subapical osteotomy and interdental corticotomies to facilitate orthodontic decrowding.

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Table 1. Demographic characteristics, surgical procedure, timing protocol, total treatment time, and satisfaction with treatment for the study sample.

Case	Sex	Age at time of surgery, years	Orthognathic surgery procedure	Ancillary cosmetic procedure(s)	Timing protocol	Total treatment time, months	Satisfaction with treatment (VAS)	
							Patient	Orthodontist
1	F	17	Bimaxillary surgery: Four-piece LFI + BSSO Inferior subapical osteotomy	Rhinoplasty	SF	8	10	10
2	M	38	Bimaxillary surgery: One-piece LFI + BSSO Inferior subapical osteotomy	Genioplasty Malar augmentation (PBFP technique) Cervical liposuction	SF	10	10	10
3	F	14	Bimaxillary surgery: One-piece LFI + BSSO Inferior subapical osteotomy	Recontouring of the mandibular lower border	SE	12	10	10
4	F	27	Bimaxillary surgery: Four-piece LFI + BSSO Inferior subapical osteotomy	Genioplasty Malar augmentation (PBFP technique)	SF	12	10	9
5	M	25	Bimaxillary surgery: Four-piece LFI + BSSO Inferior subapical osteotomy	–	SF	8	8	9
6	M	49	Bimaxillary surgery: Four-piece LFI + BSSO Inferior subapical osteotomy	–	SF	7	10	9
7	M	18	Bimaxillary surgery: One-piece LFI + BSSO Inferior subapical osteotomy	Genioplasty	SF	7	9	9
8	M	23	Monomaxillary surgery: One-piece LFI Inferior subapical osteotomy	–	SE	9	9	10

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 preoperative 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.[9,10] This issue may be of critical importance in patients with an initially inadequate buccolingual width of keratinized gingiva (0–2 mm),[9,11,12] a narrow mandibular symphysis where the teeth may be moved out of their osseous envelope,[10,12,13] or gingival inflammation and inadequate plaque control.[11–13]

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 labiolingual 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.[3] 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.[2,3]

An alternative to orthodontic decompensation is surgical decompensation with an inferior subapical osteotomy. Although this osteotomy was originally designed to correct alveolar protrusion by retropositioning the osteotomized segment,[7] 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 dentoalveolar 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 correction[3–5] and transient demineralization of the operated bone due to the RAP.[2,5,6] 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

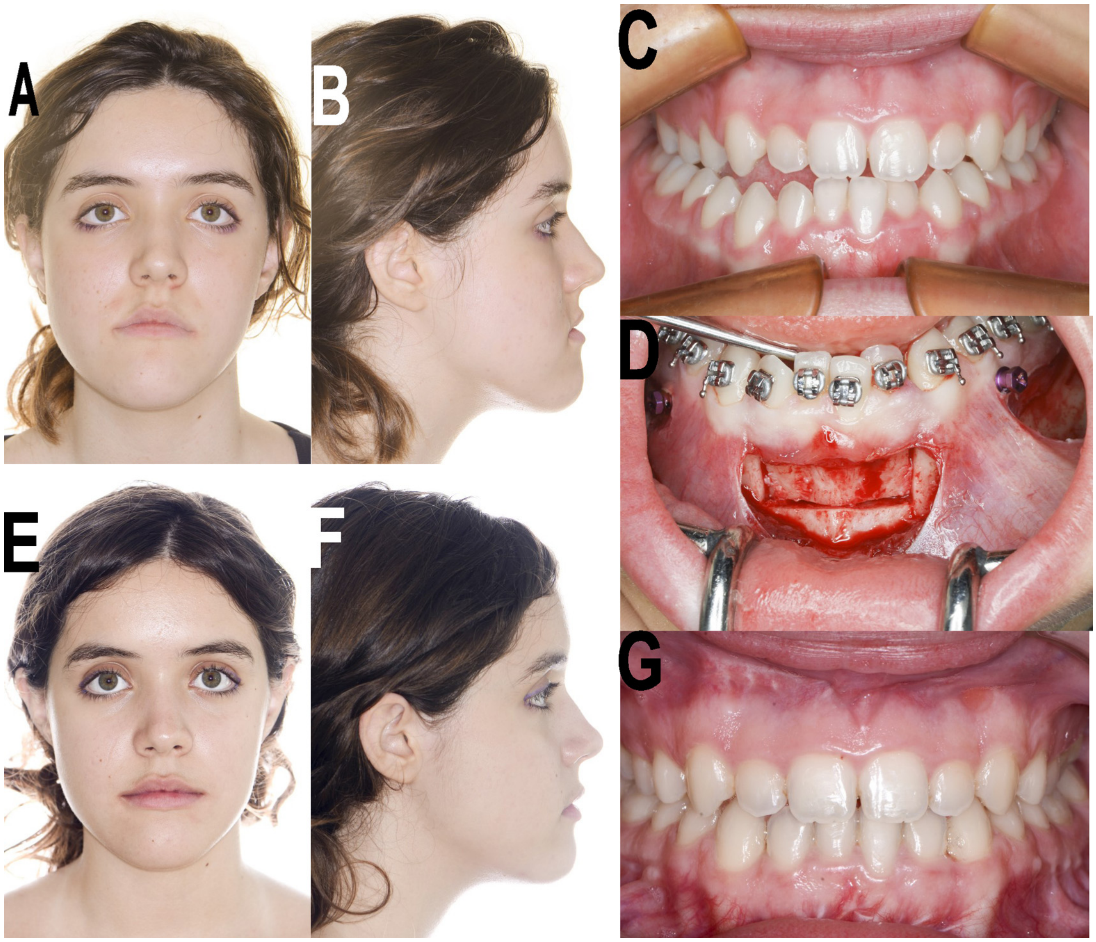

Fig. 4. Case 3 (see Table 1 for surgical details). Preoperative extraoral (A and B) and intraoral (C) pictures. Intraoperative view of the inferior subapical osteotomy (D). Final extraoral (E and F) and intraoral (G) pictures after debonding.

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.[14] 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.[15] 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.[16] In 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.

Funding

None.

Competing interests

None.

Ethical approval

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

Patient consent

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

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