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Orthognathic Surgery and Aesthetics: Planning Treatment to Achieve Functional and Aesthetic Goals

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Abstract. *Computerized video imaging is a valuable adjunct for communication with patients and planning orthognathic surgical treatment. The incorporation of adjunctive soft tissue procedures to enhance the final aesthetic result of orthognathic surgery is a valuable addition to the orthodontic and orthognathic treatment plan. This paper presents the use of video imaging techniques in the planning and execution of comprehensive functional and aesthetically orientated orthodontic and surgical treatment.*

Index words: Video Imaging, Orthognathic Surgery, Aesthetics, Treatment Planning.

Introduction

The surgical correction of skeletal deformities dates back to the beginning of the twentieth century, but rapid progress did not occur until the 1950's. Since that time, orthognathic surgery has made great strides in the area of diagnosis and surgical techniques. Prior to the development of maxillary osteotomies, the treatment available for dento-skeletal deformities were somewhat tied to the limited surgical procedures of the time. That is, it was not very constructive to discuss treatment for a vertical maxillary excess when little could be done to correct the problem. With the evolution of the LeFort I osteotomy, orthodontic and surgical skills improved, treating not only anteroposterior problems, but vertical and transverse maxillary problems as well. Now that surgical techniques allow surgeons to make specific changes to skeletal structures, more attention can be addressed to aesthetic results. The contemporary diagnostic treatment plans of the 1990's must address the complexities of function and aesthetics.

Analysis of the soft tissue response to maxillary and mandibular bony movements have been quantified in the literature (Mansour *et al.*, 1983; Quast *et al.*, 1983; Carlotti *et al.*, 1986). The aesthetic outcome of an orthognathic procedure has always been

an important aspect in the judgment of treatment success, if not by the clinician, then certainly by the patient! Techniques for the stabilization of surgical osteotomies have improved with the introduction of rigid fixation. These techniques have improved patient comfort and have created more demand for orthognathic surgery. Improved techniques have also allowed the utilization of adjunctive procedures to further refine the aesthetic outcome (Gallagher *et al.*, 1984; Waite *et al.*, 1988).

The incorporation of soft tissue surgical procedures in conjunction with maxillary and mandibular osteotomies not only offers the possibility of further enhancing the aesthetic outcome of orthognathic surgery, but also allows the surgeon to compensate for the deleterious aesthetic effects of some procedures (Collins and Epker, 1982; O'Ryan and Schendel, 1989). The most common example of this phenomenon is the widening of the alar bases of the nose seen with maxillary impaction. Adjunctive rhinoplasty procedures permit greater control of this area and can, indeed, improve abnormal nasal morphology while achieving maxillary correction.

The process of orthodontic and surgical treatment planning involves a synthesis of clinical judgment, observation of the functional relationships of soft tissue to underlying hard tissue, knowledge of the soft tissue response to hard tissue movements, and

the experience of the involved clinicians. With the integration of soft tissue surgical procedures combined with orthognathic surgery, there has been a growing interest in not only the analysis of soft tissue abnormalities in the presence of skeletal dysplasia, but also in improving communication with the patient about the effect of orthognathic surgery on the soft tissue. In the past few years, there has been much interest in the use of computerized videometrics to gather visual images of the frontal face and profile, and the integration of soft tissue analysis with cephalometric prediction in determining the final aesthetic outcome.

The incorporation of hard and soft tissue planning with the aid of computerized video cephalometrics offers great potential in not only improving communication between orthodontists, surgeons, and patients, but also in facilitating the visualization of proposed treatment plans. The possibilities offered by allowing treatment planners to test the soft tissue outcome of proposed surgical procedures prior to actually finalizing a treatment plan should be obvious. The logical maturation of orthognathic treatment should not be limited to refining methods of fixation and improving long-term stability, but should also involve an improvement in the 'predictability' of these procedures. Accordingly, the surgical team may now use image manipulation as an aid in discussing functional and aesthetic options with the patient. This technique has already proven to be a powerful tool of communication. Six months after surgery, 89 per cent of patients who were counselled and planned with video-imaging techniques reported they felt that their final outcome was as good as or better than the video prediction (Sarver *et al.*, 1988; Sarver and Johnston, 1990). In comparison, Kiyak *et al.* (1984) reported that in the same time period, only 65 per cent of 'non-imaged' patients reported satisfaction with their surgical result. The authors feel that the process of counselling and planning treatment using video-imaging is effective because it helps model realistic patient expectations by using a visual template which is meaningful to the patient.

The purpose of this paper is to present a method for the integration of computer techniques of hard and soft tissue planning illustrated by the following two case reports.

Case 1

This 12-year-old female was referred with a chief complaint of a cleft palate defect with midface deformity (Fig. 1). The patient had undergone primary treatment with alveolar bone grafting, but still lacked alveolar bone support. The dentoalveolar problem

was compounded by her thumb-sucking habit which persisted until age 11.

Her profile was characterized by a pronounced midface and suborbital deficiency with a pronounced lack of chin projection, as measured from the N-B line to B-point (Fig. 2). Remarkably, she also appeared bimaxillary protrusive, a characteristic not often seen in cleft patients. Frontal facial examination demonstrated a collapse of the alar base on the left side of the nose secondary to the alveolar cleft defect (Fig. 1). The maxillary midline was approximately 5 mm to the left of the mid-sagittal plane. Dentally, she had a bilateral cross-bite with anterior open-bite (Fig. 3). There was 8 mm of crowding in the mandibular arch. The mandibular second molars were impacted while the maxillary left lateral incisor



FIG. 1 This patient presented with a unilateral cleft defect with a flat midface.

FIG. 2 The profile exhibited bimaxillary protrusion with full lips, but the midface was remarkably deficient with minimal nasal tip projection and minimal chin projection as well.



FIG. 3 An anterior open bite was present with severe bilateral cross-bite and maxillary mid-line shift.

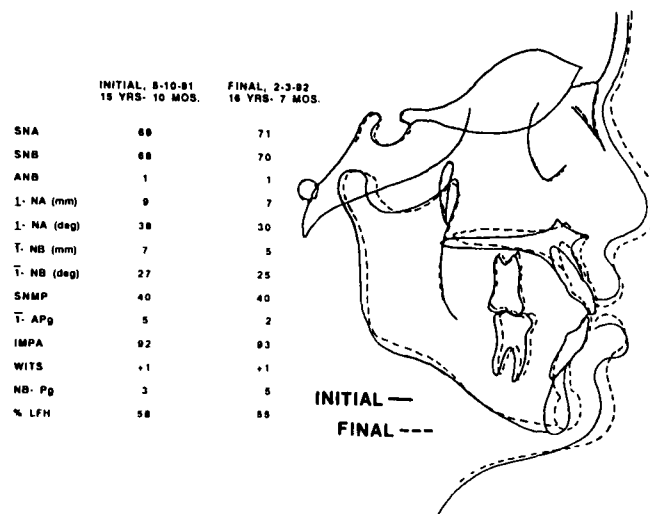


FIG. 4 Initial cephalometric analysis revealed a severe retrognathic maxilla and mandible. Superimposition of treatment tracing shows maxillary advancement.

was absent. Cephalometric evaluation demonstrated a severely retrognathic maxilla and mandible with a steep mandibular plane (Fig. 4). The maxillary incisors were protrusive and procumbent while the lower incisors were in normal position relative to the mandibular dental base.

Treatment plan

Dental treatment objectives included:

1. Closure of the open bite.
2. Decrowding of the dental arches. Extraction of bicuspsids were required, not only to provide space for decrowding, but for reduction of the protrusion as well.
3. Midline correction.

Aesthetically, a treatment planning conflict became apparent (Fig. 5). While the midface was markedly deficient, this patient exhibited severe dentoalveolar procumbency with lip fullness. This effect was worsened by lack of nasal projection. Extra-oral anchorage was planned to maximize reduction of the dental protrusion. Our ideal aesthetic treatment goals included:

1. Reduction of lip fullness.
2. Midface advancement.
3. Augmentation of nasal projection via rhinoplasty.
4. Chin augmentation via inferior border osteotomy.

The orthodontic treatment plan which included bicuspid extraction was designed to correct the

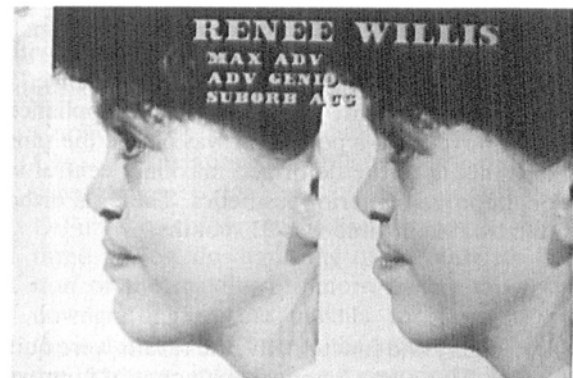


FIG. 5 The video projection of our treatment plan with maxillary advancement and suborbital augmentation. This illustration does not include projected rhinoplasty to increase tip projection.

cross-bite and decrowd the arches. Although conflicting treatment goals revolved around the retraction of teeth in a midface deficient patient, it was agreed with the family in the initial imaging session that all of the treatment goals did tie together. Predictability of bite closure was uncertain and orthognathic surgery was discussed. Therefore, retraction of the anterior teeth was agreed as a necessity since advancement of the midface was planned.

Progress of treatment

A quad-helix was utilized to correct the cross-bite. Straight pull headgear was used for anchorage supplementation although the cervical aspect was soon

discontinued due to the patient complaining of headaches. The mandibular second bicusps were extracted to facilitate decrowding of the anterior teeth and to provide room for the mandibular second molars as the first molars moved mesially.

Maxillary space was closed with incisor retraction and the maxillary left cuspid was 'lateralized'. After a 20-month treatment period of arch alignment, a moderate open-bite was still present and a maxillary osteotomy was proposed for bite closure. An integrated video consultation was performed to discuss and plan aesthetic options with the patient and family. In concert with the surgeons and patient, a unified treatment plan was reached which included:

1. Posterior maxillary impaction.
2. Zygomatic osteotomy for midface augmentation.
3. Hydroxylapatite augmentation for the malar ridge and sub-orbital region.
4. Rhinoplasty for tip projection, symmetry and refinement of nasal morphology.
5. Advancement genioplasty.

The surgical procedures were accomplished without complications. Finishing mechanics involved 6 months of treatment, after which fixed appliances were removed and a positioner was placed the same day. Bonding of the deformed maxillary central incisors improved anterior aesthetics. The total orthodontic treatment time was 31 months.

Results

Aesthetically and functionally, the results were quite pleasing. There was a noticeable amount of improvement in midface projection. Weir procedures were utilized to diminish the amount of alar widening common with maxillary advancement (Fig. 6.). Sub-orbital augmentation was performed with hydroxylapatite augmentation through tunnelling from the vestibular incision of the Lefort I osteotomy. Chin projection was improved which further balanced the midface. Elevation and projection of the nasal tip was accomplished with a nasal strut incorporated in the rhinoplasty (Fig. 7). The final occlusion was adequate, with bite closure being completed. Dental aesthetics were further improved with bonding and recontouring of the hypoplastic maxillary left central incisor (Fig. 8).

Case 2

This patient was originally referred at 8 years of age for consultation and evaluation of a unilateral cross-bite. At the initial visit, some mandibular asymmetry was noted, but not considered severe enough to be



FIG. 6 A pleasing aesthetic result was obtained with reasonable symmetry.

FIG. 7 The profile improved with increased nasal, midface and chin projection.

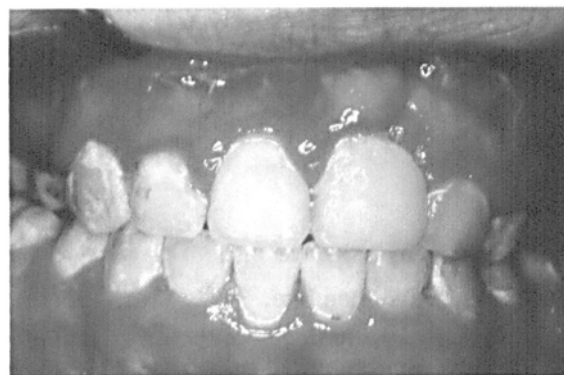


FIG. 8 The dentition demonstrates open bite closure, and good occlusal and midline correction.

classified as a true laterognathia. Maxillary expansion was performed, and the patient was placed on periodic recall and observation. Over a period of 8 years, the mandibular growth pattern became more asymmetric and Class III. Interceptive growth modification efforts were unsuccessful and by the time the patient was physically mature (age 17), she was evaluated for definitive treatment. The following problem list evolved:

1. Mandibular left laterognathia, with the midsymphysis 1 cm to the left of the mid-sagittal plane (Fig. 9).
2. Maxillary compensation for the mandibular asymmetry; the right side of the maxilla being inferior to the left side (Fig. 10).



FIG. 9 This patient's frontal examination revealed a severe left laterognathia, with wide alar bases and dorsum of the nose.

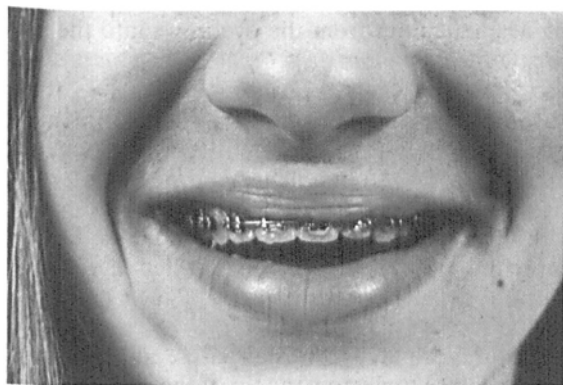


FIG. 10 The maxilla was canted with the right side being more inferior than the left. In addition, only 50% of the maxillary anterior teeth showed on smile.



FIG. 11 A wide alar base was evident with a broad nasal tip.

3. Class III skeletal relationship, due primarily to the vertical maxillary deficiency.
4. Class III dental relationship on the right and a cross-bite on the left, secondary to the left laterognathia.

Although her aesthetic concerns were centred primarily around the asymmetry, other concerns were noted:

1. Because of the vertical maxillary insufficiency, only 50 per cent of the maxillary incisors were exposed at full smile (Fig. 10).
2. Secondary to the maxillary compensation, a cant to the smile line was noted (Fig. 10).
3. The nasal morphology (Fig. 11) was evaluated and described as being broad in the alar width and in the nasal dorsum.
4. The profile was adequate (Fig. 12), but characterized by a convexity not consistent with a Class III dental and skeletal relationship.

Combined surgical orthodontic treatment was planned. The orthodontic treatment goals consisted of orthodontic levelling, alignment and decompensation. The surgical treatment goals were:

1. Correction of the mandibular asymmetry and Class III relation via bilateral sagittal split osteotomies.
2. LeFort I osteotomy with discrete movements in three planes: downgrafting of the anterior portion of the maxilla for more incisal show and downgrafting of the maxilla for levelling. In three-dimensional terms, the maxilla was planned to 'yaw' inferiorly and anteriorly with the LeFort osteotomy.

Some of the aesthetic concerns were intensified by these proposed movements. The downgraft and potential advancement of the maxilla would not only tend to widen the base of the nose, but would also increase the convexity of the profile. A presurgical video-imaging session was held with the patient,



FIG. 12 Pretreatment profile of patient and video projection of treatment.

patient's family, orthodontist, and the oral and maxillofacial surgeon. The maxillary downgraft was planned and mandibular rotation predicted. Since the mandible would rotate both down and backwards, an advancement genioplasty was planned to maintain chin projection (Fig. 12).

Frontally, both nasal morphology as well as transverse chin position were discussed. Regardless of whether the alar width increased, the patient felt her nose was too wide and expressed a desire to have correction performed. Simultaneous to the orthognathic procedure, a rhinoplasty was planned. The unified treatment plan was finalized as:

- (1) orthodontic decompensation and arch coordination;
- (2) maxillary and mandibular osteotomies;
- (3) advancement genioplasty with movement to the right for symmetry;
- (4) rhinoplasty to decrease the alar width (using Weir procedures), lateral nasal infractures to decrease dorsum width, and tip procedures to narrow the nasal tip (Fig. 13).

Stabilization of the anterior maxilla was accomplished with plates and hydroxylapatite interpositional blocks for maximum stability of the downgraft and the base of the nose. Rigid internal osteosynthesis was also used in the ramus procedures. This allowed exchange of the nasal tube with an endotracheal tube so that the rhinoplasty could be performed.

The cephalometric superimposition reflects the downgraft of the anterior maxilla with the effect of chin advancement and rhinoplasty (Fig. 14). Excellent symmetry was achieved, although some fullness



FIG. 13 The presurgical video projection illustrates correction of the asymmetry of the mandible and chin while narrowing the base and dorsum of the nose.

on the right side remained. The effect of rhinoplasty with the maxillary osteotomy achieved quite pleasing aesthetic lines from the eyebrows into the nasal dorsum and tip (Fig. 15). Final occlusal goals were also attained with a total orthodontic treatment time of 18 months. The vertical relationship of the maxillary incisors to the upper lip upon smiling were greatly improved with the anterior downgraft of the maxilla (Fig. 16). The profile exhibited ideal balance with the chin and the upper face. Nasal morphology improved with a straight dorsum blending into the supratip break of the nasal tip (Fig. 17). A submental view of the nose shows the effect of the Weir procedures to narrow the alar bases, and a Goldman tip procedure to narrow the tip of the nose (Fig. 18). Dentally, our treatment goals were attained with closure of the anterior open bite and correction of the Class III malocclusion (Figs. 19A, 19B).

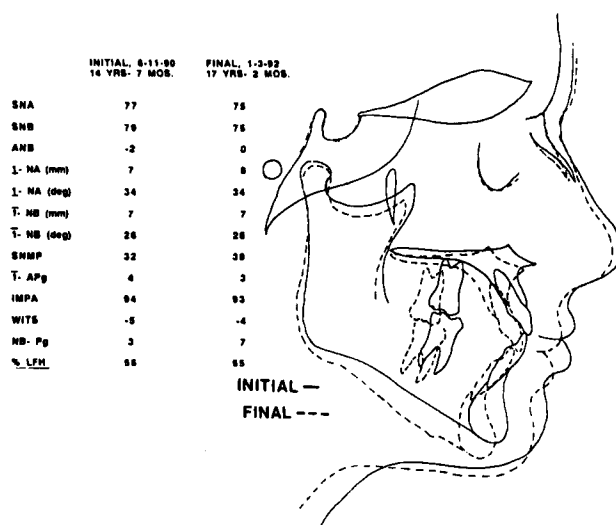


FIG. 14 Cephalometric evaluation revealed an inconsistency of a convex profile and skeletal Class III relationship. Surgical results included a maxillary downgraft, rhinoplasty and advancement genioplasty.



FIG. 15 Post-treatment frontal image demonstrating correction of laterognathia.



FIG. 16 On smile, the patient obtained more esthetic tooth tip exposure due to the maxillary downgraft.



FIG. 17 The profile projects balance with excellent nasal projection.



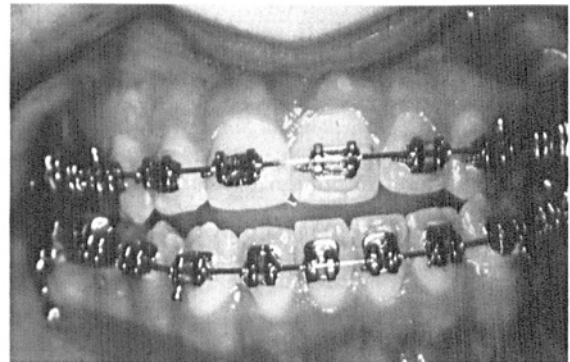
FIG. 18 Nasal tip projection was improved while alar base widening was minimized.

Conclusion

The use of rigid fixation techniques has not only greatly increased post-operative comfort for orthognathic patients, but has also permitted the incorporation of soft tissue procedures to address aesthetic deficiencies either present originally or created by the hard tissue movements required in correcting functional jaw deformities. The two cases presented involved rhinoplasty, but in general, any number of other soft tissue procedures may be considered (liposuction, rhytidectomy, otoplasty, etc.). The demands placed on the technical skills of the surgical team are greatly intensified, but once these skills are achieved, the results can be gratifying.

The use of video-cephalometric treatment planning is helpful, since it allows the orthodontist and surgical team both to communicate more effectively, and to predict with reasonable accuracy the projected outcome of differing treatment plans. In essence, different treatment plans may be demonstrated and 'tried out' before committing a patient to

A



B



FIG. 19 Presurgical (A) and post-treatment (B) frontal view of open bite occlusion.

a particular plan. Of greatest importance, however, is patient participation, since communication with the patient is greatly facilitated with imaging. Our experience has been that patient's expectations of the final aesthetic outcome is much more realistic (Sarver, 1991).

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