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Evaluation of the esthetic results of a 40-patient group treated surgically for dentoskeletal Class III malocclusion

A dentoskeletal Class III malocclusion results in unesthetic alterations of the soft tissues, which may cause psychologic and interpersonal problems. Surgical treatment, if based on cephalometric evaluations alone, can result in inadequate correction of facial esthetics. The aim of this paper is to discuss the esthetic needs observed in surgical planning of a group of 40 Class III patients and to compare the presurgical esthetic parameters with those recorded in the sixth month of follow-up. To obtain the proper esthetic result and to restore proper stomatognathic functionality, surgical treatment planning required the integration and correction of skeletal cephalometric planning. In 24 of the 40 patients, the skeletal and esthetic planning were in agreement with each other. In the remaining 16 patients, the correction of skeletal planning with the esthetic planning was necessary to obtain the correct esthetic and functional restoration. In all patients, esthetic, radiographic, and functional analysis at the sixth month of follow-up revealed the restoration of correct facial esthetics in the vertical, transverse, and sagittal planes; no temporomandibular joint problems; and a high degree of personal satisfaction regarding the esthetic and functional result obtained, including improvements in social life and in masticatory function. Cephalometric indications should always be compared with esthetic clinical indications and, possibly, the skeletal planning must be corrected by the esthetic needs, so that esthetic and functional success can be reached at the same time. (Int J Adult Orthod Orthognath Surg 2002;17:171–179)

Dentoskeletal Class III represents the most frequent splanchnocranial malformation in Europe, particularly in Italy, France, and Germany,[1] and consists of anomalies of the form and position of the mandible and/or the maxilla with subsequent alteration of the occlusal plane. Such anomalies are found mainly in the sagittal dimension, but simultaneous involvement both of the vertical and/or transverse planes is frequently observed. As reported by Cunningham et al[2] and Finlay et al,[3] a dentoskeletal Class III malocclusion can result in esthetic deformities and facial asymmetry, with consequent psychologic and relational discomforts for patients.

The development of materials and techniques in orthognathic surgery has allowed optimization of the treatment of maxillomandibular malformations, and current surgical correction aims at restoring good functionality as well as improvement of facial symmetry and esthetics. Therefore, success in dentoskeletal Class III surgical treatment now consists of achieving both correct functionality and excellent esthetics.

As previously reported in the literature,[4–9] dentoskeletal Class III surgical treatment, when based on skeletal planning and on cephalometric evaluations, can result in inadequate correction or even worsening of facial esthetics.[9,10] Therefore, to guarantee correct postsurgical appearance it is always necessary to have the patient's facial esthetics clinically assessed 3-dimensionally.

Table 1 Esthetic parameters considered and corresponding profilometric points

Profilometric points	Esthetic parameters
H-Mb	Upper third
Mb-Sn	Midface third
Sn-Me'	Lower third
Me'-H	Medial line
ZA-ZA	Transverse diameter of the midface
Go'-Go'	Transverse diameter of the lower third
G'-Sn-Pog'	Angle of facial harmony
ULA-Sn-C	Nasolabial angle
	Gummy smile
	Exposure of superior incisive teeth at rest
	Interincisive line
	Gonial angle projection
	Zygomatic projection

*According to Arnett et al[9,10] and Farkas.[11]

C= columella; G = glabella; Go' = soft tissue gonion; H = hairline; Mb = midbrow; Me' = soft tissue menton; Pog' = soft tissue pogonion; Sn = subnasale; ULA = upper lip andterior; ZA = zygomatic arch.

The purpose of this study was to examine the difficulties observed in clinical diagnosis and in surgical planning for a 40-patient group treated surgically for dentoskeletal Class III malocclusion at the Maxillofacial Surgery Department of the University of Rome "La Sapienza" and to illustrate the 3-dimensional esthetic evaluation used at the 6-month follow-up.

Materials and methods

A group of 40 patients with dentoskeletal Class III malocclusion who underwent orthognathic surgical treatment at the Maxillofacial Surgery Department of the University of Rome "La Sapienza" between July 1998 and June 2000 was selected for this study. The group included 17 men and 23 women, all Caucasians, with a mean age of 25.7 years (range, 20 to 33). To evaluate 3-dimensionally the esthetic alterations caused exclusively by maxillomandibular malformations, our study did not include either post-traumatic dentoskeletal Class III cases or dentoskeletal Class III cases associated with cleft lip and palate.

To accomplish presurgical orthodontic planning and assess eventual temporomandibular joint (TMJ) dysfunction, all patients first underwent a preliminary visit, with clinical examination of the occlusal relationships and stomatognathic functionality. During this first visit, 8 of the 40 patients were found to have a TMJ dysfunction. Presurgical orthodontic therapy, based on both the examination of plaster casts and 3-dimensional clinical assessment of the occlusion, was carried out in all patients over an average period of 6 to 8 months, until correct dental alignment was achieved. In the 8 aforementioned patients, the orthodontic therapy and application of occlusal bites led to the remission of TMJ dysfunction.

The surgical planning was based in all patients upon the integration of the needed skeletal corrections, which were based on cephalometric measurements on lateral radiographs, with the esthetic treatment plan, which was based on clinical 3-dimensional esthetic clinical examination.

Following the experience reported by Arnett and Bergman,[9] Arnett et al,[10] and Farkas,[11] the esthetic clinical analysis was carried out to assess facial proportions in 3 dimensions by placing patients in centric occlusion, with relaxed lips and natural head position.

The 3-dimensional esthetic assessment was repeated at the 6-month follow-up appointment. Postsurgical outcomes were assessed by comparing the presurgical esthetic evidence to the postsurgical evidence. We found and reported the following esthetic parameters (Table 1), which are considered fundamental when examining facial 3-dimensional proportionality:

Table 2 Presurgical esthetic problems, cephalometric planning, and treatment planning due to esthetic needs of 40 patients

Esthetic problems	No. of patients	Cephalometric planning	Remaining esthetic problems	Treatment correction
Vertical hyperplasia of the lower third, vertical hypoplasia of the midface, gonial angle width above normal	5	Mandibular setback	Gonial angle below normal in 3 patients	Posterior raising of the maxilla
Vertical and sagittal hyperplasia of the lower third, vertical and sagittal hypoplasia of the midface, facial midline deviation, gonial angle above normal, nasolabial angle below normal, malar deficit	7	Mandibular setback and maxillary advancement	Sagittal projection deficit of the third midface and nasolabial angle below normal in 3 patients. Sagittal projection deficit of the midface, nasolabial angle below normal and gonial angle below normal in 1 patient	Increase in maxillary advancement in 3 patients. Increase in maxillary advancement and posterior raising in 1 patient
Sagittal hyperplasia of the lower third with vertical hyperplasia and sagittal hypoplasia of the midface, nasolabial angle width below normal, facial median line deviation and malar deficit	4	Mandibular setback and maxillary advancement	Sagittal projection deficit of the midface, nasolabial angle below normal, persistence of vertical hyperplasia of the midface in 1 patient	Increase in maxillary advancement and total raising
Sagittal hyperplasia of lower third, vertical hyperplasia of the midface and gonial angle width above normal	8	Mandibular setback, maxillary raising and advancement	Gonial angle below normal persistence of vertical hyperplasia of the midface in 3 patients	Increase in total maxillary raising and posterior raising
Sagittal and vertical hyperplasia of the lower third, vertical hypoplasia of the midface, nasolabial angle width above normal and facial median line deviation	6	Mandibular setback	Gonial angle below normal in 2 patients	Posterior raising of the maxilla
Sagittal and vertical hyperplasia of the lower third, sagittal hypoplasia of the midface, gonial angle width below normal and malar deficit	6	Mandibular setback and maxillary advancement	Sagittal projection deficit of the midface, gonial angle below normal in 2 patients	Increase in maxillary advancement and posterior raising
Sagittal hyperplasia of the lower third, both vertical and sagittal hyperplasia of the midface, nasolabial angle above normal and deviation of median line	4	Mandibular setback, total maxillary raising, and setback	Both persistence of sagittal and vertical hyperplasia of midface and gonial angle below normal in 1 patient	Increase in total maxillary setback and raising, maxillary posterior raising

- Frontal appearance: Overall facial proportions, facial median line, proportion (widths) of the middle and inferior skeletal segments of the face, incisor show at rest, gummy smile, interincisive line
- Three-quarter view: Cheekbone projection, gonial angle
- Profile view: Angle of facial harmony, nasolabial angle, cheekbone projection, gonial angle

Following presurgical 3-dimensional clinical esthetic analysis, all 40 patients were found to have anomalies in facial proportions (Table 2).

To obtain the proper esthetic restoration and to restore both facial harmony and proper stomatognathic functionality, the surgical treatment planning required the integration and the eventual correction of the skeletal cephalometric indications with the esthetic plan. In 24 of the 40 patients, the skeletal and esthetic plans were in agreement. Six cases were treated by mandibular setback, and 18 cases needed bimaxillary repositioning (Table 2).

To obtain the correct esthetic and functional restoration in the remaining 16 patients, we needed to integrate the cephalometric indications with the esthetic needs (Table 2). Five patients were found to have long face, with a vertical hyperplasia of the lower third and an alteration of the transverse dimensions of the face; in the lateral view, an abnormal gonial angle was detected. In the aforementioned patients the skeletal treatment plan indicated a mandibular setback only, whereas the 3-dimensional esthetic clinical analysis revealed in 2 cases that mandibular setback alone would have resulted in excessive closure of the gonial angle. Therefore, surgical treatment consisted in both cases of a raising of the posterior maxilla together with mandibular setback.

In 7 patients, vertical hypoplasia of the midface was detected, with an abnormality of transverse dimensions of face in contrast with the values reported in the literature,[9–11] along with a deviation of the facial midline. In the lateral view, sagittal hyperplasia of the lower third, strong sagittal hypoplasia of the midface, disharmonies of gonial angles, and a smaller-than-normal nasolabial angle were observed. In frontal, profile, and three-quarters views, a malar projection deficit was found. In such cases, cephalometric planning indicated mandibular setback and maxillary advancement. In 3 patients this treatment would have resulted in the persistence of sagittal projection deficit of the midface and a nasolabial angle that was smaller than normal; therefore, maxillary advancement was increased.

In 1 of the 7 above-mentioned patients, the cephalometric measurements determined the persistence of a sagittal deficit of the midface and a smaller-than-normal nasolabial angle, instead of a too-narrow gonial angle. Therefore, maxillary advancement was increased and a posterior raising of the superior maxilla with mandibular setback in occlusion was performed.

We noted that 4 patients (Table 2), when examined in the frontal view, exhibited vertical hyperplasia of the midface, gummy smile, exposure of maxillary incisors at rest, and alterations in the facial transverse dimensions, in contrast with the values reported in the literature,[9–11] as well as facial midline deviation. When examined in profile, a sagittal hyperplasia of the lower facial third was observed, with sagittal hypoplasia of the midface and a nasolabial angle that was smaller than normal. In frontal, profile, and three-quarters views, a malar projection deficit was recorded. The skeletal treatment plan indicated bimaxillary repositioning with maxillary advancement and mandibular setback. In 1 patient, a sagittal projection deficit with vertical hyperplasia of the midface persisted, and the nasolabial angle was below normal. Therefore, we decided to increase the maxillary advancement and to raise the maxilla, maintaining the mandibular setback.

When examined in the frontal view, 8 patients (Table 2) exhibited vertical hyperplasia of the midface and alterations in the facial transverse dimensions in contrast with the values reported in the literature[9–11]; when examined in a frontal view, we noticed sagittal hyperplasia of the lower third of the face, and the gonial angle was larger than normal. Cephalometric surgical treatment suggested a bimaxillary repositioning with maxillary raising, maxillary advancement, and mandibular setback in occlusion. Since 3 patients presented a gonial angle below normal and vertical hyperplasia of the midface, we decided to increase the maxillary raising, including a posterior raising, while maintaining the mandibular setback.

Six patients (Table 2) presented vertical hyperplasia of the lower third, vertical hypoplasia of the midface, altered facial transverse dimensions in contrast with the values reported in the literature,[9–11] and a deviation of the facial midline; when examined in profile, sagittal hyperplasia of the lower third and a larger-than-normal nasolabial angle were observed. The skeletal treatment plan required a mandibular setback in occlusion, but 2 patients exhibited a gonial angle that was smaller than normal. Therefore, as indicated by esthetic needs, both patients received a posterior maxillary raising with mandibular setback in occlusion.

Six patients (Table 2) exhibited vertical hyperplasia of the lower third and altered facial transverse dimensions, in contrast

with the values reported in the literature.[9–11] When these patients were clinically analyzed in profile, we noted sagittal hyperplasia of the lower third and sagittal hypoplasia of the midface with a gonial angle that was smaller than normal; in front, profile, and three-quarters views, a malar projection deficit was reported. The cephalometric-based treatment plan called for a mandibular setback and a maxillary advancement. In 2 of the 6 patients, a sagittal deficit of midface with a gonial angle below normal would have remained after surgery; therefore, in both cases the maxillary advancement was increased and a posterior raising with mandibular setback in occlusion was performed.

With respect to the remaining 4 patients (Table 2), presurgical esthetic 3-dimensional clinical analysis showed the following. In the frontal view, we found vertical hyperplasia of the midface with alterations in the facial transverse dimensions, in contrast with the values reported in the literature,[9–11] and a facial midline deviation. In profile, the clinical analysis revealed sagittal hyperplasia of the lower third, sagittal hyperplasia of the midface, and a larger-than-normal nasolabial angle. The cephalometric analysis suggested a surgical treatment consisting of maxillary setback, total maxillary raising, and mandibular setback. However, this planning would have resulted in the persistence of sagittal and vertical hyperplasia of the midface and a gonial angle below normal in 1 patient. Therefore, the surgical treatment was corrected according to the esthetic needs, and consisted of mandibular setback and an increase of maxillary setback and total raising; a posterior raising of the maxilla was included as well to correct the gonial angle.

The integration of cephalometric indications with 3-dimensional clinical esthetic assessment allowed correct surgical treatment planning and therefore bone repositioning with excellent esthetic and functional results as well as a correct occlusion.

Thirty-four patients of our group underwent a combined approach of Le Fort I osteotomy and bilateral sagittal split osteotomy, while the remaining 6 cases had a mandibular setback. Rhinoseptoplasty was performed in 9 cases, genioplasty in 5 cases, and extraction of third molars in 4 cases. The correct repositioning of the maxilla, based on the integration of the skeletal treatment planning with the esthetic needs, was accomplished with maxillary advancement by Le Fort I osteotomy for 13 patients; advancement and posterior raising for 7 patients; advancement and raising for 5 patients; posterior raising for 5 patients; raising and setback for 3 patients; and raising, setback, and posterior raising for 1 patient. The maxillary raising was carried out according to the integration of the esthetic and cephalometric indications and consisted of an average of 3.5 mm of repositioning, whereas cephalometric measurements alone indicated a need for only 3 mm of repositioning. Maxillary advancement was carried out according to the integration of esthetic and cephalometric indications as well, and consisted of an average of 3.4 mm of repositioning, while cephalometric measurements alone suggested only 2.8 mm of repositioning. To avoid postsurgical enlargement of the nasal base, due to raising of the superior maxilla and/or advancement greater than or equal to 3 mm, 17 patients received an alar cinch suture and anterior nasal spine osteotomy. In the other 17 patients, the circumvestibular incision, which is usually carried out in the maxilla, was substituted at the piriform rim area with a wide V-shaped incision. This different type of incision for Le Fort I osteotomy does not require periosteal detachment below the piriform area; therefore, nasal base dimensions[12] are not altered. Maxillary retention was obtained through two 4-holed miniplates and 4 screws anteriorly and 2 osteosynthesis wires and 2 suspensions at the back, while for the mandible 3 bicortical screws on each side were used at the mandibular angle.

We compared the presurgical values of the esthetic parameters with those recorded in the sixth month of follow-up to obtain an objective examination of the esthetic results achieved by our 40-patient group.

Results

Postsurgical 3-dimensional esthetic analysis, carried out in the sixth month of

Table 3 Patient's personal evaluation of esthetic results at the 6-month follow-up appointment

Opinion	No. of patients
Optimum result	35
Good result	3
Overall good result, although secondary esthetic finishing is required	2

follow-up, revealed in all examined patients, as observed in a frontal view, the restoration of correct vertical facial proportions, lack of deviations of the facial median and interincisive line, disappearance of gummy smiles, and correct exposure of incisors. When we examined the patients in a frontal view, the transverse diameter proportions of the medial and inferior skeletal segments of the midface differed from the values reported in the literature,[9–11] but no esthetic problems in the facial transverse dimension were reported in the aforementioned patients.

In profile, both the restoration of correct total facial sagittal proportions and the correct restoration of zygomatic bone projection of the nasolabial and gonial angles were evident. At the 6-month follow-up examination, no unesthetic widening of the nasal base was observed.

During the postsurgical period, the gonial angle, examined in three-quarters and in profile views, showed a certain proportionality with facial structures in all patients and a symmetry between the 2 projections of the gonial angle. The examination of the zygomatic bone, evaluated in frontal view, in profile, and in three-quarters view, showed that in all 40 patients the correct malar projection had been restored.

Finally, no joint and functional problems were seen, and a high degree of personal satisfaction regarding the esthetic result obtained, such as improvements in social life and in masticatory functionality (Table 3), was reported by patients.

Discussion and Conclusion

Over the last 20 years the development of orthognathic surgery techniques and materials has allowed the standardization of treatment of maxillomandibular malformations, with a reduction in both relapse and postsurgical functional problems. Therefore, the current aim of surgical correction is to reach the right occlusal and skeletal relationships and correct esthetics simultaneously. According to our experience, the success of surgical correction of dentoskeletal Class III cases is determined by both presurgical orthodontics and correct surgical planning. Presurgical orthodontic treatment is useful because it eliminates dental compensation[13,14] and can correct presurgical TMJ dysfunctions.

As regards our 40-patient group, presurgical clinical examination revealed 8 cases of TMJ dysfunction, which were resolved presurgically through orthodontic treatment and through the application of occlusal bites. In the sixth month of follow-up, clinical examination showed that no patients had TMJ functional problems. Furthermore, cephalometric measurements taken from bilateral TMJ tomograms and cranial radiographs in sub-chin-vertex projection, carried out according to Iannetti[1] and Kawamata et al,[15] revealed a normal condyle-fossa relationship.

Correct surgical planning is determined by the integration of the skeletal treatment plan with the esthetic treatment plan. Dentoskeletal Class III patients can present with very severe esthetic anomalies; vertical proportionality, total facial sagittal projection, transverse dimension of the lower facial third, median symmetry of soft tissues, malar projection, and nasolabial and gonial angles can all be altered from the norm (Table 1). As previously reported,[9–11] surgical treatment planning that is based

exclusively on cephalometric measurements guarantees correct final skeletal relationships, but it does not ensure a satisfactory esthetic result. The skeletal treatment planning is based on cephalometric measurements and it aims at reaching both proper maxillomandibular skeletal relationships and normal Class I occlusion. Esthetic treatment planning is based on the clinical assessment of important esthetic parameters, which are frequently altered in Class III patients (Table 1); this planning aims at restoring facial harmony through surgical restoration of facial proportionality and symmetry, by always trying to reach the correct occlusion.

According to other authors' experiences,[5,9–12] cephalometric indications must always be compared with esthetic clinical indications and the skeletal planning may need to be corrected by the esthetic planning, so that esthetic and functional success can be achieved simultaneously. In our 40-patient group, the original surgical treatment plan, which was based exclusively on cephalometric evaluations, would have caused esthetic problems in 16 patients (Table 2); therefore, we had to correct the skeletal planning of surgical treatment through 3-dimensional esthetic planning of soft tissues.

Esthetic treatment planning should be based on a 3-dimensional comparison of the soft tissue projections from the midface and lower third of the face with the soft tissue projection of the upper third of the face. All these elements, while directly linked to the conformation of the basicranium, are not involved in the surgical treatment. The basicranium represents the dimensional guide for splanchnocranial skeletal development; its conformation directly influences the correct 3-dimensional proportion of the middle and lower skeletal segments of the face.[16,17] Therefore, according to our experience, the use of the facial third superior skeletal segment as a reference for maxillomandibular repositioning allows correct planning of the surgical treatment and restoration of both facial 3-dimensional proportionality and median symmetry of soft tissues.

In Class III patients, an objective clinical examination can detect alterations in nasolabial and gonial angles, as well as anomalous proportions. The correction of these esthetic parameters, less important within the facial esthetics, should not represent a primary goal of the esthetic planning because of the poor predictability of soft tissue displacement following skeletal repositioning. As reported in the literature, the prior quantification of soft tissue displacements cannot be accurately predicted, because soft tissue thickness and muscle tone vary from one person to another, as do the degree of bony deformity and the amount of surgical movement of important skeletal structures for soft tissue projection, such as anterior nasal spine.[18–25]

Anomalies of the midfacial vertical dimension, which can be outlined through 3-dimensional clinical evaluation of the facial thirds (Table 2), can be corrected by associating maxillary and mandibular osteotomies with genioplastic procedures[18,26] or by modifying the planned maxillomandibular repositioning according to narrow or wide dimensions of the upper facial third, always focusing on the restoration of a correct occlusion.

The sagittal dimension was assessed by measuring the G'-Sn-Pog' angle (Table 1). As highlighted in the literature,[10] this angle is of paramount importance for determining sagittal excess or flaws of the midfacial skeletal base through a comparison of sagittal projection of soft tissues of the superior skeletal segment of the face. Restoration of correct sagittal soft tissue projection of the medial and inferior skeletal segments of the face can be obtained through the correction of cephalometric-based maxillary and/or mandibular skeletal displacement, depending on sagittal dimensions of the superior skeletal segment; nevertheless, correct occlusion must always be the foremost goal.

The transverse proportions were analyzed by evaluating the relationship between transverse mandibular diameter (Go-Go) and zygomatic transverse diameter (ZA-ZA). Several authors have reported that the normal value of facial transversality is represented by a 70% relationship between bigonial diameter and zygomatic transverse diameter.[9–11] The recorded values for our 40-patient group differed from

the values reported by the previously mentioned authors: 87.85% during the presurgical period and 86.35% at the 6-month of follow-up, although esthetic clinical alterations of the facial transverse diameter were not reported at either time point.

The gonial angle influences the harmony of the sagittal plane in profile view, and the bigonial diameter determines the transverse width of the inferior skeletal segment in frontal view. Therefore, restoration of the correct gonial angle represents an important esthetic parameter to be examined presurgically; moreover, it must be properly restored through the contingent correction of skeletal cephalometric planning. In our group, during the presurgical period, the gonial angle was excessively large in 20 patients and smaller than normal in 6. The corrective surgical treatment, carried out according to the symbiosis between esthetic planning and cephalometric treatment plan, allowed full restoration of the sagittal and the vertical dimensions of the midface thanks to the correct 3-dimensional repositioning of the skeletal basis in all the aforementioned 26 patients. According to our experience, the surgical protocol for correction of Class III patients must be based on the correct integration of skeletal treatment planning and esthetic treatment planning of soft tissues, and it has to aim at correcting both the occlusion and the facial 3-dimensional proportionality. In the totality of the 40 cases the surgical correction restored both the correct occlusion and the proper facial harmony. The main objective of the surgical treatment of maxillomandibular malformations is the patients' personal satisfaction. In the 6th month of follow-up, 35 patients reported complete personal satisfaction, both esthetically and functionally, 3 patients expressed good personal satisfaction, and the remaining 2 affirmed their intention to undergo further surgical treatments to improve the esthetic result (Table 3).

As is often reported in the literature,[19–27] the facial esthetics of a patient may improve so suddenly that they can make the patient's face unrecognizable: 6 of the 40 patients of our study felt the need to change their documents 6 months after the surgical correction.

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