

Maxillofacial-Osteotomies: A 23-Case Series

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ABSTRACT

Harmony among disproportionate maxillofacial bones was surgically reestablished for 23 patients (14 females and 9 males). Malocclusion was in the mean time corrected. Patient age ranged between 17 and 35 years. This paper aims to present preoperative evaluation, plans, surgical procedures, fixation modalities and complications of 34 facial osteotomies carried out for these patients. Work before the operation included alter-photo studies, occlusion examination, cephalometric analysis, dental casts, model surgery and wafers. Orthognathic repositioning operations interested the maxilla or the middle third of the face in 12 patients, the mandible in 4 and both jaws in 7. Osteotomies were craniofacial disjunction in 2 cases, maxillary mono-block in 5 and anterior segmental in 13 and mandibular sagittal split in 5, subapical incisivocanine in 4 and genioplasty in 3. Fixation modalities are discussed. Complications were few, minor and temporary. Almost all patients were satisfied.

INTRODUCTION

Maxillofacial skeleton builds the foundation on which facial beauty stands [1,2]. While most dento-alveolar irregularities can readily respond to orthodontia and many mild to moderate facial skeletal contour defects are correctable with autogenous or alloplastic materials, only orthognathic surgery can afford the fundamental correction of the maxillofacial deformity whatever its degree. This article aims to present maxillofacial surgical planning, procedures and complications in 23 patients with 34 facial osteotomies (not including rhinoplasties).

PATIENTS AND METHODS

Twenty three adults presented with imbalanced facial skeletal components. Patient age ranged between 17 and 35 years with the mean of 22. Fourteen patients were females and 9 were males. Two patients were Negro. Deformities were developmental in 21 patients, sequelae of bilateral cleft lip and palate in one patient and of old orbitozygomatico-maxillary fracture in another. Although the malocclusion was manifest in patients with maxillo-mandibular dysmorphoses, all pa-

tients were seeking surgery mainly for cosmetic reasons.

Clinical evaluation was assisted with an image-altering PC program. Teleradiography and cephalometric studies were used to help in putting the operative plan. Occlusion casts on articulators and mock surgeries were done in maxillo-mandibular deformity cases. Two dental print acrylic wafers were prepared for peroperative consecutive application in 6 bi-maxillary osteotomy patients and were guided with a "face bow" in 2 of them where osteotomies were completely interruptive. Three patients were transferred to orthodontia in preparation for surgery to better align their teeth arches and incisors positions so as to enable achievement of good postoperative occlusion. At least one of assisting doctors was an oral surgeon participating in case management and delivering peri-operative dental care.

Which bone(s) is (are) to be moved, in which direction and for how many millimeters? Cephalometrically proposed osteotomies were taken in consideration, yet the operation in each case was designed according to the clinical sense, patient needs and basic surgical principles. Orthognathic repositioning procedures were maxillary or interested the middle third of the face in 12 patients, mandibular in 4 and bimaxillary in 7. Thirty four osteotomies were carried out in the 23 patients (Table 1). Osteotomy lines followed the known traces of Wassmund [3] in 13 cases, Obwegeser [4,5] and Dal Pont [6] in 5, Le Fort I [7] in 5, Kole [8] in 4 and Le Fort III in 2. Genioplasty osteotomies were done in 3 cases. A septorhinoplasty was contemporary associated in 4 cases.

RESULTS

Surgical procedure:

All operations were carried out under general anaesthesia with a transnasal endotracheal intuba-

tion in maxillo-mandibular cases. Local infiltrates contained epinephrine 1:200000. The upper first premolars were extracted in 10 cases undergoing anterior maxillary segmental osteotomy. An upper first premolar was extracted in one case to correct an associated maxillary horizontal deviation. The 4 premolars were extracted to allow a 10mm setback in another case. Two un-exfoliated deciduous upper canines were extracted in the remaining segmental maxillary case. Tooth extraction involved the lower first premolars in the mandibular subapical anterior osteotomy 4 patients. It involved the lower third molars in one of the 5 sagittal split osteotomy (SSO) patients to give room for an 11mm mandibular setback.

Planned osteotomy sites were subperiosteally and submucoperiosteally dissected [9]. Osteotomy lines were drawn with a sterilized pencil marking on the bare bony cortex. Fine osteotomes, chisels and a hummer completed the work of the motorized drills, burrs and saws. Low maxillary and body mandibular osteotomies were carried out 4mm away from the canine and dental apices. Freely mobile bone segments were moved in directions and for millimeters exactly as it had been planned.

The fixation plates and screws metal was stainless steel in quit a few early cases and titanium in the remaining majority of cases. A transient intermaxillary fixation (IMF) was used prior to interossous metal application for getting maximal dental intercuspitation and perfect occlusion in cases of maxillo-mandibular osteotomies. This guiding IMF was left in place for the first 6-10 postoperative days to help rapid swelling resolution and patient comfort and these patients were instructed to avoid cutting hard food with their incisors for almost one month. Fixation of maxillary segmental anterior osteotomy relayed upon 6-week IMF in the earliest 3 cases with or without interossous wires and in 2 later cases where the applied plates and screws were considered as less than adequate. Fixation of the mandibular sagittal split osteotomy relayed upon IMF with one lag screw per side in one case, 3 lag screws in another and a plate and monocortical screws in a third case.

Resected bone pieces were reused as grafts incarcerated in fracture-line spaces to help early consolidation. Sub-mucosal separate stitches and mucosal closure were carried out with absorbable synthetic sutures. Surgical procedures are detailed within case-presentation reports given below. Blood was transfused in two cases: the first case combined Le Fort I and SSO and the second case combined Le Fort III and Le Fort I osteotomies. Prophylactic

antibiotics and oral hygiene were afforded. A secondary operation for removal of the fixing interossous metals was carried out some months later for 3 patients upon their request, in 2 of them the metals were stainless steel, heavy and palpable. The follow up period ranged between 4 months and 6 years.

Report of cases:

Relevant preparatory work and specific surgical procedure of the performed maxillofacial osteotomies are elaborated through the following eight patient presentations:

Case 1 (maxillary anterior segment setback):

A 21-year old girl complained from excessively protruded upper incisors and a gummy smile. Her posterior occlusion was perfect; she had a proclined maxilla with Angle [10] class I molar relationship and class II canine relationship. The maxillary incisivo-canine osteotomy procedure was started with extraction of the upper first premolars. A transverse palatine submucoperiosteal tunnel in between their sockets was dissected. Two vertical upper vestibular incisions in continuity with the sockets exposed the bone up to the pyriform aperture and infraorbital foramen. Resection of the relevant parts of the alveolar, palatine and nasal skeleton was done. The incisivo-canine maxillary segment was set 6mm back and 4mm up. Two miniplates fixed the segment on each side. The operation took 3 hours. IMF was removed on day 10 and the upper arch bar in week 6. The preoperative cephalometric wide angles ANB < 8° > and upper-incisor/SN (UI/SN) < 118° > have got down to < 4° > and < 103° > near norms (Fig. 1).

Case 2 (bi-maxillary incisivo-canine setback):

A 26-year old Negro female was examined for a pronounced bimaxillary proalveolism. Her occlusion was normal class I. The distance from the upper 1st to the nasal floor (UI-NF) was 40mm (normally 27.5) and the angle UI/NF was 119° (normally 112). Lower incisor to mandibular plane (LI-mP) measured 50mm (normally 40.8) and the angle LI/mP was 108° (normally 96). Removal of the 4 first premolars gave room to set back her anterior dentoalveolar segments. A wafer prepared on mock-surgery casts guided the temporary IMF prior to plates application fixing the mandibular subapical osteotomy segment with 6mm set back. Final occlusion was guided with a second previously prepared wafer just before plate application fixing the anterior maxillary segment set 6mm back and 4mm up. The operation took 5 hours. Although interossous fixation plates were

trustable, the patient felt comfort to keep her IMF for 6 weeks (Figs. 2a,2b).

Case 3 (mandibular setback):

A 25-year old man presented with a promandibulism with class III. His deformity had been previously treated by an orthodontist who had overcorrected the lower incisors labial inclination and ended with a tip-to-tip anterior bite. The mandibular sagittal split procedure was started with application of arch bars. The S-shaped mucosal incision crossing the anterior ridge of the mandibular ascending ramus and the outer and inner subperiosteal dissection exposed the bone. The osteotomy line was started on the internal aspect horizontally above the lingula with Lindemann side burr, continued with burrs, saws and or osteotomes downwards on the internal oblique line and then on the external aspect of the mandibular angle. The temporomandibular-joint-carrying (proximal) portion and the nerve-vessels-teeth-carrying (distal) portion were telescoped for 6mm setback and fracture lines were trimmed. Fine adjustment of occlusion was done with minimal grinding of one or two premature teeth contact points. Fixation, after manual condylar repositioning high and back in the fossa, was established with IMF and one miniplate with 4 mono-cortical screws applied through a submandibular neck skin approach 2-finger breadth below the basilar border (Sebileau-Risdon incision) on each side. Prosthetic malar enhancement was carried out through the mouth superior vestibule. The operation took around 5 hours. IMF was discarded after 6 weeks and the interosseous metals were removed 6 months later upon the patient's request (Figs. 3a,3d).

Case 4 (mandibular advancement and chin reduction):

An 18-year old girl was referred for possible correction of a retromandibulism, malocclusion class II and 4mm mandibular deviation to the right side. Cephalometric study and casts on articulators calculated the required mandibular advancement as 6mm on the right side and 10mm on the left. The mandible to cranial base was retrusive; B/NaV (N-B) measured -7mm (normally -2) Pg/NaV +3mm (normally -2). Patient was refusing any skin scars. Reduction genioplasty was made through an intra-oral lower vestibular incision above the mucosal reflection line. The chin anterior surface was exposed while paying attention to the mental neurovascular bundles integrity and 6mm bone was removed with an electric saw and burrs reducing the chin anterior projection. The outer lower lines of the bilateral sagittal split osteotomy were

carried out as anterior as opposite the 6th tooth [6] to allow for the advancement of 10mm on the right side and 6 mm on the left. During the splitting maneuver, the buccal cortex on the right side was accidentally broken. The application of interosseous material through her narrow mouth was not readily practical and the IMF was kept in place for 7 weeks after the operation (Figs. 4a,4c).

Case 5 (maxillary advancement and mandibular setback):

A 20-year old man was seen in consultation for correction of his maxillo-mandibular discrepancy. The preoperative studies roughly distributed his 11mm class III malocclusion to 7mm retromaxillism and 4mm promandibulism. The maxilla to cranial base was retrusive measuring SNA at 74° (normally 82±2) and A/NaV at -12mm (normally 1±2). The mandible to cranial base was protrusive measuring SNB at 89° (normally 80±2), B/NaV at 2mm (normally -2) and Pg/NaV +6mm (normally -2). Two wafers were prepared, one for guiding Le Fort I maxillary advancement and the other for guiding the final occlusion after sagittal splitting mandibular setback. Bilateral mandibular osteotomies were started before execution of Le Fort I osteotomy and complete mobilization of the mandibular segments was deferred to come after maxillary fixation. The maxillary Le Fort I osteotomy procedure was approached through a vestibular incision above the mucosal reflection. The nasal lining was elevated within the nasal apertures. The osteotomy was started anteriorly in the pyriform aperture and continued horizontally through the maxillary sinuses, 4mm above the canine tooth apex, reaching the maxillary tuberosity at the level of the lower third of the pterygoid process. A curved chisel was used to separate the tuberosity from the pterygoid on each side. The vomer was sectioned after elevation of its both sides mucosa. The medial wall of maxillary sinus was cut below the inferior turbinate to complete the palatoalveolar complex separation while taking care not to injure the descending palatine arteries which pass through the mucoperiosteum and assure the bony block vascularization. Two miniplates on each side secured maxillary advancement, a plate in the canine and another in the tuberosity relatively strong areas or pillars. Mandibular interosseous fixation was skipped and substituted with IMF for 6 post-operative weeks to avoid neck scars as the patient had asked for. The procedure took 9 hours and two units of whole blood were transfused late during the operation. The attained perfect balanced profile, distributing the 11mm maxillo-mandibular discrepancy into upper 7 and lower 4, would not

be achievable with a single osteotomy of either one of the two jaws (Figs. 5a,5b).

Case 6 (shortening of the middle third of the face and mandibular advancement):

A 20-year old female patient complained from a long face, gummy smile and lower jaw retrusion. Cephalometry read 9° for the angle ANB, 71° for SNB and 47° for mP/SN (corresponding normal values are 2°, 80° and 32° respectively). In preparation for surgery, she was referred to an orthodontist who corrected the incisors overjet changing UI/SN from 127° to 99° and LI/mP from 99° to 90°. Osteotomies combined mandibular bilateral sagittal splitting and maxillary anteriorly doubled Le Fort I interruptions. The mandible was advanced for 10mm and fixed with one lag screw on each side, one of the two was transbuccally applied. The maxilla was impacted for 15mm anteriorly and 6mm posteriorly and fixed with 2 wire ligatures on one side and a wire ligature and a miniplate on the other side. IMF was used for 6 postoperative weeks. The alae of the nose have become flared because a suture holding their bases was missed. Some cephalometric figures have remained after the operation far from the normal values measuring 10°, 74° and 43° for ANB, SNB and mP/SN angles. The improvement in the mandible to cranial base relations is supported with the amelioration in B/NaV (N-B) from -22mm to -17 and in Pog/NaV (N-Pog) from -25mm to -18. The reduction in the anterior maxillary height has been translated cephalometrically into N-UI reduction from 99mm to 84, UI-NF from 41mm to 29, N-ANS from 58mm to 55 (most of the bony wedge resection was below the anterior nasal spine), PNS-N from 56mm to 50 and U6th -NF from 29mm to 24 (Figs. 6a,6c).

Case 7 (first degree hypertelorism correction):

A 17-year old girl was examined because of a very broad nasal root. Her intercanthal distance measured 34mm. Neither exorbitism nor orbital axis marked deviation was present. A sub-cranial reduction of the interorbital distance through a variant of partial medial orbital osteotomy with anterior-medial ethmoidectomy and septorhinoplasty was planned to treat this 1th degree hypertelorism. Approach was direct through a vertical ellipse excision of the frontonasal dimpled extra skin. A superiorly based periosteal flap elevated from the glabellar and nasal dorsum for eventual repair of any accidental skull base crack was not used; X-ray views and wide submucoperiosteal intranasal dissection ascertained the level of the cribriform plate of ethmoid and helped to avoid any cerebrospinal fluid leak. Medial parts of the anterior

ethmoid bones with the nasal bridge and dorsal septum skeleton together with <4>mm strip of dorsal border of the upper lateral cartilages were resected almost en-block. Partial medial orbital osteotomy in continuity with the lateral nasal osteotomy was passed just anterior to the medial canthal ligament insertion. The anterior ethmoidal arteries were coagulated. The lateral nasal walls were approximated while changing their coronal orientation to the normal slopping sagittal direction. Domes of the alar cartilages were approximated with Prolene 4/0 stitches. Skin incision was closed with a frontonasal Z-plasty (Figs. 7a,7b).

Case 8 (Advancement of the middle third of the face while conserving the occlusion):

A 26-year old female patient complained from dish-face with short nose. She had balanced mandibular relations with the skull base and a normal class I occlusion. There was a pronounced retrusion of the middle third of the face and SNA measured 76° (normally 82). Vertical cephalometry confirmed nose shortness with 44mm for N-ANS (normally 50) and 77mm for ANS-Gn (normally 61). The distance from upper 1th to the nasal floor (UI-NF) was 39mm (11mm above normal). There was a manifest hypoplastic naso-zygomatico-maxillary complex (Binder's syndrome). Surgery aimed to correct the midface retrusion, the subnasal vertical excess and the nose shortness in one sitting. Approaches to the middle third of the face included the coronal, infraorbital and superior vestibular intraoral incisions. An extensive nasal sub-mucosal dissection was carried through a unilateral interseptocolumellar incision. Le Fort III (Tessier variant I) [11] osteotomy was started transnasally below the naso-frontal suture, passed anterior to the medial canthal ligament attachment and lacrimal sac. It was turned to the orbital floor passing by the anterior end of the inferior orbital fissure, then to the lateral orbital wall cutting transversally the anterior half of the lateral orbital border below the lateral canthal ligament attachment and turned down vertically and backward taking a transmalar way to the maxillary tuberosity. A high nasal septum osteotomy starting at the nasofrontal part fracturing the perpendicular plate of the ethmoid and the vomer back and down to the posterior nasal spine completed the craniofacial disjunction. Le Fort I anterior double level osteotomy with one centimeter subnasal bone resection and anterior maxillary impaction corrected the short upper lip and freed the middle third of the face to be moved independently while conserving the patient preoperative good occlusion. The central part of the face in between Le Fort III and Le Fort I osteotomies was

pulled forwards and tilted anteriorly downwards. Split in situ calverial bone grafts filled the nasofrontal (one cm vertical), lateral orbital (7mm antero-posterior), vertical transmalar and Le Fort I gaps, supported the columella and augmented the dorsonasal, infraorbital and malar regions. Interosseous metal devices fixed Le Fort I and Le Fort III osteotomy sites and the onlay grafts. Two units of blood were transfused during the procedure. Systemic corticosteroids were administered during the first postoperative few days. The patient complained from transient blurring of vision during the first couple of weeks after the operation. A secondary costochondral graft was added to the nose dorsum 7 months later. A relapse roughly estimated as 20% was visible one year after the operation and did not increase over the next 4 years follow up (Figs. 8a,8h).

Complications:

- 1- During the application of the arch bar to fix the anterior maxillary segment, an excessively tight wire guillotined a second premolar crown. It was immediately reattached back to its place with a dental adhesive and managed later by a restorative dentist.
- 2- Malocclusion and inadequate fixation were behind a 48-hour postoperative redo in one of the maxillary anterior segmental osteotomy cases.
- 3- Relapse started 6 months after maxillary advancement in a class III cleft case despite grafting the pterygo-maxillary space on both sides with corticocancellous bone during the opera-

tion. The used stabilizing materials were transosseous wires and IMF. The relapse developed over a 3-month period and measured 3mm corresponding to around 20% regression.

- 4- A moderate flaring of alae nasi was noticed after shortening of the middle third of the face with a Le Fort I osteotomy in one case (Fig. 6). A couple of non-absorbable deep stitches approximating the two alae bases to each other and to the anterior nasal spine could have prevented this.
- 5- A bimaxillary segmental anterior osteotomy lady has not been satisfied by the results of her operation because she is still exerting an effort to keep her lips closed at rest. A 3-piece maxillary osteotomy would have allowed better maxillary impaction and lips contact at ease. She is reluctant to undergo further surgery.
- 6- When the upward move of the anterior maxillary segment exceeded 4mm in 2 cases, the vertical level discrepancy between the canine and the more posterior tooth (usually the second premolar) on each side gave a "Dracula" smile, a side-effect said to be temporary rather than a complication.
- 7- Manifest rapid body weight loss in 2 cases was a direct side effect of IMF kept in place for good 6 weeks.
- 8- The craniofacial disjunction further deteriorated a preexisting roundness of the palpebral fissure on one side. A trial was made to tighten the lower lid through a lateral canthopexy procedure and it was not fully successful.

Table (1): Patient and osteotomy series.

Descriptive Diagnosis and number of cases	Osteotomy lines	Repositioning moves: direction and distance (in mm)
Maxillary proalveolism (n=8)	Wassmund	Back:3-8 Up: 3-4
Maxillary & mandibular proalveolism (n=4)	Wassmund	Back: 3-10 Up:2-6
	Kole	Back: 2-10 Down: 2 (in one case)
Retrogenia	Advancement genioplasty	Forward: 12
Maxillary proalveolism & retrogenia	Wassmund	Back: 3 (only on the right side) Up: 3
	Advancement genioplasty	to the right side: 4 Forward: 4
Promandibulism (n=2)	Obwegeser setback	Back: 6 in one case & 11 in the other
Retromandibulism & progenia	Obwegeser mandibular advancement	Forward: 6 (on the left side) & 10 (on the right)
	Reduction genioplasty	Reduction: 5
Promandibulism & retromaxillism	Obwegeser setback	Back: 4
	Le Fort I maxillary advancement	Forward: 7
Retromandibulism & long face syndrome	Obwegeser mandibular advancement	Forward: 10
	Le Fort I maxillary impaction	Up: 15 (anteriorly) & 6 (posteriorly)
Retromaxillism	Le Fort I maxillary advancement	Forward: 15
Retruded middle 1/3 of the face (Binder's syndrome)	Le fort I maxillary impaction	Up: 10
	Le Fort III advancement of the middle third of the face	Forward: 7 & Downward:10
Hypertelorism (1 st degree)	Medial orbital osteotomy	Medial: <6> per side
Orbito-zygomatico-maxillary retrusion (on one side)	Le fort I and Le Fort III (on one side)	Up, forward & lateral: <7>



Fig. (1): Maxillary alveolar hyperplasia (a) with gummy smile (c) and two months after incisivo-canine set back and up (b) & (d).

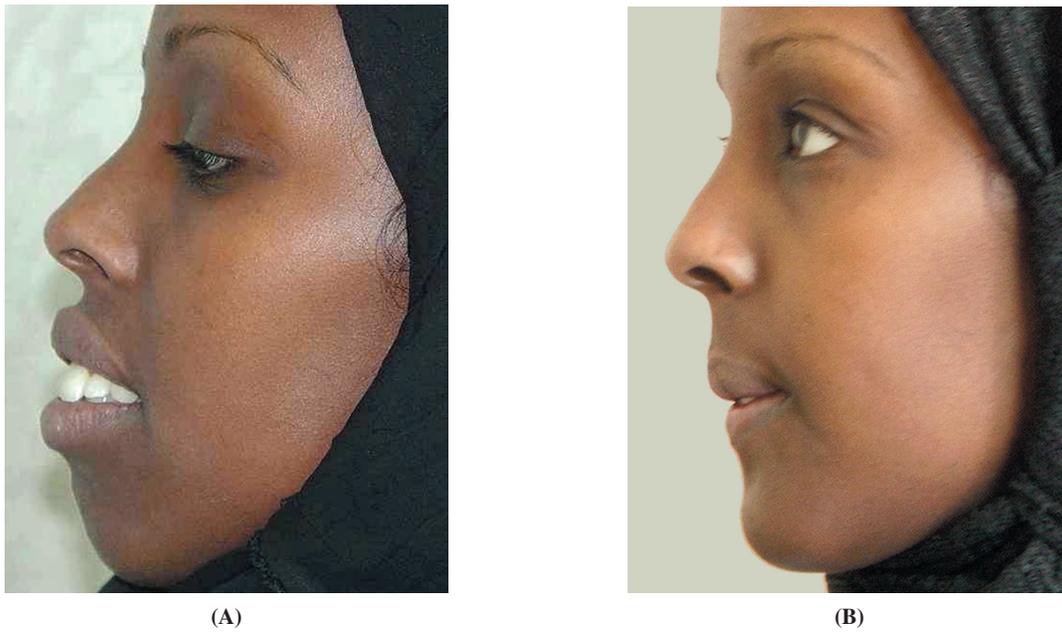


Fig. (2): Alveolar hyperplasia, before (a) & 3 months after bi-maxillary anterior segmental osteotomy (b).

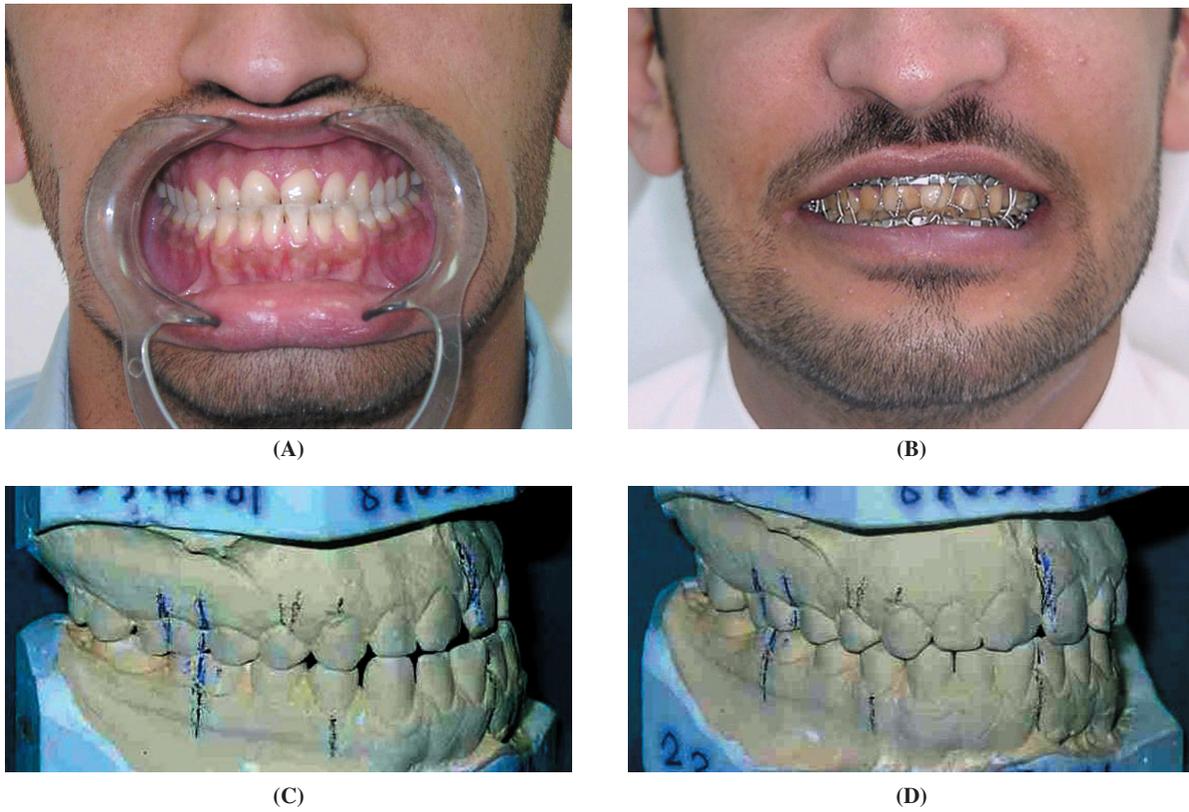
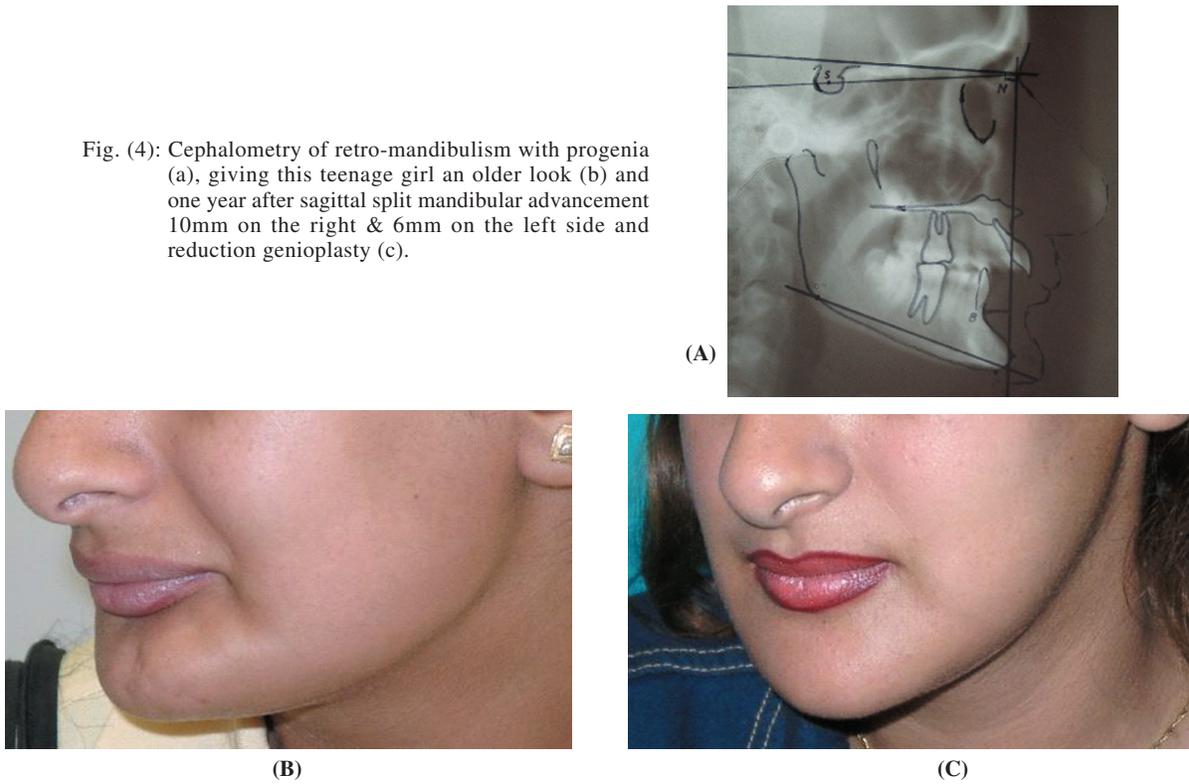


Fig. (3): Pro-mandibulism showing class III 1st molar & canine malocclusion (a) and few weeks after bilateral sagittal split osteotomies & 6mm mandibular set back (b). Preoperative casts (c) and model surgery (d) ascertained the plan.

Fig. (4): Cephalometry of retro-mandibulism with progenia (a), giving this teenage girl an older look (b) and one year after sagittal split mandibular advancement 10mm on the right & 6mm on the left side and reduction genioplasty (c).



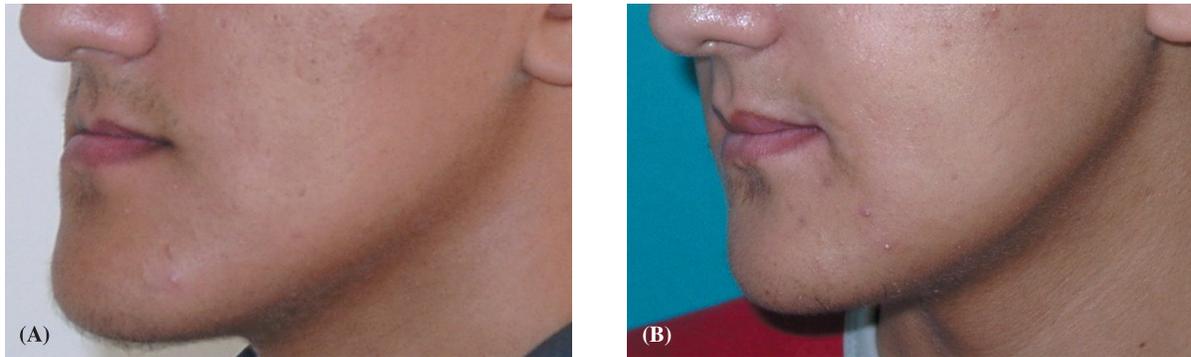


Fig. (5): Maxillo-mandibular disharmony with severe class III malocclusion & an overjet of 11mm (a) and 6 months after 7mm maxillary advancement by Le Fort I osteotomy and 4mm mandibular set-back by sagittal split osteotomy (b).

Fig. (6): Long face syndrome with retromandibulism planning (a) and pre & 4 months after Le Fort I maxillary impaction & sagittal split mandibular advancement (b & c).

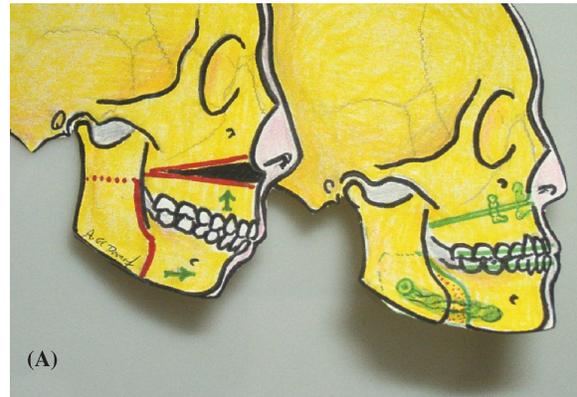


Fig. (7): First degree hypertelorism (a) and 6 months after partial medial orbital osteotomy combined with a rhinoplasty (b).



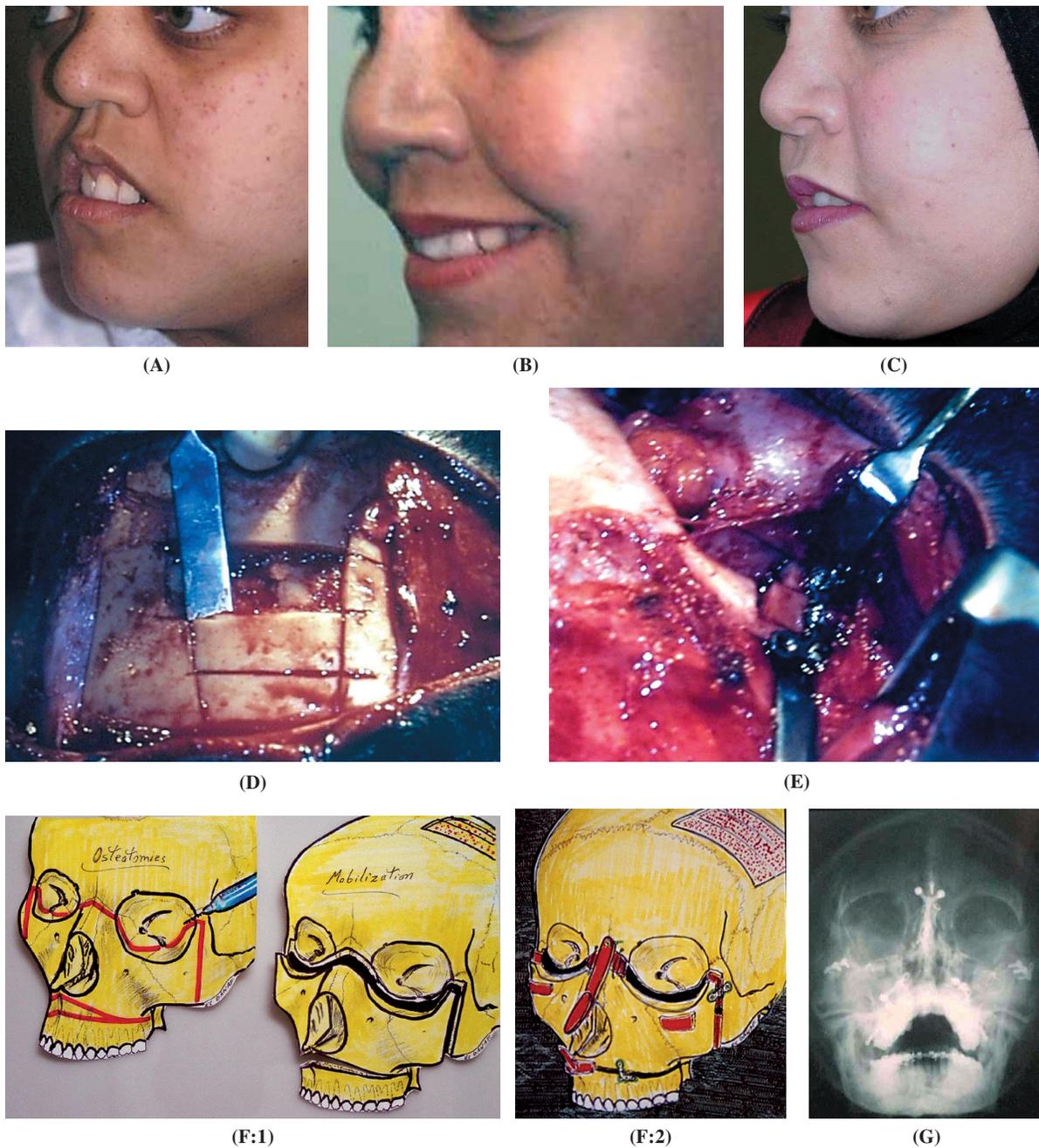


Fig. (8): Retruded middle third of the face with foreshortened nose (a), one year (b) & six years (c) after advancement & shortening of the middle third of the face through a combined Le Fort III & Le Fort I osteotomies and nasal lengthening through a contemporary perinasal osteotomy. Perioperative views of calvarial bone in situ harvesting (d) & right zygomatico-frontal osteosynthesis (e), drawings (f:1,2) and postoperative occipitomeatal (Water's) X-ray film showing the metals in place (g).

DISCUSSION

Developmental maxillofacial “differences” declare an architectural imbalance among skeletal components of the face. Pioneers [3-16] over the past decades have put orthognathic surgical principles and osteotomy designs to correct max-

illofacial disharmonies. Osteotomies in the maxilla and mandible intend to change the spatial situation of the basal bones to give the required form and to treat accompanying malocclusions. Health and psychosocial function show significant improvements after orthognathic surgeries [17].

Cephalometric analysis may not be constantly relayed upon; cranial bases especially in maxillofacial deformity cases are not always normal. Epker [15] emphasized “we must rely more on our clinical evaluation than on a cephalometric analysis”. Surgically induced changes in cephalometric readings do not frequently signify the quality of results and do not correlate with the degree of patient satisfaction.

Team work in maxillofacial surgery is essential. Oral surgeons definitely recognize occlusion prints on teeth and calculate cephalometries better than unassisted plastic surgeons can alone do. Preoperative orthodontia should prepare for perfect postoperative occlusion. It is not infrequent to see real basal maxillary and mandibular protrusion or alveolar hyperplasia with severe gummy smiles in patients whose incisors have been tilted or moved too much lingually by an independent orthodontist hindering their complete adequate final treatment with a simple osteotomy. Residual gum show, after effective orthodontic incisors redressing in alveolar hyperplasia, brings patients to plastic surgeons. In order to get perfect postoperative occlusion, understanding orthodontists and patients should accept an eventual deformity accentuation with presurgical orthodontic incisors movements in some cases [16]. A Japanese group [18] substituted preoperative orthodontia with a surgical subapical anterior segmental mandibular lingual inclination before the final session of correction of a > 20mm class III deformity with Le Fort I maxillary advancement and sagittal split mandibular setback.

Blood transfusion has become infrequent in orthognathic surgery [19]. Transfusion is not necessary for single-jaw surgery unless a coronal flap or iliac bone harvest is required [20]. It is acceptable to ask for cross-matching 2 units of blood for bimaxillary osteotomy operation. A recommendation has been reported [21] to revise the tariff for ordering blood to a "group and save" with antibody screen, providing that a 30-min indirect antibody cross-match is available.

Fixation with plate and screws in orthognathic surgery started some 20 years ago and has allowed early postoperative discard of the intermaxillary blockage in most instances. When compared to wire osteosynthesis, rigid fixation has improved stability in non-segmental osteotomy cases [22]. The 2.0-mm locking plate/screw system the standard fixation modality in the mandible [23]. Although the relapse after sagittal split mandibular advancement was found to be the same regardless of the use of rigid fixation or transosseous wiring;

the potential for such relapse was greater in patients fixed with the transosseous wiring [24]. Unlike the newer and lighter titanium plates, the stainless steel plates were easily palpable and patients frequently asked to get rid of them. Routine removal of uncomplicated miniplates is not clinically indicated [25].

Two miniplates with their 8 screws on each side of the maxillary incisivocanine segment with a non-interrupted one piece upper arch bar assure adequate fixing setup and permit discard of intermaxillary blockage. A recent national report on 7 anterior maxillary osteotomy cases fixed only with IMF with follow up extended up to 9 years, shows long-term stability [26]. The mandibular incisivocanine segment or the genioplasty segment is adequately fixed with 2 miniplates and 8 screws with or without a lower arch bar respectively.

Intraoral application of plate and screws to fix mandibular sagittal split portions necessitates soft tissue powerful retraction leaving more sensory disturbances and or a transbuccal piercing wound leaving a small but usually ugly facial scar. Driving the screws at 60° angle to the mandibular bone surface instead of 90° did not significantly lower the stability in an experimental design [27]. The submandibular skin approach passes deep to the platysma away from the mandibular branch of the facial nerve and the neck linear scar is usually unnoticeable [28]. The risk the inferior dentoalveolar nerve is injured becomes high when the canal is low near the basilar border in a thin mandible [29], a common finding in cases of retromandibulism. Bicortical lag screw rigid fixation in bilateral sagittal osteotomy induced around 5.6mm and 3.5mm increases in the transverse intergonion distance and interramus width respectively [30]. Tightening of the bicortical screws to close the interosseous space displaces the condyles laterally putting the joints in a torsion constraint [31]. A plate with mono-cortical screws allows a minimal range of adaptation to take place at the osteotomy sites protecting the joints from any torque [32]. Adjusting and bending the titanium plates has been recommended to avoid postoperative joint disorders through any displacement of the condyles [33]. A mean of 2.4mm forward relapse was reported one year after sagittal split mandibular setback [34]. Better occlusion, better stability with less relapse, better mandibular motion recovery and less temporomandibular joint dysfunction symptoms, are all achievable only with raising the quality of condylar repositioning [35]. Although condylar repositioning devices reduces the postoperative 2-4mm and 2-4° condyle displacement to < 2mm and

< 2°, the manual positioning is easier, but it requires the utmost care and an experienced operator [36]. Extraction of the 8th (to give room for enough mandibular setback) and its removal when impacted (to assure better consolidation) some 6 months before sagittal splitting are encouraged. Fracture of proximal and/or distal segments during SSO tends to occur more frequently in the younger age group (< 20 years) with an unerupted third molar [37].

Wassmund in 1927 described Le Fort I osteotomy passing through the pterygoid apophyses and Schuchardt in 1942 recommended the pterygo-maxillary disjunction [38]. After Le Fort I maxillary impaction, the posterior maxillary further upward movement with time is usually greater than the anterior maxillary relapse and both are negligible. Routine bone grafting with internal rigid fixation improves the skeletal stability after Le Fort I maxillary advancement in both cleft and non-cleft patients and after maxillary inferior repositioning where relapses may reach up to 5% [39]. With 4 screws for each plate, the postoperative skeletal changes associated with 2-plate fixation (one on each side of the pyriform orifice) do not appear to differ significantly from those seen with 4-plate fixation (2 plates on each side; one near the orifice and the other in the buttress area) [40]. The dental arch bar is important for fixation adjustments, security and eventual salvage [13]. Uncontrollable variables, including patients age, sex, the degree of Le Fort I maxillary advancement and simultaneous mandibular advancement, were found with no effect on post-operative skeletal stability [41]. Combined maxillary advancement and mandibular setback procedure appears to be a fairly stable independent of the type of fixation used to stabilize the mandible, rigid or wire [42]. The precision level of the currently available face-bow devices used for maxillary positioning in Le Fort I osteotomy combined with sagittal split ramus osteotomy, has recently been questioned [43].

The combination Le Fort III and Le Fort I osteotomies was first realized in 1971 by the eminent Paul Tessier [12]. He advanced the midface portion leaving the tooth-bearing maxilla posteriorly attached to the pterygoid processes for Binder's syndrome and stabilized the moved orbitonasal segment with calvarial bone grafts and miniplates and screws. After advancement of the middle third of the face, a variable degree of relapse has been reported by many authors [9,12,13,15,44]. It is known that corticocancellous bone grafts incarcerated between the stable pterygoids and the advanced maxillary portions as well as plate and screws

fixation modality are reliable means to prevent these relapses. Wolfe [44] has recommended cuts in the nasal mucoperiosteal sleeves to help freely move midfacial skeleton segments and reduce relapses after advancements.

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REFERENCES

- 1- Whitaker L.A.: Aesthetic surgery of the facial skeleton. Clin. Plast. Surg., 18 (1): 212, 1991.
- 2- Martinez J.M.: Use of multiple alloplastic implants for cosmetic enhancement of structural maxillofacial hypoplasia. Aesth. Surg. J., 23 (6): 433-440, 2003.
- 3- Wassmund M.: Lehrbuch der praktischen Chirurgie des Mundes und der Kiefer. Berlin, Meusser, Leipzig, 1935.
- 4- Trauner R. and Obwegeser H.L.: The surgical correction of mandibular prognathism and retrognathia with considerations of genioplasty. Part I. Oral Surg. Oral Med. Oral Path., 10: 677- 689, 1957.
- 5- Obwegeser H.L.: The indications for surgical correction of mandibular deformity by the sagittal splitting technique. Br. J. Oral Surg., 1: 57, 1964.
- 6- Dal Pont G.: Retromolar osteotomy for correction of prognathism. J. Oral Surg., Anesth. & Hosp. D. Serv., 19: 42-47, 1961.
- 7- Le Fort R.: Etude expérimentale sur les fractures de la mâchoire supérieure. Revue de Chirurgie 23, 208, 1901.
- 8- Kole H.: Surgical operations on the alveolar ridge to correct occlusal abnormalities. J. Oral Surg., 12: 515-529, 1959.
- 9- Stricker M., Van der Meulen J.C., Raphael B. and Mazzola R.: Craniofacial Malformations. Churchill Livingstone, Edinburgh, London, Melbourne and New York, pp 389, 1990.
- 10- Angle R.D.: Treatment of malocclusion of the teeth: Angle's system. (7th Ed). SS White, Philadelphia, 1907.
- 11- Tessier P.: Ostéotomies totales de la face. Syndrome de Crouzon, Syndrome d'Apert, Oxycephales, Scaphocephalies, Turricéphalies. Ann. Chirurg. Plast., 12: 273, 1967.
- 12- Tessier P.: Total osteotomy of the middle third of the face for faciostenosis or for sequelae of Le Fort III fractures. Plast. Reconstr. Surg., 48: 533-541, 1971.
- 13- Marchac D.: Problèmes posés par la contention après ostéotomie de type Le Fort III. Revue de Stomatologie, Paris, 78 (3): 193-198, 1977.
- 14- Schuchardt K.: Experiences with the surgical treatment of deformities of the jaws: prognathia, micrognathia and open bite. In Wallace A.B. (editor): Second Congress of International Society of Plastic Surgeons. London, E & S Livingstone, 1959.
- 15- Epker B.N. and Wolford L.M.: Middle-third facial osteotomies: their use in the correction of acquired and devel-

- omental dentofacial and craniofacial deformities. *J. Oral Surg.*, 33: 491-514, 1975.
- 16- Tucker M.R.: Correction of Dentofacial Deformities. In Peterson L.J., et al (editors): "Contemporary Oral and Maxillofacial Surgery" St. Louis, 3rd Ed., Mosby-Year Book, Inc. pp 614-695, 1998.
 - 17- Moteqi E., Hatch J.P., Rugh J.D. and Yamaguchi H.: Health-related quality of life and psychosocial function 5 years after orthognathic surgery. *American J. Orthodontics and Dentofacial Orthopedics*, 124 (2): 138-142, 2003.
 - 18- Iino M., Ohtani N., Niitsu K., Horiuchi T., Nakamura Y., and Fukuda M.: Two-stage orthognathic treatment of severe class III malocclusion: report of a case. *Br. J. Oral Maxillofac. Surg.*, 42 (2): 170-172, 2004.
 - 19- Kurian A. and Ward-Booth P.: Blood transfusion and orthognathic surgery-a thing of the past? *Br. J. Oral Maxillofac. Surg.*, 42 (4): 369-370, 2004.
 - 20- Sammanbds N., Cheung L.K., Tong A.C.K. and Tideman H.: Blood loss and transfusion requirements in orthognathic surgery. *J. Oral Maxillofac. Surg.*, 52 (1): 21-24, 1996.
 - 21- Dhariwal D.K., Gibbons A.J., Kittur M.A. and Sugar A.W.: Blood transfusion requirements in bimaxillary osteotomies. *Br. J. Oral Maxillofac. Surg.*, 42 (3): 231-235, 2004.
 - 22- Van Sickels J.E. and Richardson D.A.: Stability of orthognathic surgery: a review of rigid fixation. *Br. J. Oral Maxillofac. Surg.*, 34 (4): 279-285, 1996.
 - 23- Ellis E. and Graham J.: Use of a 2.0-mm locking plate/screw system for mandibular fracture surgery. *J. Oral Maxillofac. Surg.*, 60 (6): 642-645, 2002.
 - 24- Berger J.L., Pangrazio-Kulbersh V., Bacchus S.N. and Kaczynski R.: Stability of bilateral sagittal spit ramus osteotomy: rigid fixation versus transosseous wiring. *Am. J. Orthod. Dentofacial Orthoped.*, 118 (4): 397-403, 2000.
 - 25- Mosbah M.R., Oloyede D., Koppel D.A., Moos K.F. and Stenhouse D.: Miniplate removal in trauma and orthognathic surgery-a retrospective study. *Internat. J. Oral Maxillofac. Surg.*, 32 (2): 148-151, 2003.
 - 26- Ibrahim S.A. and Al-Swify A.A.: Anterior maxillary osteotomy; soft and hard tissues changes, and their long term stability. *Ainshams Dental J.*, March 2000 (Internet: Netfirms Web Hosting).
 - 27- Uckan S., Schwimmer A., Kummer F. and Greenberg A.M.: Effect of the angle of the screw on the stability of the mandibular sagittal split ramus osteotomy: a study in sheep mandibles. *Br. J. Oral Maxillofac. Surg.*, 39 (4): 266-268, 2001.
 - 28- Landa L.E., Tartan B.F., Aguz A, Skouteris C.A., Goron C. and Sotereanos C.G.: The transcervical incision for use in oral and maxillofacial surgical procedures. *J. Oral Maxillofac. Surg.*, 61 (3): 343-346, 2003.
 - 29- Teerijoki-Oksa T., Jääskeläinen S.K., Forssell K., Forssell H., Vähätalo K., Tammisalo T. and Virtanen A.: Risk factors of nerve injury during mandibular sagittal split osteotomy. *Internat. J. Oral Maxillofac. Surg.*, 31 (1): 33-39, 2002.
 - 30- Becktor J.P., Rebellato J., Becktor K.B., Isaksson S., Vickers P.D. and Keller E.E.: Transverse displacement of the proximal segment after bilateral sagittal osteotomy. *J. Oral Maxillofac. Surg.*, 60 (4): 395-403, 2002.
 - 31- Spitzer W.J. and Steinhauer E.W.: Condylar position following ramus osteotomy and functional osteosynthesis. *Internat. J. Oral Maxillofac. Surg.*, 16: 257-261, 1987 .
 - 32- Schendel S.A.: Orthognathic Surgery. In: Vander Kolk C.A. (editor): *Cranio-maxillofacial, Cleft and Pediatric Surgery*. In: Achauer B.M. et al. (editors): *Plastic Surgery Indications, Operations and Outcomes*. Volume two, Mosby Inc., St Louis, P 892, 2000.
 - 33- Ueki K., Nakagawa K., Takatsuka S. and Yamamoto E.: Plate fixation after mandibular osteotomy. *Internat. J. Oral Maxillofac. Surg.*, 30 (6): 490-496, 2001.
 - 34- Ayoub A.F., Millett D.T. and Hasan S.: Evaluation of skeletal stability following surgical correction of mandibular prognathism. *Br. J. Oral Maxillofac. Surg.*, 38 (4): 305-311, 2000.
 - 35- Bettega G., Cinquin P, Lebeau J. and Raphael B.: Computer-assisted orthognathic surgery: Clinical evaluation of a mandibular condyle repositioning system. *J. Oral Maxillofac. Surg.*, 60 (1): 27-34, 2002.
 - 36- Renzi G., Becelli R., di Paolo C. and Lannetti G.: Indications to the use of condylar repositioning devices in the surgical treatment of dental-skeletal class III. *J. Oral Maxillofac. Surg.*, 61 (3): 304-309, 2003.
 - 37- Reyneke J., Tsakiris P. and Becker P.: Age as a factor in the complication rate after removal of unerupted/impacted third molars at the time of mandibular sagittal split osteotomy. *J. Oral Maxillofac. Surg.*, 60 (6): 654-659, 2002.
 - 38- Raphael B., Bettega G. and Lebeau J.: Maxillo-mandibular disharmonies. (In French). *Ann. Chir. Plast. Esthet.*, 42 (5): 481-514, 1997.
 - 39- Kerawala C.J., Stassen L.F.A. and Shaw I.A.: Influence of routine bone grafting on the stability of non-cleft Le Fort I osteotomy. *Br. J. Oral Maxillofac. Surg.*, 39 (6): 434-438, 2001.
 - 40- Murray R.A., L. George Upton L. and Rottman K.R.: Comparison of the postsurgical stability of the Le Fort I osteotomy using 2- and 4-plate fixation. *J. Oral Maxillofac. Surg.*, 61 (5): 574-579, 2003.
 - 41- Hoffman G.R. and Brennan P.A.: The skeletal stability of one-piece Le Fort I osteotomy to advance the maxilla. Part 2. The influence of uncontrollable clinical variables. *Br. J. Oral Maxillofac. Surg.*, 42 (3): 226-230, 2004.
 - 42- Politi M., Costa F., Cian R., Polini F. and Robiony M.: Stability of skeletal class III malocclusion after combined maxillary and mandibular procedures: Rigid internal fixation versus wire osteosynthesis of the mandible. *J. Oral Maxillofac. Surg.*, 62 (2): 2004 m.politi@med.uniud.it.
 - 43- Kwon T.G., Mori Y., Minami K. and Lee S.H: Reproducibility of maxillary positioning in Le Fort I osteotomy: a 3-diminsional evaluation. *J. Oral Maxillofac. Surg.*, 60 (3): 287-293, 2002.
 - 44- Wolfe S.A.: Lengthening the nose: A lesson from craniofacial surgery applied to posttraumatic and congenital deformities. *Plast. Reconstr. Surg.*, 94 (1): 78-87, 1994.