

Leading Clinical Paper
TMJ Disorders

Intraoral distraction osteogenesis for the correction of facial deformities following temporomandibular joint ankylosis: a modified technique

A. A. Sadakah¹, R. F. Elgazzar^{1,2},
A. I. Abdelhady^{1,2}

¹Tanta Dental Hospital and School, Tanta University, Egypt; ²College of Dentistry, King Faisal University, Saudi Arabia

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Abstract. The aim of this study was to evaluate the feasibility of transoral bimaxillary distraction osteogenesis before releasing temporomandibular joint (TMJ) ankylosis using intraoral mandibular distractors. Nine patients (5 males, 4 females) aged 14–35 (mean 19) years were included. A bilateral Le Fort I osteotomy was performed together with a mandibular osteotomy on the affected side(s). An intraoral distractor(s) was inserted in the lower jaw, followed by an intermaxillary fixation (IMF) to maintain preoperative dental occlusion. The distractor was activated, after a latency period of 5–7 days, 2 times daily by 0.5 mm. There followed a consolidation period of 6–8 weeks. TMJ ankylosis was then released via a peri-auricular incision, a gap arthroplasty was performed, and mandibular movement was established after removal of the IMF and distractor. Optimal results were achieved clinically and radiologically with minimal relapse and complications. Apart from minor complaints, the distraction process was smooth and tolerable in all cases. Total mandibular elongation ranged from 17 to 25 mm (20.7 mm). Occlusal canting decreased to 0° in 7 patients and to 1° in 2 patients (mean 0.2°). After a mean follow-up period of 17 months, a mean postoperative mouth opening of 34.7 mm was achieved (0.6 mm preoperatively) and no re-ankylosis was detected. Intraoral distraction of a deformed mandible and maxilla before releasing TMJ ankylosis is a feasible and perhaps advantageous technique.

Key words: temporomandibular joint ankylosis; intraoral bimaxillary distraction osteogenesis; Le Fort I osteotomy; mandibular deformities; maxillary deformities.

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Various studies^{5,6,9,11,19,31} have reported the aetiology of temporomandibular joint (TMJ) ankylosis to be most commonly associated with trauma (13–100%), local

or systemic infection (0–53%) and systemic diseases, such as ankylosing spondylitis, rheumatoid arthritis and psoriasis (28%), and to occur after TMJ surgery.

This syndrome not only prevents mouth opening and chewing, but affects the growth and position of the mandible. This can eventually produce progressive facial

distortion, with devastating psychosocial effects compounding the already difficult problem of not being able to open the mouth.

Adult patients with TMJ ankylosis usually have various degrees of anatomical facial deformities, including microgenia, reduced facial height, poor jaw neck definition and of occlusal discrepancy. In unilateral patients, facial asymmetry is less associated with occlusal discrepancy; however, canting of their occlusal plane is more due to mandibular hypoplasia on the affected side, with secondary ipsilateral vertical deficiency in the maxillary process^{21,26}.

The correction of facial deformities following TMJ ankylosis remains a difficult and challenging problem in oral and maxillofacial surgery. Various techniques for treating this problem have been described but with no uniformly successful results. Expected complications may vary from limited intrinsic opening due to relapse, loss of vertical height of the affected ramus, foreign body reactions and re-ankylosis³⁵.

The treatment of TMJ ankylosis requires restoration of proper mandibular form, length and vertical dimension, occlusal stability and satisfactory joint movement. With children, future symmetrical growth must also be considered^{12,26}.

Costo-chondral grafts have long been an effective method of treatment in the reconstruction of the ramus-condyle unit after freeing TMJ ankylosis^{28,30,31}, but problems have been experienced with an unpredictable amount of growth that adds to the deformity^{9,25}. Bone contouring using autogenous grafts or alloplastic material in these patients has the disadvantage of donor site morbidity, late

resorption, difficult shaping and tissue reactions^{6,35}.

Distraction osteogenesis has recently become a mainstay for the treatment of craniofacial syndromes with mandibular hypoplasia including TMJ ankylosis^{15,18,27,30,37}. Its success in lengthening the mandible opens new perspectives for interceptive therapy, where other surgical techniques including orthognathic surgery and/or bone grafting procedures have not proved to be satisfactory^{15,20,30}. Many authors^{23,28} have reported marked occlusal disturbances following mandibular distraction osteogenesis which are sometimes difficult to be corrected orthodontically.

When treating patients with TMJ ankylosis, some authors (LOPEZ and DOGLIOTTI)¹⁶ prefer to first restore the jaw movements, and address the secondary facial deformities afterwards. ORTIZ-MONASTERIO et al.²² and CHO et al.³ have recommended simultaneous bimaxillary distraction osteogenesis with the use of external devices in patients with hemifacial microsomia for correction of their facial asymmetry. Similarly, many others, including GUERRERO et al.⁸, PAPAGEORGE and APOSTOLIDIS²⁴ and LIANG et al.¹⁵, prefer simultaneous mandibular distraction and arthroplasty in patients with TMJ ankylosis and mandibular hypoplasia. An unstable proximal condylar segment remains a problem during the distraction process.

In the present study, patients were treated by a 2-stage surgical protocol: (1) bimaxillary distraction osteogenesis to correct the maxillary and mandibular deformities and (2) releasing of the TMJ ankylosis for mandibular motion at a later stage. The aim was to introduce a modified surgical technique for the management of

patients with TMJ ankylosis syndrome, assess the feasibility of using intraoral bimaxillary distraction osteogenesis for correction of facial deformities before releasing the ankylosed joint(s), and evaluate this technique in restoring mandibular motion.

Materials and methods

This study was carried out in the Oral and Maxillofacial Surgery Department, Tanta Dental Hospital and School, Tanta University, Egypt, with the approval of the Tanta University Ethical Committee. There were 9 patients (5 males and 4 females), their ages ranging from 14 to 35 years (mean 19 years), presenting with TMJ ankylosis. Seven of them were unilateral and 2 bilateral. Six patients had recurrent ankylosis following previous failed surgery, while 3 were *de novo* cases (Table 1). Pre and postoperative assessment of all patients included facial and occlusal evaluation, panoramic radiographs, frontal and lateral cephalograms, photographs and study models (Fig. 1a and b).

To calculate the real mouth opening, the following equation was used:

Mouth opening

$$= \text{maximal inter-incisal opening} \\ + \text{the overbite measure.}$$

Preoperative and 17-month postoperative vertical mouth opening was measured for each patient using a ruler and the mean computed (see Fig. 5g); lateral excursion of the mandible was not measured. Deficiencies in the mandibular ramus and body were calculated by comparison with the opposite healthy side (in the unilateral

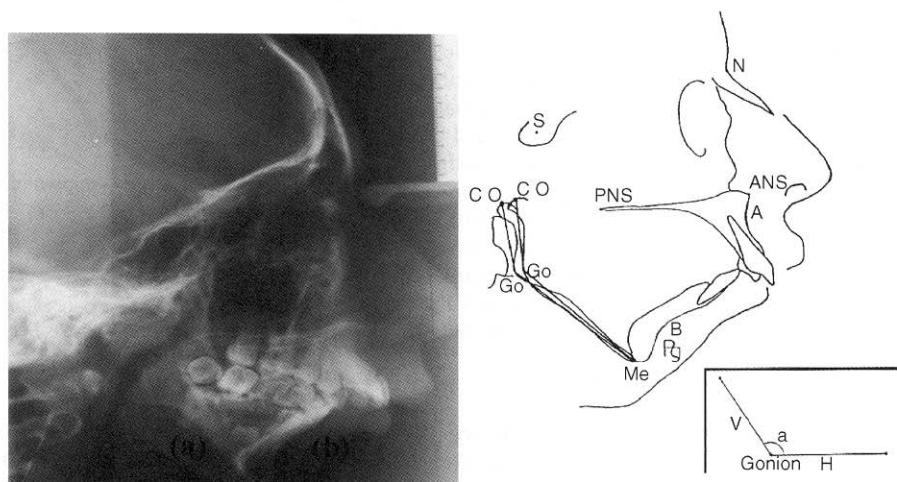


Fig. 1. (a and b) Analysis of preoperative cephalogram showing large, high gonial angle and short ramus in TMJ ankylosis patient.

Table 1. Bimaxillary distraction osteogenesis for treating sequelae of TMJ ankylosis: patient data and results

Number	Age	Side	Previous surgery (years ago)	Mouth opening (mm)		Latency period (days)	Follow-up period (months)	Elongation (mm)	Maxillary canting		Relapse (mm)	Maxillary height (mm)		SNB		Pharyngeal airway (mm)	
				Preoperative	Postoperative				Preoperative	Postoperative		Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative
1	18/M*	Unilateral (L)	1 (6 y)	0	36	6	24	23	15.5°	1°	4	49	57	65°	75°	3.8	10.5
2	14/F*	Unilateral (L)	—	3	35	5	22	17	10.5°	0	0	45	54	63°	76°	3.5	9.6
3	19/M*	Unilateral (R)	1 (8 y)	0	34	6	20	20	13.5°	1°	5	52	59	64°	77°	4.5	11.5
4	23/M*	Bilateral	2 (10 y)	0	35	7	18	R = 23 L = 20	3° (R)	0	4	51	58	62°	78°	4.2	13.0
5	16/F*	Unilateral (L)	1 (7 y)	0	34	7	18	19	13°	0	3	54	58	59°	75°	3.5	11.3
6	17/M*	Unilateral (L)	—	0	34	6	16	22	10°	0	3	44	55	66°	79°	3.7	12.2
7	14/F*	Unilateral (R)	—	2	33	5	12	17	11°	0	1.5	42	56	60°	75°	3.8	9.5
8	15/F*	Unilateral (R)	1 (10 y)	0	32	5	12	19	11.5°	0	3	42	55	59°	73°	4.0	10.6
9	35/M*	Bilateral	2 (20 y)	0	39	7	12	R = 25	2° (R)	0	5	55	61	64°	75°	5.8	12.5
Mean	19		10	0.6	34.7	6	17.1	20.7	10	0.2	3.1	48.1	57	62.4	75.9	4.1	11.2
SD	6.6		5	1.1	2.0	0.9	4.5	2.6	4.6	0.4	1.65	5.0	2.68	2.6	1.8	0.7	1.2
Min.	14		6	0	32	5	12	17	2	0.0	0	42	53	59	73	3.5	9.5
Max.	35		20	3	39	7	24	25	15	1	5	55	61	66	79	5.8	13

SNB: sella-nasion B-point angle.

* Age in years/sex

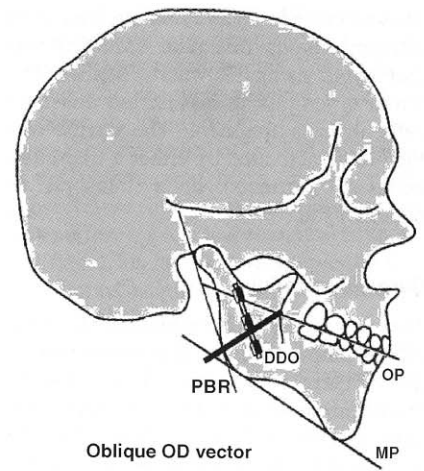


Fig. 2. An oblique distraction vector, slightly above the angle of the mandible.

cases), the opposing upper jaw, and according to normal measurements previously presented by LOSKEN et al.¹⁷

Distraction osteotomy planning

In this study, both vertical and horizontal rami of the mandible were found to be deficient. An oblique distraction vector, therefore, was decided upon and the osteotomy was planned in the ramus just above the gonial angle^{2,7} (Figs 2 and 3). In this manner, ramal elongation with preservation of the gonial angle and movement of the chin in a more forward position were to be achieved. A standard Le Fort I osteotomy procedure with incomplete separation was planned in the maxilla. Intermaxillary fixation (IMF) was decided upon to allow simultaneous bimaxillary movement (the max-

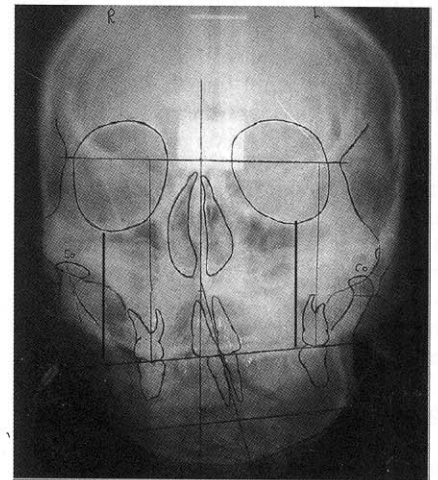


Fig. 3. Postero-anterior cephalogram showing canting of occlusion and deviation of the central line as sequelae of TMJ ankylosis.

illa was considered as a floating bone). An intraoral ramus distractor (Martin) was employed using 3 micro screws (5–7 mm in length), to be inserted transbuccally in each fragment. The device was then to be activated by either a transcutaneous (3 patients) or a transoral (6 patients) rod.

Surgical technique

This was based on the simultaneous mandibular and maxillary distraction technique of ORTIZ-MONASTERIO et al.²² and the modification suggested by CHO et al.³ Surgery was divided into 2 stages. The 1st stage was for the undertaking of the osteotomies, together with application of the distractor; the 2nd stage was to release the ankylosis and to remove the IMF and the distractor. All procedures were performed under general anaesthesia.

In the 1st surgical stage, intraoral exposure of the mandible and maxilla was performed on a subperiosteal plane. Using an oscillating saw, a Le Fort I osteotomy without displacement was performed in the maxilla, and then the mandible was osteotomized unilaterally or bilaterally, according to the ankylosis side. A suitable, uni-directional, intraoral ramus distractor was chosen, and the microplates were bent to fit the lateral mandibular shape. Before commencing a mandibular osteotomy, the distraction device was then temporarily fixed in the correct position, using 1 screw in each segment. The device was then temporarily removed. A complete mandibular osteotomy, with preservation of the inferior alveolar bundle, was performed in the ramus. The osteotomy was achieved in the buccal, anterior and posterior mandibular bones using a saw and in the lingual bone using a suitable wedge osteotome without the need for reflection of a full lingual flap. The distraction device was then secured in the predetermined position using 3 screws in each segment. Afterwards, both jaws were fixed together by IMF to allow maxillary rotation as well as movement, according to the mandibular distraction.

After a waiting period of 5–7 days, distraction was performed at a rate of 0.5 mm 2 times daily until satisfactory results were obtained. As this was being done at home, the parents were trained and given an instruction leaflet as well as a schedule to record the distraction events during the activation period. The mandible and the maxilla were distracted until the gonial angles were positioned at the same horizontal level, canting of the maxilla

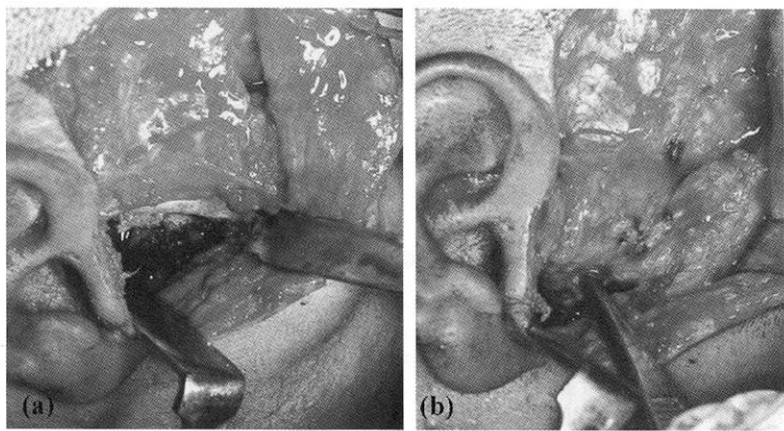


Fig. 4. (a) Release of the TMJ ankylosis through a standard peri-auricular incision; and (b) gap arthroplasty with interpositional temporal myofascial flap.

was almost zero and the central line was restored.

After 8–12 weeks, when existence of new bone was radiographically confirmed, all patients underwent the 2nd surgical stage, which included:

1. release of the TMJ ankylosis (+/- coronoidectomy) through a standard peri-auricular approach, where minimal gap arthroplasty with an interpositional temporal myofascial flap was performed (Fig. 4a and b);
2. release of the IMF;
3. removal of the distractor through a small intraoral incision.

All patients were followed up clinically and radiographically for an average period of 17 months postdistraction (Table 1).

Statistical analysis

The Minitab 13.1 statistical package was used for data analysis. Descriptive statistics were used to describe and compare the preoperative and postoperative clinical and radiological variables.

Results

The results of this study (Table 1) were based on clinical observations, and the analysis of postoperative panoramic and cephalometric radiograms.

The intraoral distraction device was found to be well tolerated by all patients who were able to perform their normal daily activities without great discomfort. The distraction process was uneventful in all cases, without infection or other major complications. Successful distraction osteogenesis was achieved in all patients, whereby bone formation was depicted

radiographically, and verified clinically during the 2nd stage of surgery.

Marked correction of facial asymmetry was noticed in all cases, with restoration of the lip midline and lip competence. Centralization of the chin point with improvement in its prominence and contour was also achieved. Canting of the occlusion and retrusion of the mandible were satisfactorily improved (Figs 5h and 6a–f). Facial height and gum show, however, was minimally increased in one of the bilateral cases. Further chin correction was needed in some cases by means of advancement genioplasty.

In spite of the absence of the TMJ condyle, patients showed a functioning articulation with an adequate range of mandibular movement. An average postoperative interincisal opening of 34.7 mm was achieved (compared to 0.6 mm, preoperatively) after a mean follow-up period of 17 months (Fig. 5e and g). Snoring and sleep apnea problems were greatly improved in all patients, as a result of improving the upper airway (Table 1).

Cephalometric analysis (Figs 5a–f and 6g–i) showed improvement in all measurements (Table 1). The total mandibular elongation ranged from 17 to 25 mm (20.7 mm) and the mean vertical dimension of the maxilla on the affected side was increased to 57 mm compared to a preoperative measurement of 48.1 mm, while it remained almost unchanged on the unaffected side (in the unilateral cases). Occlusal canting decreased to 0° in 7 patients, and to 1° in 2 patients (mean 0.2°). The posterior pharyngeal airway space was increased from an average of 4.1 mm preoperatively to 11.2 mm postoperatively. The SNB angle increased on an average from 62.4° preoperatively to 75.9° postoperatively. A mean relapse of about

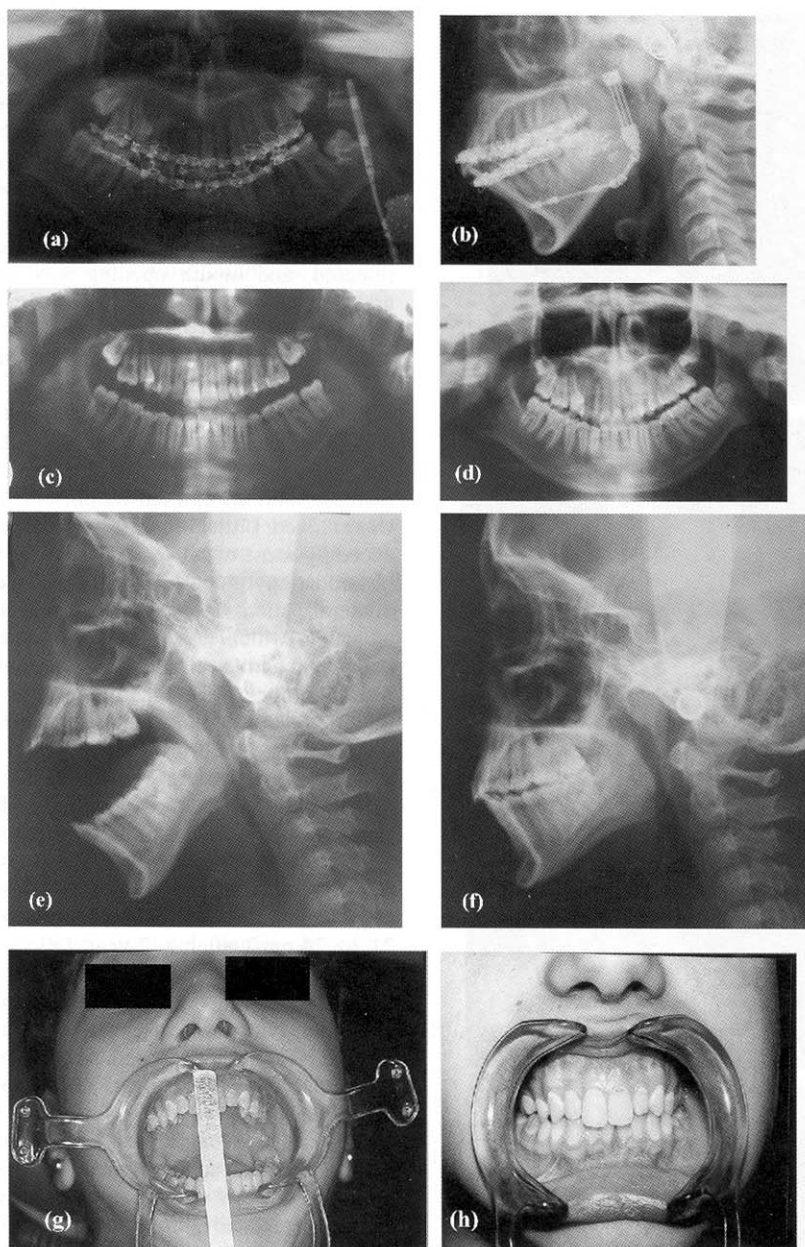


Fig. 5. (a) OPG showing left TMJ ankylosis and short left vertical ramus and the distraction device is activated; (b) lateral cephalogram showing the distraction gap during the consolidation period before commencing the 2nd stage; (c) 8-month postoperative OPG showing release of the left TMJ ankylosis, elongation and maturation of the left vertical ramus; (d) 17-month postoperative OPG showing the distracted left ramus and erupting wisdom teeth; (e) 17-month postoperative lateral cephalogram showing adequate mouth opening and functioning articulation; (f) 17-month postoperative lateral cephalogram showing the jaw relation, occlusion of teeth and improved upper airway; (g) 17-month postoperative frontal view showing adequate mouth opening and functioning articulation; (h) intraoral 17-month postoperative photograph showing an acceptable occlusion with 1.5-mm relapse viewed at the central line.

3 mm was found 12 months postoperatively (Table 1).

Discussion

Micrognathia, a deviated central line, canting of the occlusion and sleep apnea were the main disorders in this study. The

primary surgical objective in the treatment of these disorders was to establish a functional and aesthetic facial anatomy that would remain stable in the long term, using minimal interventional procedures.

CARLSON² classified the surgical procedures for release of the ankylosed condyle into 3 groups: condylectomy, gap arthro-

plasty and interpositional arthroplasty. In the present authors' department, all treatment methods for managing TMJ ankylosis and accompanying sequelae have been successfully tried in the last 20 years. Since the bony callus of the TMJ ankylosis is not pathological bone, in this study, conservative interpositional arthroplasty was performed, using a temporal myofascial flap. This helped to preserve the vertical ramus height and at the same time guarded against reankylosis.

Distraction osteogenesis has gained popularity as a surgical technique for the treatment of orthognathic disorders for the following reasons: donor site morbidity is eliminated, the complexity of the procedure is minimized and, by using the current intraoral technique of simultaneous distraction, there is no external scarring. In addition, there are no emotional and cosmetic disadvantages to using external devices and the pre-existing dental occlusion can be preserved.

RUBIO-BUENO *et al.*²⁹ have used internal and external distraction devices to correct mandibular hypognathia in hemifacial microsomia, and reported some complications. These include loosening of the supporting screws in the extraoral devices and anterior rotation of the condylar segment. Some patients also experienced pain in the ipsilateral TMJ during the distraction period; the authors attributed this to distraction forces pushing the condyle up into the glenoid fossa. AZUMI *et al.*¹ studied the positional and morphologic changes of the mandibular condyle after mandibular distraction osteogenesis in skeletal class II patients, and concluded that most of the condyles were displaced in an upward and backward direction in the glenoid fossa, and the amount of displacement is correlated with the amount of mandibular lengthening. In the current study, release of the TMJ ankylosis was postponed to the 2nd stage of surgery after distraction so that the immobile joint represented a fixed point that would push the mandible forward, rather than backward as mentioned above. AZUMI *et al.* also reported a variable posterior and lateral open bite, following the change in ramus length. In the current study, the pre-existing dental occlusion was maintained by IMF during the distraction and consolidation period, which allowed the osteotomized maxilla to move simultaneously with the distracted mandible, so as to correct the occlusal canting and restore the midline.

Muscular resistance, particularly from masseter and medial pterygoid muscles, is one of the most crucial factors in creating resistance during distraction osteogenesis,

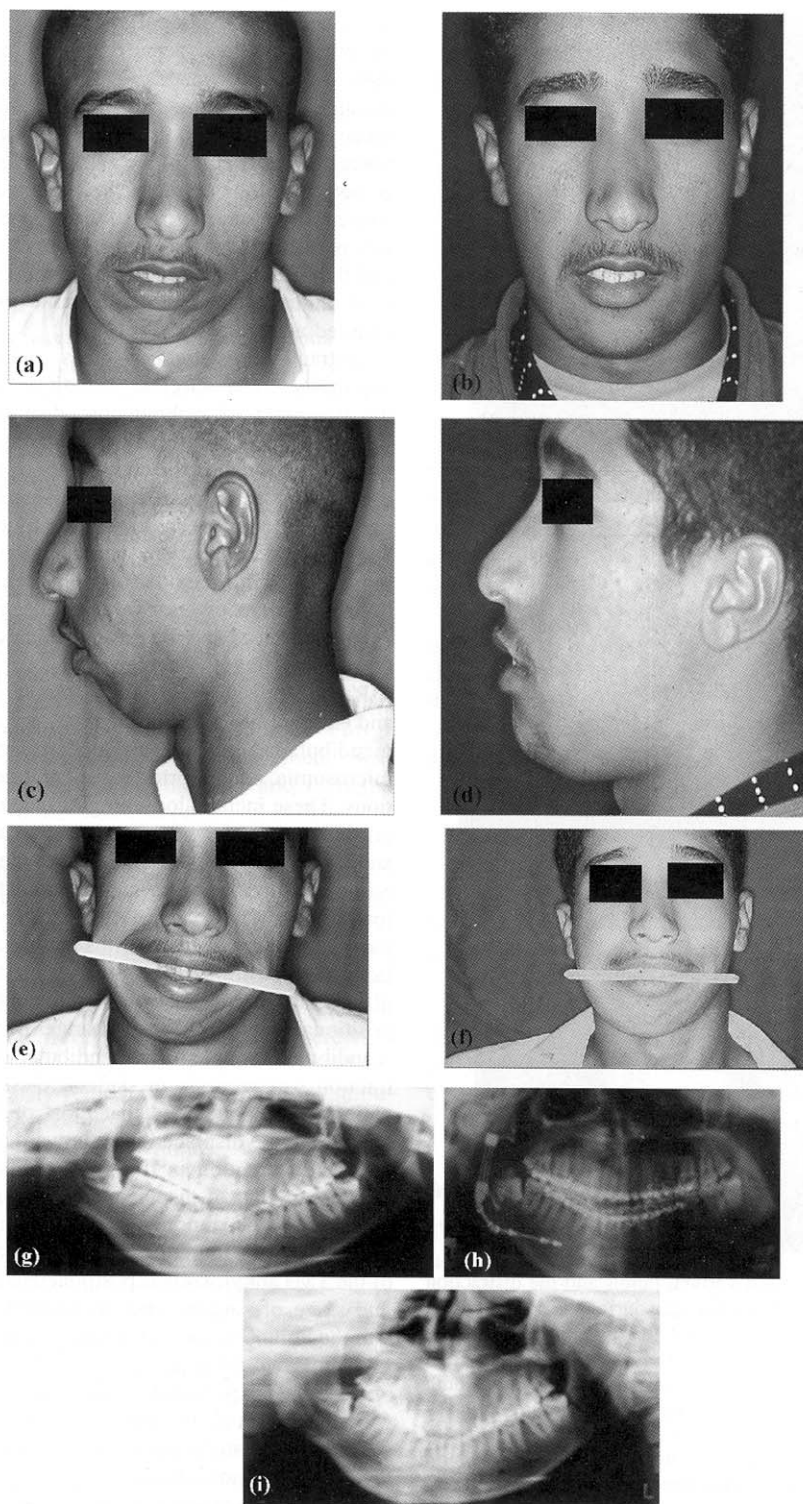


Fig. 6. (a) Preoperative frontal photograph of 19-year-old patient, showing the mandible deviated to the right (ankylosis) side; (b) postoperative frontal photograph showing that the mandibular deviation is corrected; (c) preoperative view showing hypognathia of the mandible; (d) postoperative view showing correction of the mandibular hypognathia; (e) preoperative frontal photo showing canting of the occlusion (15°); (f) postoperative frontal photograph showing canting correction (0°); (g) preoperative OPG view showing severe ankylosis of the right TMJ and short ramus; (h) OPG view showing the distraction gap during the consolidation period before the TMJ ankylosis is released; (i) OPG view after releasing the TMJ ankylosis and maturation of the distracted callus.

as well as during jaw exercises after releasing the ankylosis. In this patient series, muscle tendons, attached to the mandible, therefore, were dissected free during the 2 surgical stages. In the 2nd stage, to guard against intraoperative iatrogenic mandibular fracture, osteotomy and manipulation of the bony ankylosis were performed first, the IMF was released, and mouth opening was tried and regained to the maximum, followed by removing the distraction device.

Postoperative physiotherapy included gradual intraoral bilateral insertion of wooden spatulas (2-mm thick); 10 spatulas (20 mm) were used immediately after surgery, followed by daily number increase until an optimal mouth opening was attained. Little discomfort was experienced by most of our patients during the physiotherapy process. Only one of the 2 bilateral patients had minor occlusal discrepancy, which was managed by intermaxillary active elastics for 2 weeks. None of our patients had any sign of fracture or green-stick fracture at the distracted segment during the 2nd stage of surgery or physiotherapy.

SAEED and KENT³¹ used costo-chondral grafts for management of TMJ ankylosis. They surprisingly reported re-ankylosis in 18 (out of 22) cases, and a limited improvement in mouth opening (from 21 to 24 mm) after a 2-year follow-up period. In the current study, none of the 9 patients showed any sign of re-ankylosis and the average postoperative mouth opening was 34.7 (compared to 0.6 mm preoperatively) by the end of the follow-up period.

In a study on long bones¹⁰, it has been emphasized that an intact intramedullary blood circulation with overlying periosteum is essential to allow bone regeneration after lengthening. KARAHARJU-SUVANTO et al.¹³ have reported from their study on sheep that the cutting of the intramedullary blood vessels or overlying periosteum does not affect bone healing. In the present study, the inferior alveolar bundle and the overlying periosteum were kept intact at all times, so as to preserve the limited mandibular bone volume and to maintain the integrity of the inferior alveolar nerve. Consistent with WHITESIDES and ROGER³⁶, temporary hypoesthesia was encountered in 5 patients, who completely recovered in a few weeks postoperatively.

Different rates of daily distraction have been reported in earlier studies^{2,10,29}. In this study, the distraction rate was 0.5 mm 2 times daily, and it showed optimal results.

There has been some controversy as to when distraction should commence after

the osteotomy procedure. For long bones, ILIZAROV¹⁰ recommended a 5–7-day delay before starting gradual distraction. With mandibular distraction, SNYDER et al.³² indicated a period of 1 week, while KARP et al.¹⁴ and COSTANTINO et al.⁴ waited for 10 days. Considering the healing capacity of mandibles and the relatively young age of the patients in this study, a waiting period of 5–7 days was applied and found to be optimal.

The mean relapse in mandibular length in this study was 3 mm, which is comparable with other studies^{29,33,34}. This relapse, however, was not found to be clinically significant; this can be explained by the fact that the patients did not have a normal, and therefore a more forgiving, TMJ.

The present authors recommend transoral bimaxillary distraction osteogenesis in the course of managing patients with TMJ ankylosis, before freeing their ankylosed joint. This was found to be effective in improving patient aesthetic results, and preserving the pre-existing occlusion, thus avoiding occlusal problems that are difficult to solve orthodontically. A successful combination of endoscopic techniques to create osteotomies and insert distraction devices, particularly in patients with locked jaw, would make surgery easier for the surgeon and safer to the patient. The distraction technique used in this study should be reserved for cases with minimal dental disorders. Cases with severe dental problems necessitate a thorough orthodontic treatment plan, both before and after distraction osteogenesis.

It can be concluded that bimaxillary distraction of the deformed mandible and maxilla, before freeing the TMJ ankylosis, is a feasible and effective technique for treating sequelae accompanying TMJ ankylosis. Postponing the release of the ankylosed joint is even more advantageous in preventing rotation and upward movement of the condylar segment during the course of distraction.

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Address:

Reda Fouad Elgazzar
Department of Oral and
Maxillofacial Surgery
Tanta Dental Hospital and School
6th floor
Tanta University
Egypt
E-mail: reda_elgazzar@yahoo.co.uk