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Comprehensive Management of Temporomandibular Joint Ankylosis — State of the Art

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<http://dx.doi.org/10.5772/59165>

1. Introduction

Temporomandibular joint (TMJ) ankylosis is one of the most challenging TMJ disorders that can negatively affect oral related daily functions like mastication, speech and hygiene [1,2]. The accepted definition of ankylosis is the bony or fibrous tissue fusion between articular surfaces including the meniscus, glenoid fossa and condylar heads [3]. Consequently, jaw functions like the maximal incisal opening (MIO) and lateral excursive movements progressively decrease. This chapter describes the most important issues of early and late management of TMJ ankylosis in both children and adults.

2. Etiology and pathogenesis of TMJ ankylosis

Trauma to the TMJ has been cited as the most common underlying reason responsible for ankylosis; however, local infections (e.g. otitis media) and systemic disorders (e.g. rheumatoid arthritis) also can also cause unilateral or bilateral TMJ ankylosis in some cases [4-7]. By improving the immediate management protocol of condylar fracture and proper application of antibiotics to fully address ear infections, the prevalence of ankylosis has decreased significantly in recent years. In addition to the common etiologic factors of TMJ condylar ankylosis, some affected infants with unknown etiological factors have been reported in the literature (Figure 1 a-c) [8].

The pathogenesis of the TMJ ankylosis is described by a sequence of events. The increased intra-articular vascular supply at the traumatized joint develops fibrosis and ultimately

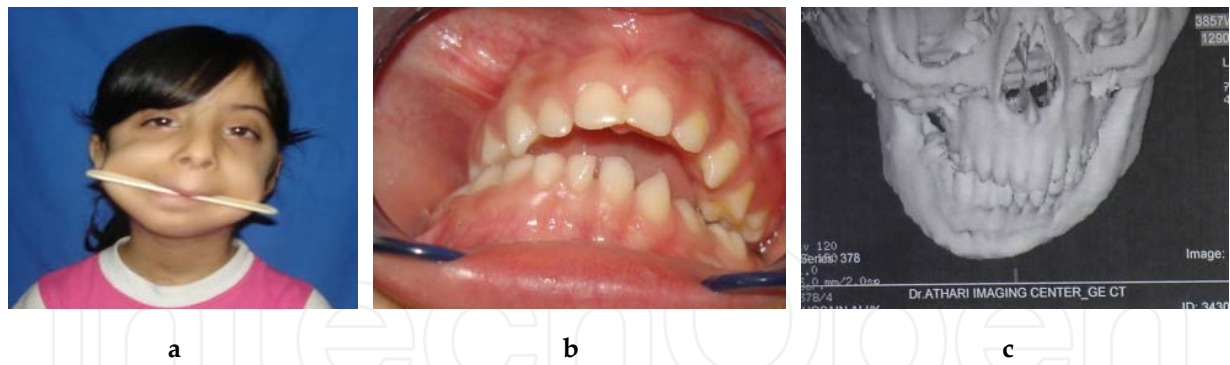


Figure 1. A 5-year-old girl with bilateral condylar ankylosis of unknown etiology (no history of trauma or infection). a) Extraoral facial photograph of the patient demonstrate the upper occlusal canting with the help of a tongue depressor, b) Intraoral photograph shows midline deviation, mandibular shift and increased overjet of the patient, c) three dimensional cone beam computer reconstruction of the patient demonstrates the facial asymmetry.

excessive localized bone formation [4]. Most of the animal studies consider intra-capsular hematoma as the main underlying reason for development of the ankylotic mass following trauma. Observed hemorrhage contains different cellular pathways activated by bone morphogenic proteins (BMPs) and tumoral growth factors (TGFs) [9]. However, a study on human subjects, revealed that hematoma in the joint space does not always result in bony ankylosis [2]. This excessive bone mass does not have a neoplastic nature, but has the potential of continual growth [10]. The presence of abnormal bony mass may restrict mandibular movement, which subsequently may lead in loss of the functional matrix of bone and muscle interaction, and consequently result in growth failure [11]. Inadequately treated or excessive treatment of condylar fractures may lead to growth retardation or growth excess, respectively [3]. Therefore, the best treatment steps for post-traumatic ankylosis and resulting growth abnormality is prevention.

3. Diagnosis and clinical features of TMJ ankylosis

Maximum mouth opening in the presence of pain or without it is a clinical indicator of traumatized condyles [12]. In addition to routine extra and intraoral photographs, supplemental diagnostic records may be needed for complete diagnosis of each case. Towne's projection, posteroanterior and cone beam CT (3D) radiographs are commonly used for this purpose (Figure 2 a, b).

Due to the flexibility of bone, it is possible to open the mandible to some extent, particularly in unilateral ankylotic cases [13]. Long-standing TMJ ankylosis can result in functional loss and facial deformity of affected individuals. In growing patients (mostly under 15 years) lack of adequate growth at the condyles, which are the main growth centers of the mandible, forward and downward movement of the mandible does not occur [13]. This growth retardation can result in a distorted mandibular structure in all three dimensions, highlighted mostly on sagittal views. Furthermore, deepening of the antegonial notch following continuous subperiosteal bone formation at the angles may be seen in most of the affected. However,

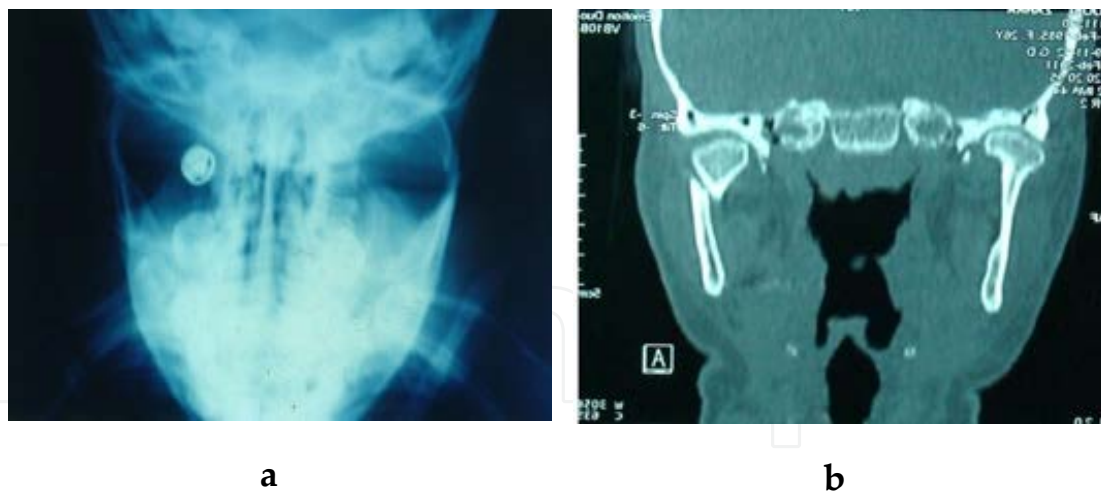


Figure 2. a) Posteroanterior view of a condylar neck fracture, b) Coronal section of computer tomography scan of another adult patient with unilateral condylar fracture on the right side.

ankylosis in patients older than 15 years of age experience mild facial deformities concomitant with significant functional loss. Depending on the type of ankylosis (unilateral or bilateral) clinical features can vary.

In the case of unilateral ankylosis, the patient also develops a mandibular asymmetry and subdivision malocclusion [14]. Furthermore, in unilateral cases canting of the upper occlusal surface thought to be caused by compensatory vertical eruption of the posterior maxillary teeth ipsilateral to the restricted condyle is seen (Figure 3 a-c). On the other hand, in bilateral ankylosis, more limited range of interincisal opening and absence of maxillary occlusal canting is observed. Patients with bilateral ankylosis develop retrognathia, short posterior facial height and openbite with possible upper airway obstruction and severely convex facial profile (Figure 4 a, b) [15].

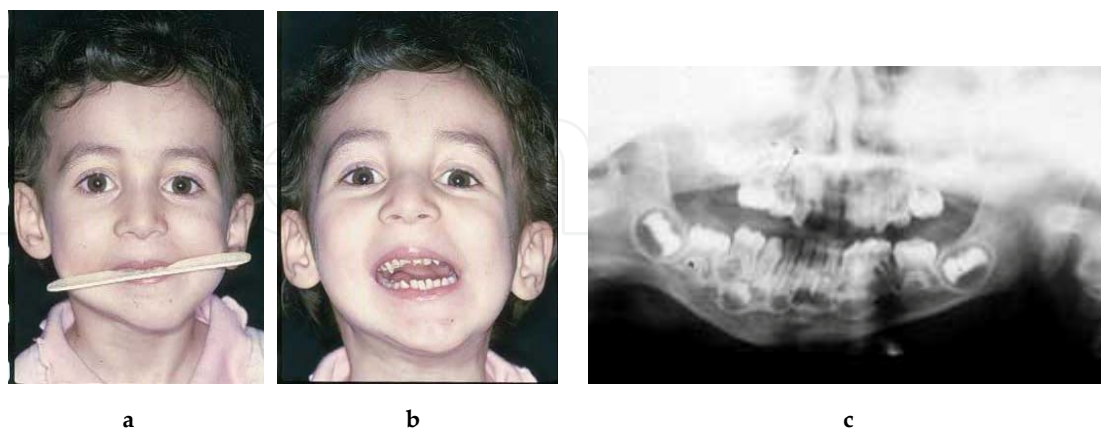


Figure 3. A 3-year-old girl with unilateral condylar ankylosis following trauma at birth, a) on facial examination, the patient presented with facial asymmetry, shortened ramus height, jaw deviation and the chin was noticeably deviated to the left and the maxilla was canted downward on the right side. b) The mandibular border became flat and elongated on the unaffected side and round on the affected side. The asymmetry is usually the least at the cranial base area and becomes worse at the lower parts including the chin. c) Radiographic image showing the mandibular border.

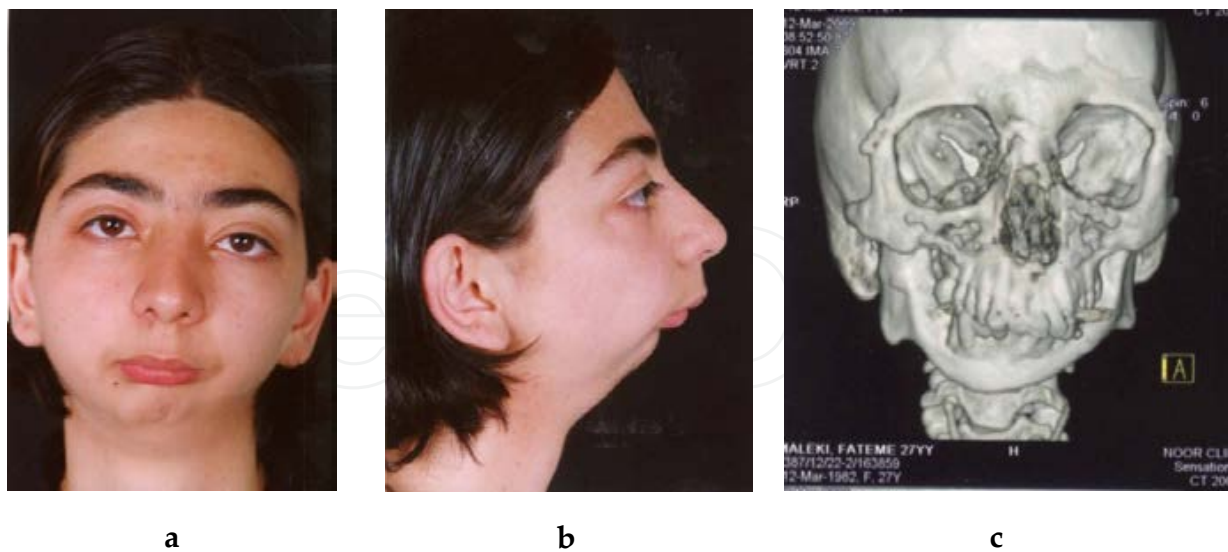


Figure 4. An 18-year-old girl with bilateral condylar ankyrosis. a) Long term effect of bilateral condylar ankyrosis in a growing adolescent, which result in limited mouth opening, micrognathia and absent neck chin angle. b) The profile view is helpful to assess anteroposterior and vertical facial imbalance as well as aid in the determination of etiology of the asymmetry. c) 3D CT scan.

Prevention of TMJ ankyrosis following trauma:

Regaining normal range of mandibular movement should begin as soon as possible after trauma. Many clinicians recommended a few days [5-7] of no-intervention immediately after the injury. This phase allows resolution of pain and swelling of the TMJ before reestablishment of normal range of movement [16]. However, care must be taken not to overextend this phase regarding ankyrosis development. Excellent compliance of the affected individuals with physiotherapy and functional appliances immediately after trauma is an essential part of future growth and development. Failure to achieve a high level of compliance to physiotherapy and application of intraoral appliances, increase the risk of future ankyrosis, which would be more problematic for patients as time passes.

3.1. Early management in childhood

Prevention of the ankyrosis of the traumatized condyles requires maintenance of the normal range of movement. In most cases, if the normal range of movement can be achieved, the TMJ will heal without any functional complication. When the patient is able to reach maximal opening, even in the presence of pain, the simplest prevention regimen would be insertion of a removable appliance, which guides the mandible into its correct position during closure. The design and fabrication of different types of removable appliances depends on the clinical situation of each patient, but commonly all are fabricated from a construction bite in which advances the mandible on the affected side more than the contralateral side in addition to concise maxillary and mandibular midlines. The major difficulty with construction bite is that the clinician must be able to guide the mandible to the proper position, rapidly and accurately. Different types of appliances and various combinations of components can be incorporated in

these appliances to meet individual requirements. Depending on compliance and age of the affected child, we use four different techniques:

1. Two simple removable Hawley appliances attached together while the patient is in centric occlusion (CO) guiding the lower jaw to symmetric position (Figure 5).
2. Fixed functional appliance with the aid of cement luting agent on the primary molars bands for more secure retention (Figure 6-a).
3. Usage of bi-zygomatic suspension wires in more severe cases in the absence of patient compliance and inadequate intraoral retention of the appliance.
4. Interdental Kobayashi wires with guiding interarch elastics, in cases of excessive restricted mandibular movement, which do not permit the clinician to take an impression (Figure 6-b).

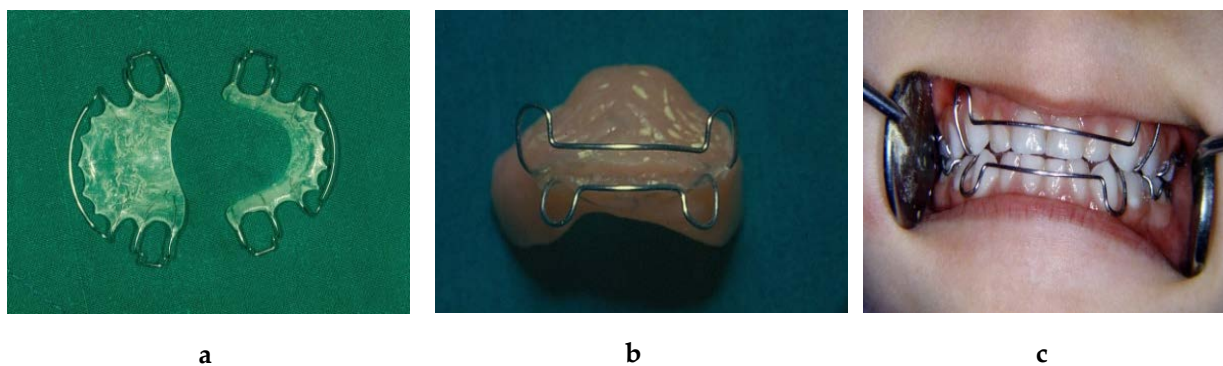


Figure 5. Two simple removable Hawley appliances attached together is the most common appliance used to guide the patient into symmetric position.

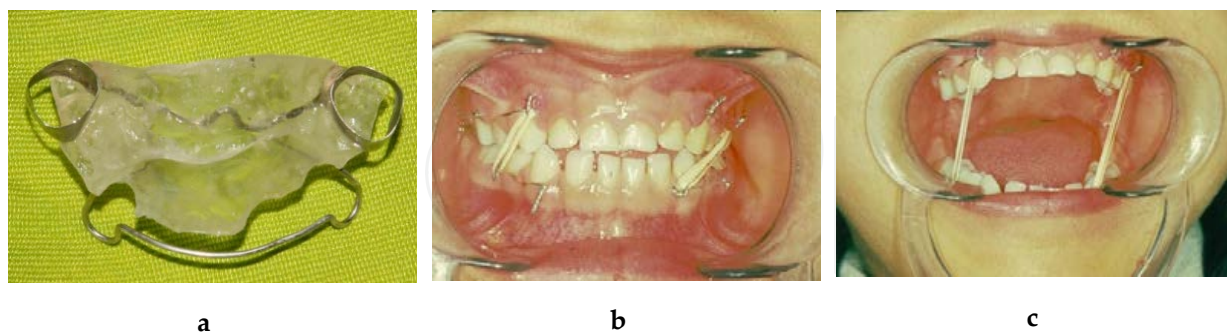


Figure 6. a) Fixed functional appliance with molar bands that can hold the mandible in its correct position full-time, b and c) Interdental Kobayashi wires and guiding interarch orthodontic elastics.

Despite the improvements, removable appliances are not a practical way to manage more severe situations that require extra manipulation of the TMJ fracture. A closed reduction often is useful to re-establish normal jaw function as a next step [17]. In fact, if the fractured condyle is still within the articular fossa, there is an opportunity to heal in a quite adequate functional

position, only by maintaining the occlusion. This technique is preferred over open reduction due to high success rate, less complications and technical problems and also less remnant facial scars [18]. However, clinical decision on the most appropriate type of treatment must be made considering different individualized factors like patient age, medical history, risk of infection, and risk of chronic pain, risk of scarring or nerve injury, and also presence of other concomitant facial, mandibular or cranial fractures [19]. Conservative management of condylar fractures is still the preferred option, however, in rare cases of condylar displacement into the middle cranial fossa, or lateral extracapsular displacement of the fractured segment, open reduction is selected [17]. The advantages of open treatment for condylar fractures would be the possibility of restoring the anatomical position of the fragments and disc, and subsequently immediate functional movement of the jaw, which greatly avoids the development of ankylosis of the traumatized joint [20].

3.1.1. Treatment

3.1.1.1. Unilateral condylar fracture

A 4-year-old boy was brought in approximately five hours after being hit on the left side of the face. He complained of pain on the left side (Figure 7 a). The impressions of upper and lower arch with limited jaw opening were performed and an attached upper and lower Hawley appliance was fabricated to guide the patient into correct closure (Figure 7 b). The condyle of the affected side healed and positive outcomes were maintained during a 1-year follow-up (Figure 7 c and Figure 8 a, b).

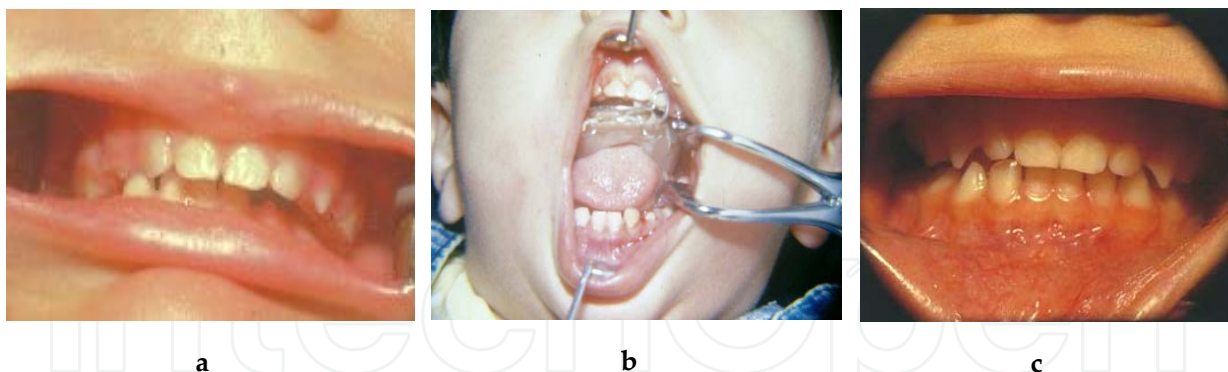


Figure 7. a) Pretreatment intraoral photograph shows inability of the patient to open the mouth. b) Removable appliance inserted for further guidance of the lower arch. c) Frontal facial view at the end of active treatment.

3.2. Early management in adulthood

Sometimes adult patients suffer severe trauma to the condyles, particularly as a part of a catastrophic event [21]. Although, because of absence of required growth in later stages of life, this restricted condylar growth might not result in severe facial deformities, but it may result in limited mandibular function. Recent improvements in treatment techniques including advent

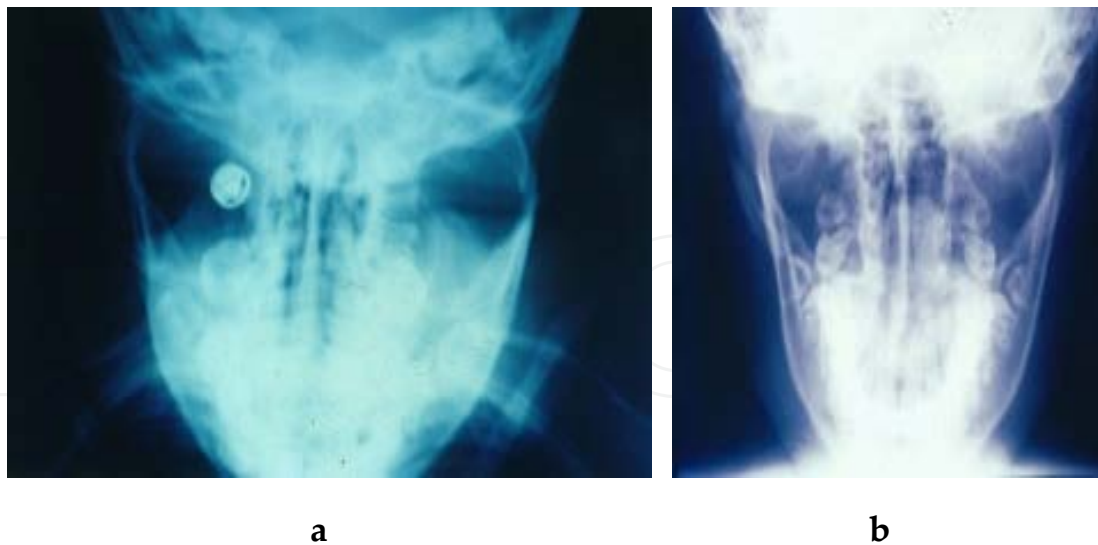


Figure 8. Same patient shown in Figure 7. a) Note the presence of condylar neck fracture at posteroanterior projection radiograph immediately before treatment with removable appliance. b) Follow-up radiograph of the patient which reveals adequate alignment of the fractured bony segment after 1-year.

of temporary anchorage devices (TAD) can help clinicians manage the other jaw fractures presenting with the traumatized condyles. In contrast to the traditional techniques like intermaxillary wire fixations, application of TADs does not restrict the range of normal functional movements. In addition, comparing their application in growing patients, TADs could be inserted in mature bony structures of the jaws without any additional risk regarding possible damage to un-erupted dental crypts. This approach removes the necessity of presence of enough remaining dentition to be used as guidance of jaw movements (Figure 9 a-c). With the help of these TADs and temporary light interarch elastics one can guide directional remodeling of traumatized condylar segments, in a manner similar to removable appliances [21].

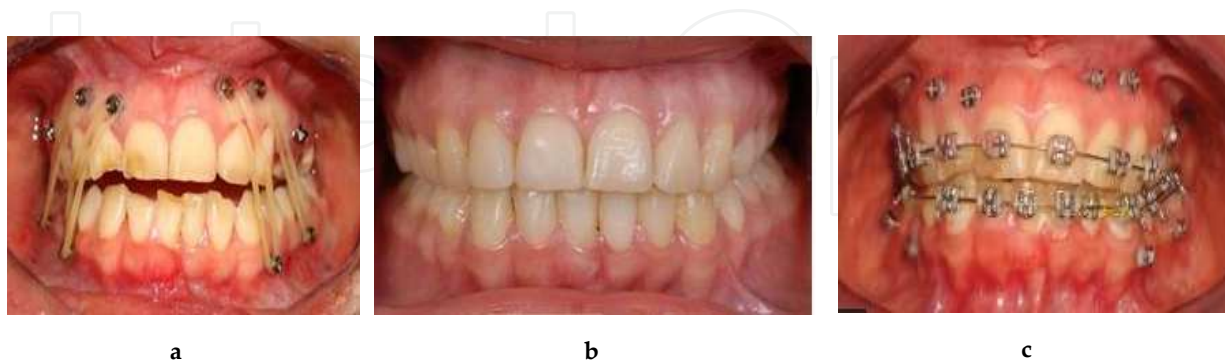


Figure 9. a) Settling of the occlusion and guidance of proper healing procedure by means of TADs and light intermaxillary elastics in an adult patient, b) orthodontic brackets were bonded on teeth to correct the remaining dental malposition, c) final treatment result (From Tehranchi A: Rapid, conservative, multidisciplinary miniscrew-assisted approach for treatment of mandibular fractures following plane crash Dent Res J. 2013 Sep-Oct; 10: 678–684).

4. Management of TMJ ankylosis

Treatment of TMJ ankylosis is an excellent example of an important principle in the timing of the treatment: because of devastating effects on future growth, presence of condylar ankylosis in growing patients is an indication for early treatment; in contrast, condylar ankylosis in adult patients must be treated considering the extent of functional limitation of mandibular movement. In many clinical situations pain is uncommon and limited range of opening is the first sign of condylar ankylosis, usually noticed by dental practitioners [22].

4.1. Management of TMJ ankylosis without severe dentofacial deformity

To date, various treatment approaches have been described to achieve successful management of ankylosis [23-24]; however no single treatment with uniformly successful results has been assigned for all cases [4, 25-26]. The optimum selection of an adequate technique depends directly on the details of clinical situation of the patients and is highlighted particularly in patients' growing phase, since their consequent facial deformity could be significantly worsened during growth [27]. In the aforementioned patients, orthopedic treatment with functional appliances following surgical release of ankylosis is highly recommended.

Possible treatment modalities for cases without severe facial deformities include surgical excision of an ankylotic mass, gap arthroplasty and interpositional arthroplasty [16, 24]. These techniques may be supplemented by application of different autogenous or alloplastic materials to reconstruct the ramus and affected condylar segments [28-29].

The first treatment option is gap arthroplasty, which increases the gap between the articular cavity and ramus by means of a simple bone division (Figure 10). The modifications of this technique including increasing the gap alone to reduce the re-ankylosis may not be clinically effective [30].

The second category, interpositional arthroplasty addresses the main drawbacks of the first method, which is high recurrence rate [31]. In this technique, surgeons try to fill the gap with autogenous graft materials including skin, dermis, flap of temporal muscle, cartilage or even alloplastic materials like silastic (Figure 11 a-c). The placement of these materials prevents the recurrence possibility. TMJ reconstruction is the third treatment option commonly done by means of a costochondral graft. However, other autogenous graft sources like clavicular osteochondral graft, coronoid process graft or alloplastic condylar implants can be used to reconstruct the lost segments. Autogenous sources present donor site morbidity; however alloplastic grafts are procedures with significant disadvantages of implant fracture or foreign body reaction. Between autogenous sources, costochondral grafts represent the most variable growth behavior, particularly in growing children, as compared to coronoid process graft, which demonstrate more predictable growth behavior.



Figure 10. Intra-operative view demonstrating gap arthroplasty technique.



a



b



c

Figure 11. Interpositional arthroplasty of an ankylotic condyle by means of square-shaped silastic graft material, a) Selected alloplastic silastic-based graft material, b) Insertion of the alloplastic silastic material, c) final position of the alloplastic material filling up the entire space created by the gap arthroplasty.

An approved international surgical protocol consists of 9-steps to take before and after surgery.

1. Aggressive total resection of the ankylotic segment in the condylar TMJ region. Recently, complete excision of the bony mass has been questioned regarding the increasing probability of the recurrence rate [10]. The underlying postulation was that leaving the opposing bony cut surface of the condyles after complete excision increase the amount of clot formation on dead space, which ultimately results in the formation of dense fibrous bridges that impede future mandibular movement [32]. Partial osteotomy of the region with minimal clot formation has been cited as a more potent surgical approach [32].
2. Coronoidectomy on the affected side (ipsilateral) which usually elongates in long-standing ankylosis and prevents intra-operative maximal opening because of the restriction. The autogenous bone achieved by this step can be used as a source of graft material to re-establish the ramus height of the affected side.
3. If the above-mentioned procedures do not result in normal maximum opening (more than 35 mm) without excessive force, the opposite coronoid (contralateral) must also be removed.
4. Lining of the joint with temporalis fascia or the remaining disk [16]

Remnants of the meniscus can serve as a barrier to prevent direct bony contacts and further fusion between condylar heads and glenoid fossa. However, there is controversy in the literature regarding the main role of the disc on the development of ankylosis [7]. In many traumatized cases, it has been shown that the ankylosis can occur even in the presence of an intact meniscus in the joint space [33-34].

5. Reconstruction of the ramus segment with costochondral grafts in growing patients if possible using rigid fixation (Figure 12 a-c),

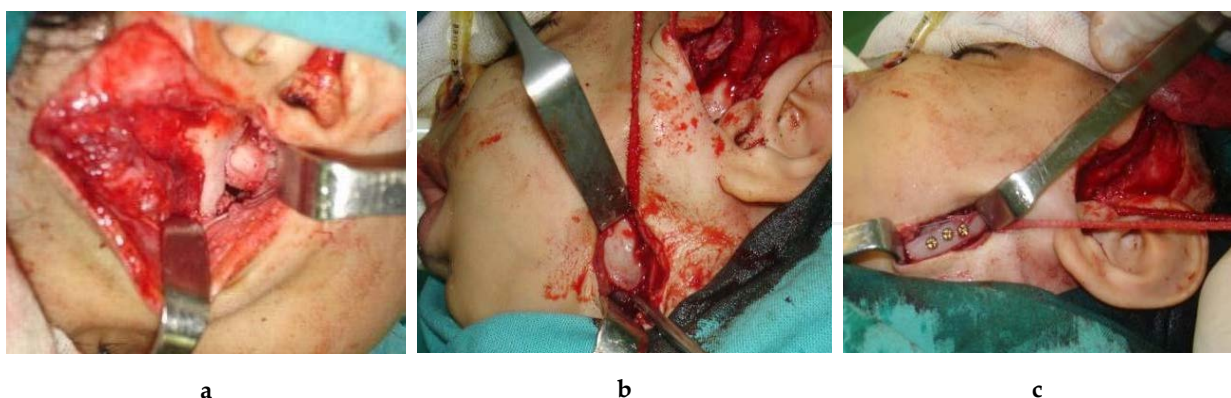


Figure 12. Intraoperative photographs of a patient with TMJ reconstruction treatment plan, a) extraoral access to the TMJ ankylotic mass through a preauricular excision, b) submandibular incision for placement of fixation plates over the costochondral graft, c) after aggressive excision of the ankylotic mass and fixation of the costochondral graft by means of fixation screws.

6. Intra-operative open bite creation on the affected side to permit settling of the bone graft, which should be maintained by a hybrid orthodontic appliance for 3-6 months (Figure 13 a) [35]. Simple removable functional appliance (Hybrid) with lingual and buccal shields on the affected side to encourage dental eruption and a bite block on the contralateral side to impede the eruption (Figure 13 b). In adult cases, however, considering the absence of passive dental eruption, the open bite should be managed by means of orthodontic brackets and light intermaxillary elastics (Figure 14 a, b).

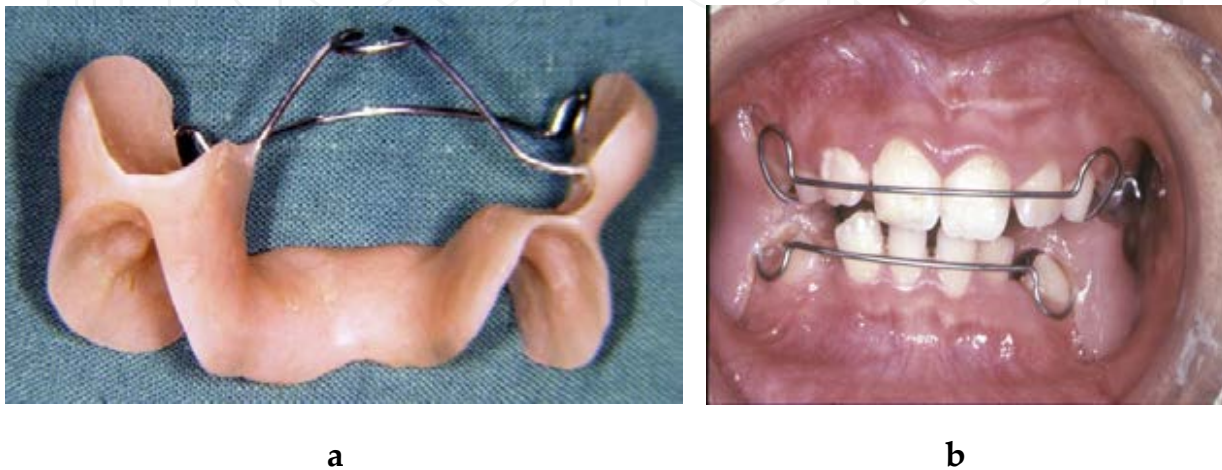


Figure 13. a) A hybrid functional appliance consist of two set of shields (lingual and buccal) to facilitate dental eruption on the affected side and acrylic bite block to impede dental eruption on the opposite site, b) A hybrid functional appliance in place



Figure 14. a) Bonding of orthodontic brackets on the upper and lower arch to correct the openbite on the affected side; note the degree of anterior open bite, b) Intraoral photograph of the final occlusion (From Behnia H: A Textbook of Advanced Oral and Maxillofacial Surgery ISBN 978-953-51-1146-7. chapter 16, Distraction Osteogenesis; 2013).

7. Early mobilization with a short period of intermaxillary fixation (not more than 3 weeks),
8. Supportive adjunctive therapy including physiotherapy with strict follow up to prevent the re-ankylosis phenomena. This therapy disrupts and prevents adhesions and soft tissue contraction in the healing stage (Figure 15 a-c).

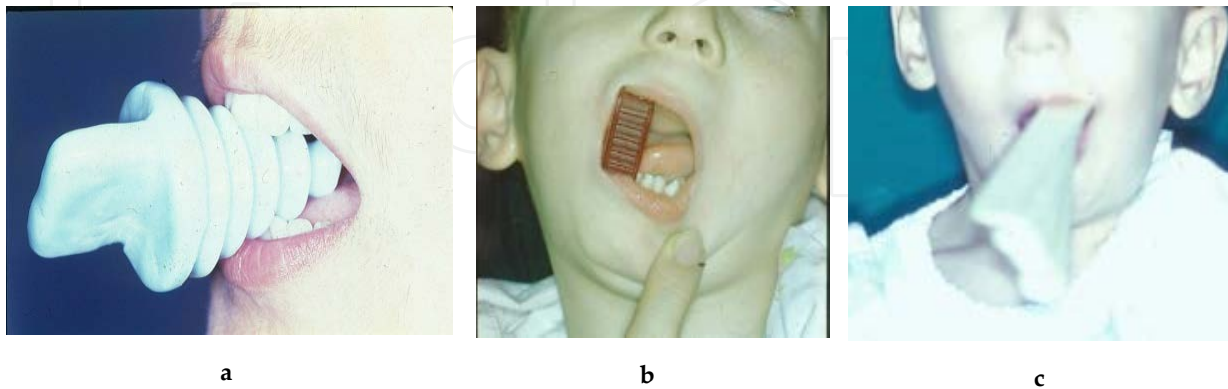


Figure 15. a-c) Adjunctive physiotherapy appliances that are used as aiding appliances during the physiotherapy phase.

9. Additional corrective surgery at the later stages when growth is completed

Recurrence of ankylosis and restricted mandibular movement are the most common complications after surgical management of the ankylotic mass. Following surgical protocol and also adequate compliance with postoperative adjunctive therapy might prevent these complications [31]. The final postoperative result is dependent directly on the selected surgical procedure, surgical technique, and attention to postsurgical physiotherapy.

4.1.1. Treatment

4.1.1.1. Unilateral condylar ankylosis

A 5-year-old girl with a history of left condylar trauma at age 2, with progressive facial asymmetry and deviation of the dental midlines due to left condylar ankylosis (Figure 16 a). There was no history of any other congenital malformation or childhood illness. On clinical examination her jaw deviated slightly to the left on closure and showed limited right lateral excursion. The ankylotic mass of the left condyle was demonstrated clearly on the MRI (Figure 16 b). An autogenous costochondral graft to reconstruct the left condyle had been done at age 5, which left an intraoperative open bite on the left side (Figure 16 c, d). A removable functional hybrid appliance was provided for the patient immediately after surgery to maintain the graft in a suitable position and let the posterior teeth on contralateral side erupt. This appliance opened the bite on the left side and brought the chin to the midline (Figure 16 e). The patient cooperated very well in the postsurgical phase with removable appliance and functional exercises of the jaws. One year after the orthodontic phase, the patient demonstrated an acceptable occlusion and facial symmetry (Figure 16 f).

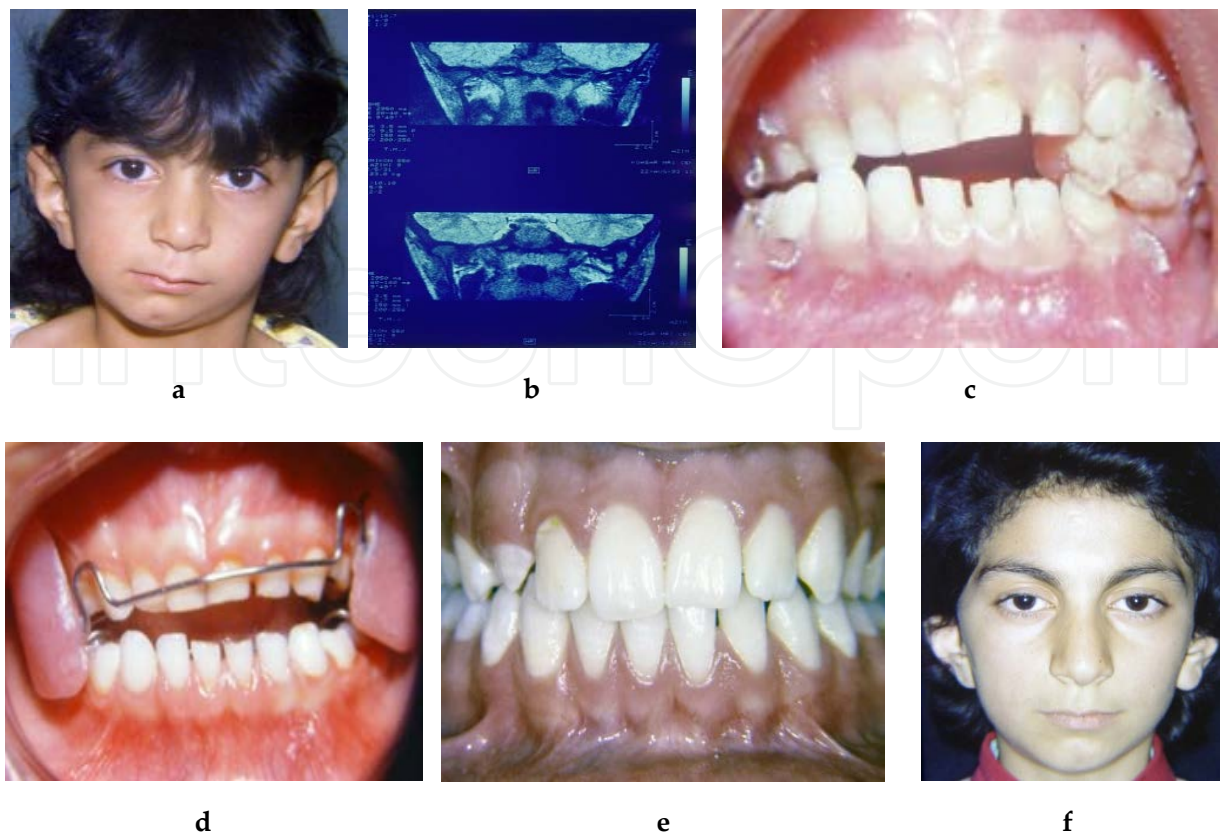


Figure 16. a) Facial view of a 5 year-old boy, b) MRI before any orthodontic intervention, c) postoperative openbite immediately after surgery to free the ankylotic condyle, d) Insertion of a hybrid functional appliance for differential dental eruption, e) occlusion of the patient. The remarkable improvement from unilateral condylar ankylosis and subsequent normal symmetric growth of facial structure was achieved. The functional appliance was also worn at night during the growth period. f) Final facial view

4.2. Management of temporomandibular joint ankylosis combined with severe dentofacial deformity

Patients with a history of persistent ankylosis usually demonstrate significant facial asymmetry. In addition to previously described surgery to release the ankylotic mass, these patients usually should undergo a second procedure to compensate developed facial asymmetries. This second procedure can range from a conservative genioplasty to orthognathic surgery of both jaws. Recently, distraction osteogenesis has become popular as another possible treatment option for the second phase [36]. However, precise monitoring of the distraction direction is an important consideration during this procedure. The final result of the distraction osteogenesis must be maintained via help of other functional appliances in growing patients [37]. Other adjunctive cosmetic surgical techniques like fat injection also can be applied to compensate the remaining asymmetry of the face [30].

Surgical treatment with costochondral graft (CCG) and distraction osteogenesis (DO) in cases with temporomandibular joint ankylosis associated with severe dentofacial deformities is

usually effective and quite reliable (Figure 17 a,b). Most of the assigned patients had significant mandibular retrognathia and asymmetry. Distraction usually started on day 7 after surgery.

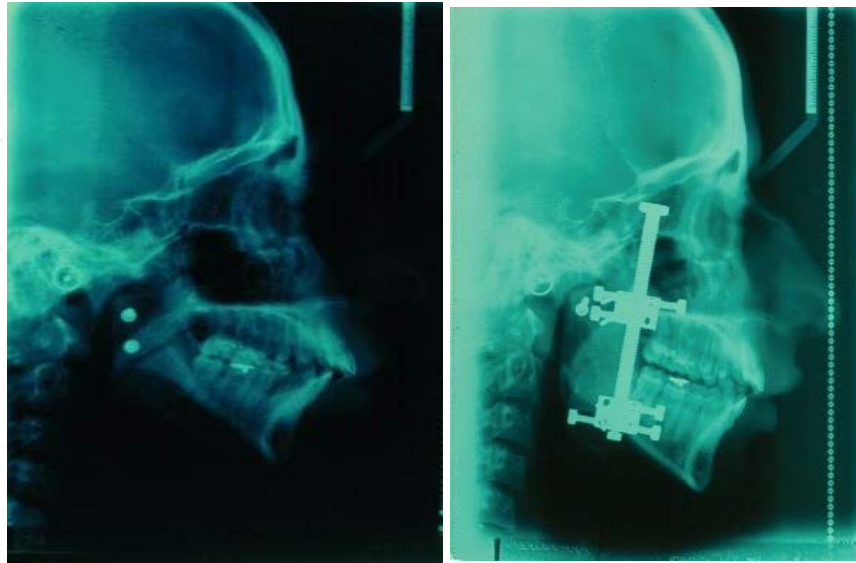


Figure 17. A case with unilateral distraction osteogenesis after receiving costochondral graft. Lateral cephalometry of the patient before (left) and after (right) distractor insertion.

4.2.1. Treatment

4.2.1.1. Bilateral condylar ankylosis

A 21-year-old male with a history of trauma at age 9, presented severe mandibular deficiency, micrognathia with restricted excursive and protrusive mandibular movement secondary to bilateral condylar ankylosis (Figure 18 a). The dental history of the patient revealed that, he had previously undergone an autogenous costochondral graft after bilateral condylectomy one year later, but re-ankylosis occurred. This whole procedure was repeated again one year after failure; however it did not fully address the patient's problem.

The treatment plan was to lengthen the mandible with bilateral distraction osteogenesis, which could advance the soft tissue volume simultaneously. Orthodontic treatment including extraction of first premolars on both sides due to preparation of adequate overjet was conducted on both sides. The extraction space was subsequently closed with moderate anchorage on both sides. Circumferential osteotomies were done on both side of the ramus and unilateral extraoral distractors (multiguider Leibinger) and were fixed in place (Figure 18 b). Considering the asymmetric representation of mandibular retrusion, the amount of mandibular advancement in the distraction phase was not equal on the right and left sides. During distraction phase, posterior open bite developed on the right side which was corrected by continuous application of cross elastic traction via fixed orthodontics (Figure 18 c). Upper and lower Hawley retainers with embedded wire on the occlusal surface of the upper posterior teeth were provided for the patient after finishing orthodontic treatment.



a



b



c

Figure 18. a) Pre-distraction facial and intraoral appearance. Significant mandibular deficiency is apparent. b) Circumferential osteotomies were made at the body of the right and left ramus and then custom-made unidirectional extraoral distractors were fixed in place. The mandible was advanced by 7 mm. The posterior open bite was created at the right side as a result of mandibular lengthening. Orthodontic triangle elastics were used concomitant with fixed orthodontic appliance to manage the posterior right open bite. c) Frontal facial view after debonding.

5. Complications after surgery

Although significant complications in the postoperative phase subsequent to surgery are not dramatic, it varies from mild pain to more serious persisting pain with restricted jaw movement and re-ankylosis. These unexpected adverse events and complications after surgery are mostly divided into two broad categories; those related to re-ankylosis and those related to the overgrowth of the cartilaginous autograft [38].

In the literature, there are two main reasons for re-ankylosis after surgical release including inadequate resection of the ankylotic mass intraoperatively and also, absence of patient compliance regarding post-operative jaw exercises [39-40]. The higher rate of reported re-ankylosis in children comparing to adults may be due to poor compliance to aggressive post-operative physiotherapy [4]. Complete diagnostic assessment of the ankylotic area, based on preoperative imaging examinations, is necessary to determine the extent of bony fusion and the length of the coronoid process on both sides [38]. The extent of bony fusion in both sagittal and coronal planes should be studied carefully to prevent any serious complication of facial nerve and maxillary artery injuries. Adequate mouth opening must be checked intraoperatively as a clinical indicator of successful surgery. Further ipsilateral or contralateral coronoidectomy with or without soft tissue release may need to be performed to achieve required mouth opening [38]. Growth behavior of inserted grafts including under and overgrowth may also present some complications in later stages of treatment. The role of jaw mobility exercises at home and at physiotherapy in prevention of re-ankylosis cannot be over-emphasized in children or adults. The preventive approach should be strict adherence to surgical protocol and post-operative physiotherapy requirements, monitored by both the orthodontist and surgeon (Figure 19).



Figure 19. a) Panoramic radiograph of re-ankylosis after previous costochondral grafting b) 3D CT showing complete bony ankylosis of the right condyle.

However, if the re-ankylosis occurs, the best option for its management depends directly on the type of ankylosis. Bony re-ankylosis needs additional surgical procedures. Fibrosis re-ankylosis may be managed by means of progressive jaw mobility exercises that can be delivered through different approaches. Some removable appliances may help clinicians

overcome this problem (Figure 20 a-d). If the patient cannot comply with these techniques, the surgeon should help them by initiating physiotherapy under local anesthesia.

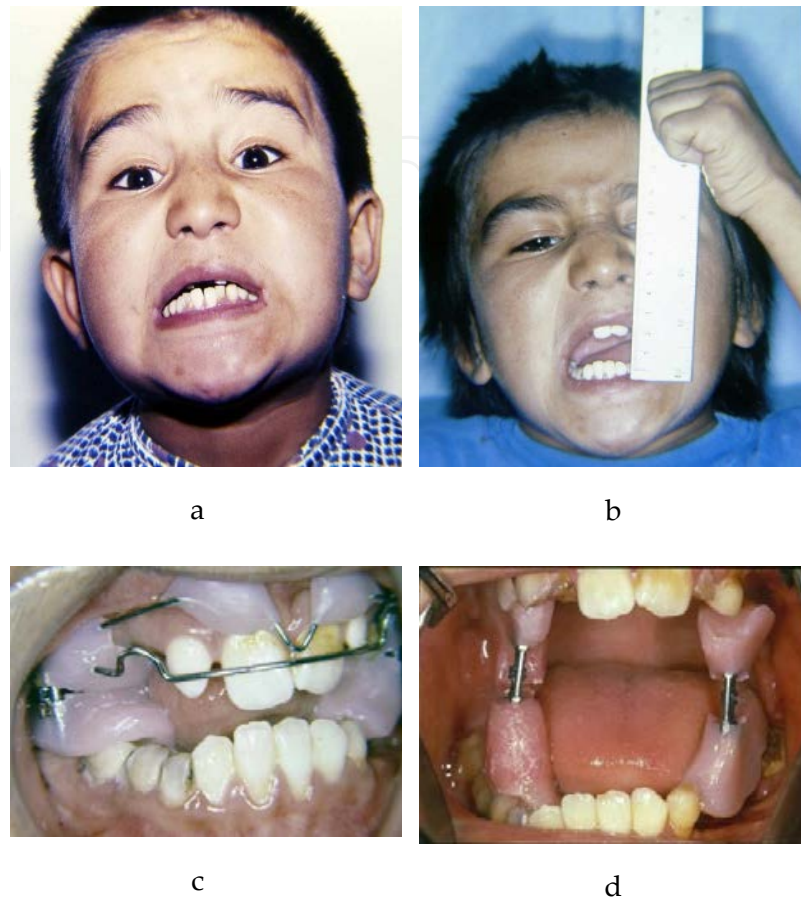


Figure 20. A 5-year-old with bilateral condylar ankylosis following a traumatic event. He underwent a surgical procedure to release the ankylotic condyles, which involved bilateral coronoidectomy also, a) Restricted opening secondary to re-ankylosis, b) Intraoral appliance consisting of labial pads, and acrylic posterior bite plates that incorporate two vertical-direction screws, c) The patient was asked to open the screw once a day, d) Because of the fibrosis type of ankylosis, the patient was able to open his mouth significantly more after treatment.

5.1. Treatment

5.1.1. Unilateral condylar overgrowth

A 29-year-old man was seen for treatment of severe facial asymmetry secondary to right condylar overgrowth (Figure 21 a-e). There was a history of TMJ ankylosis of the right condyle at age 3. Three years later, the patient underwent an autogenous costochondral graft to reconstruct the right mandibular condyle. The condylar structure was composed of the cartilage part of rib graft. As reported by the patient, the condylar overgrowth initiated approximately four years after graft surgery, when he was 10 years old, which lead to a marked facial asymmetry. On clinical examination there was chin deviation and midline divergence (mandibular dental midline shift). On functional evaluation of the patient, there was a

significant restriction on full range of anterior and transverse jaw motion, with deviation upon opening. The treatment plan was to remove the condylar overgrowth through a preauricular incision (Figure 21 f, g). Postoperative facial photography and panoramic view showed significant improvement in facial symmetry at 18 month follow up (Figure 21 h-k).



Figure 21. Male aged 29 years, a,b) severe facial asymmetry secondary to right condylar overgrowth is apparent, c-e) 3D computed tomography, posteroanterior and panoramic radiographs of the patient before surgical procedure, f) intra-operative view of the right condylar overgrowth mass, g) excess part of overgrowth of the condyle. h,i) postoperative clinical appearance of the patient after surgical removal of condylar overgrowth mass, j,k) Final posteroanterior and panoramic radiographs of the patient following 18 months follow up.

Acknowledgements

The authors thank staff of Orthodontic, Pediatric and Oral and Maxillofacial Surgery departments for general support and treatment procedures of the presented cases.

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