Hypomobility and Hypermobility Disorders of the Temporomandibular Joint

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Learning Aims

- Various etiologic factors exist for temporomandibular joint hypomobility and hypermobility.
- Proper diagnosis is the most critical part of management and long-term outcomes.
- Alloplastic total joint replacement is a surgical option in bony temporomandibular joint ankylosis, but costochondral graft and distraction osteogenesis tend to be the preferred methods in skeletally immature patients.
- When appropriate, minimally invasive procedures should be considered in the treatment of hypomobility and hypermobility before open surgical options.

55.1 Introduction

The temporomandibular joint (TMJ) plays an essential role in craniofacial development and masticatory function. TMJ dysfunction may impose physical and emotional stresses on patients, significantly impairing their quality of life. A broad spectrum of temporomandibular joint disorders (TMD) exist, but hypomobility and hypermobility are two significant pathophysiologic conditions that clinicians often encounter. Proper diagnosis is the most critical part of management for successful long-term outcomes.

The average maximal incisal opening (MIO) ranges from 36 mm to 50 mm, with male subjects and younger subjects presenting with more substantial mouth openings [1]. Although an opening of 36–38 mm may be accepted as the minimum limit for an average adult, the definition of TMJ hypomobility in millimeters may be relative to each patient due to different baseline mouth openings [2]. Generally, an MIO greater than 50–55 mm suggests TMJ hypermobility. Although it is one of the risk factors, TMJ hypermobility does not guarantee development of TMD. Patients may require surgical intervention when TMJ subluxation and dislocation continue to occur with accompanying symptoms.

This chapter discusses the spectrum of mobility problems and various etiologic factors associated with the TMJ complex. Historical and modern surgical approaches to hypomobility and hypermobility are also reviewed.

55.2 Hypomobility

55.2.1 Classification

Trismus is most commonly found in conjunction with spasm of the muscles of mastication. It can be secondary to myofascial pain dysfunction, infection, trauma, tumors, and various medications as well as psychiatric and neurologic factors. TMJ ankylosis is a fibrous or bony fusion of the condyle to the glenoid fossa. It can be classified according to location (intra-articular vs. extra-articular), type of tissue involved (bony, fibrous, or mixed), and extent of fusion (complete vs. incomplete). There are multiple classification schemes proposed in the literature; Sawhney described an extent of fusion in four stages. Type 1 is the mildest form with deformation of the condyle in close proximity to the upper articular surface, whereas type 4 involves complete ankylosis of the joint [3]. Li and coworkers incorporated computed tomography (CT) imaging and histologic characteristics to the Sawhney classification to improve the accuracy of the scheme [4]. Topazian classified complete ankylosis in three stages as follows: stage I, ankylotic bone limited to the condylar process; stage II, ankylotic bone extending to the sigmoid notch; and stage III, ankylotic bone extending to the coronoid process [5]. False ankylosis (pseudoankylosis), in contrast, describes limited mobility based on extra-articular factors such as fibrosis, mechanical obstruction (e.g., zygomatic arch fracture), muscle spasm, or other pathologies.

55.2.2 Etiology

The etiology of mandibular hypomobility is varied, and successful treatment requires an understanding of the underlying disorder. Trauma is the most common cause of ankylosis, identified as an etiologic factor in 31–98% of cases, followed by local or systemic infection (odontogenic, otitis media, and mastoiditis), which constitute 10–49% of ankylosis cases [6, 7]. The incidence of TMJ ankylosis from maxillofacial trauma and infection is higher in developing countries due to financial constraints, poor quality education, and lack of access to health care. Various systemic disease states are associated with hypomobility, including ankylosing spondylitis, rheumatoid arthritis, psoriasis, fibrodysplasia ossificans progressive, and other collagen vascular diseases such as scleroderma. Iatrogenic causes have also been identified and include the sequelae of high-dose radiation involving the muscles of mastication, craniotomy procedures, and uncommonly, orthognathic surgery. ◘ Table 55.1 lists the etiologic factors associated with mandibular hypomobility.

55.2.3 Clinical Presentation

Patients with fibrous or bony ankylosis present with restricted mandibular motion and, depending on the patient's age and the condition's etiology, may have an

Table 55.1 Etiologic factors associated with hypomobility of the mandible

Trismus	Odontogenic: myofascial pain, malocclusion, erupting teeth Infection: pterygomandibular, lateral pharyngeal, temporal Trauma: fracture of the mandible, muscle contusion Tumors: nasopharyngeal tumors, tumors that invade jaw muscles Psychologic: hysteric trismus Pharmacologic: phenothiazines Neurologic: tetanus
Pseudo-ankylosis	Depressed zygomatic arch fracture Fracture dislocation of the condyle Adhesions of the coronoid process Hypertrophy of the coronoid process Fibrosis of the temporalis muscle Myositis ossificans Scar contracture after thermal injury Tumor of the condyle or coronoid process
True ankylosis	Trauma: intracapsular fracture (child), medial displaced condylar fracture (adult), obstetric trauma, intracapsular fibrosis Infection: otitis media, suppurative arthritis Inflammation: rheumatoid arthritis, Still's disease, ankylosing spondylitis, Marie-Strümpell disease, psoriatic arthritis Surgical: postoperative complications of temporomandibular joint or orthognathic surgery

abnormality in mandibular size and shape. Unilateral pathology in children may result in significant problems with lower facial symmetry. A prominent antegonial notch usually accompanies a shortened ramus on the affected side noted on radiographs. The mandibular midline frequently deviates to the affected side with secondary effects on the maxillary occlusal plane and midfacial structures such as pyriform rims and bony orbits. Bilateral ankylosis may result in severe mandibular hypoplasia with presenting as bird face deformity.

Ankylosis in adults is characterized by limited jaw opening and decreased translation, but the morphologic characteristics found in the growing patient are frequently absent. Loss of condylar structure and mandibular angle prominence is seen in cases caused by rheumatologic disease, specifically scleroderma. An associated anterior open bite is commonly noted with the loss of ramus/condyle height (Fig. 55.1). Unilateral cases with a traumatic etiology may result in malocclusion and ipsilateral dental prematurities. The mandible will deviate to the affected side due to loss of translation.

Fig. 55.1 Patient with systemic sclerosis (scleroderma) demonstrating a limitation in jaw opening and skin changes characterized by perioral furrows and telangiectasia. (Adapted from August [158])

55.2.4 Imaging Assessment

Plain and panoramic radiographs are initial imaging modalities to evaluate for general morphology and symmetry of the condyles with minimal exposure to radiation. However, diagnostic accuracy may be limited due to the superimposition of adjacent anatomic structures. Sanders and colleagues have reported that conventional radiographs underestimate the extent of the bony ankylosis and give little information about the anatomy medial to the condyle [8].

The use of CT scans is helpful in fully defining the extent of ankylosis as well as the relationship of the ankylotic mass to important anatomic structures, especially at the skull base (Fig. 55.2) [9, 10]. Often in post-traumatic cases, the distance between the maxillary artery and the medial pole of the condyle is reduced, in which case a contrasted CT may be helpful in avoidance of these vital structures during the surgery. Three-dimensional reconstruction of the CT scans provides additional visualization of the extent of the ankylotic mass and coronoid hyperplasia.

MRI has had a great impact on TMJ evaluation, especially regarding the delineation of meniscal morphology and position. Diagnosis of fibrous ankylosis is possible with the use of MRI, but the CT scan is superior in demonstrating bony pathology [11].

55.2.5 Post-Traumatic Hypomobility

Trauma is the most common cause of bony and fibrous ankylosis as reported by multiple authors [6, 12, 13]. It is hypothesized that the formation of an intra-articular hematoma with subsequent scarring and new bone formation is the common precipitant. Hypomobility and ankylosis in growing children are of particular concern

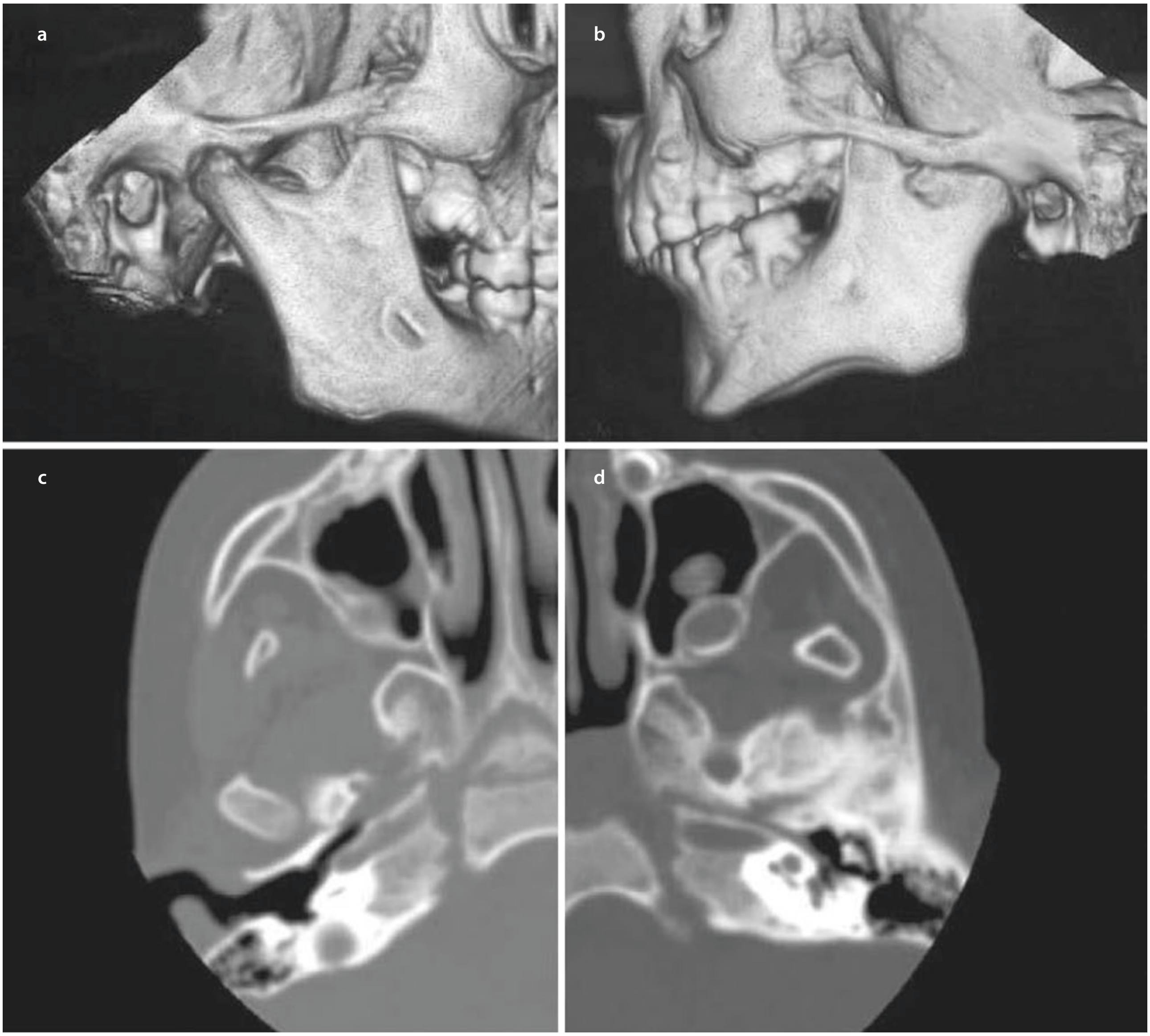


Fig. 55.2 Three-dimensional **a** and **b** and axial **c** and **d** computed tomography (CT) scans of a patient with extensive bony ankylosis of the left temporomandibular joint. **a** and **c** Note the comparison with the unaffected right side. **b** and **d** Coronoid hyperplasia is also seen on the affected left side. (Adapted from August [159])

due to a significant impact on facial growth (Fig. 55.3). In addition, resultant hypomobility can lead to speech impairment, difficulty with chewing, poor oral hygiene, limited access to dental care, and possible airway compromise. In large reviews of pediatric facial fractures, the condylar and subcondylar regions were involved in more than 40% of cases [14, 15]. In many cases, a direct blow to the chin with the transmission of the impact force to the condyles resulted in the fracture.

Comminuted fractures of the condyle are more likely to cause TMJ ankylosis than condylar neck fracture. In a review of 51 patients with TMJ ankylosis by He and coworkers, all subjects sustained an intracapsular fracture, with the sagittal pattern comprising 70% [16]. In the same group of patients, ankylosis was noted in areas of TMJ disc displacement and retrodiscal tissue tear, which supports the theory that the meniscus functions as a barrier between the fractured segments to prevent ankylosis. Other investigators have also noted the role of the meniscus in ankylosis prevention, suggesting MRI on intracapsular fractures to assess the integrity of the disc [17, 18]. A high occurrence of concomitant mandibular symphysis is also observed in TMJ ankylosis, where the resultant mandibular widening allows the fractured distal segment to be

Fig. 55.3 **a** and **b** Evident mandibular growth disturbance is noted in this child who has had bilateral condylar fractures. Note the submental scar secondary to a laceration sustained at the time of the bony injury. (Adapted from August [160])

in close contact with the zygomatic arch and glenoid fossa where ankylosis form [19]. Other predisposing factors to include an extensive trauma to the articular surface and glenoid fossa as demonstrated in animal models [20, 21].

Prolonged immobilization, secondary to treatment with maxillomandibular fixation, splinting, or mechanical obstruction, can lead to subsequent ankylosis. Extra-articular ankylosis can also occur with coronoid fractures and fractures of the zygomatic arch. In both cases, the resultant hematoma may calcify, resulting in a fusion of the coronoid process to the zygomatic arch.

Myositis ossificans traumatica (MOT), or fibrodysplasia ossificans circumscripta, is generally associated with a traumatic event or repeated episodes of minor trauma and can result in mandibular hypomobility [22, 23]. The precise mechanism remains to be elucidated but appears to involve fibrous metaplasia and subsequent ossification of both soft tissues and muscle after bleeding and myonecrosis. Of all reported cases involving the muscles of mastication, the masseter is most commonly affected [24]. Diagnosis is confirmed by identification of calcifications within the muscles of mastication on CT scans (Fig. 55.4). A minimal response is found with physical therapy and stretching exercises; consequently, surgical treatment is often undertaken to remove the ectopic bone. Other treatment modalities include acetic acid iontophoresis, magnesium therapy, and the use of etidronate sodium [25]. Because repeated relapses and refractory cases are common, the use of multiple treatment modalities may be associated with the best outcome.

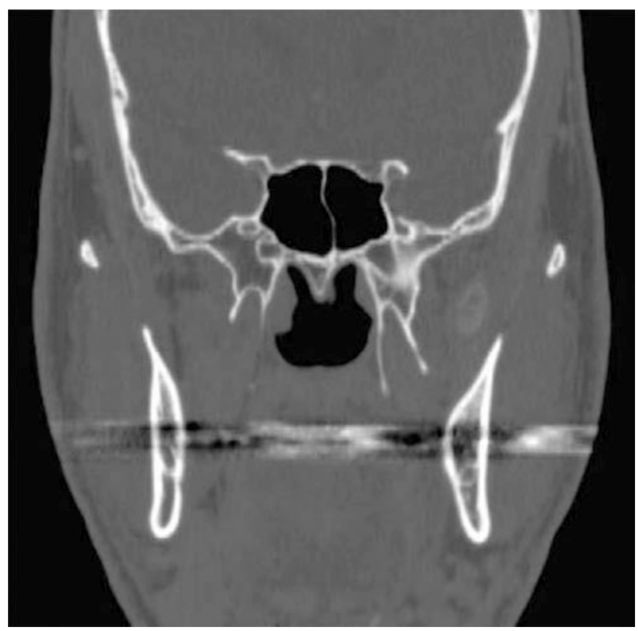


Fig. 55.4 CT scan of a patient with myositis ossificans traumatica demonstrates a focus of calcification within the medial pterygoid muscle on the left side. (Adapted from August [160])

55.2.6 Postinfectious Hypomobility

A TMJ infection resulting in hypomobility is most commonly the result of continuous spread from an odontogenic infection, otitis media, or mastoiditis [26, 27]. In the era of aggressive antibiotic treatment of infection, such reported cases are now relatively uncommon. Hematogenous spread of infection has also been reported in association with disease states such as tuberculosis, gonorrhea, and scarlet fever.

Various case series describe deep fascial space infections manifesting themselves as hypomobility and often being misdiagnosed at initial presentation [28, 29]. Odontogenic infection is commonly associated with trismus. In such cases, associated symptoms (fever, dysphagia) are likely present, and CT scanning is invaluable in determining a diagnosis and in treatment planning. Medial pterygoid abscess formation of fibrosis secondary to hematoma organization can be precipitated by an inferior alveolar nerve block or posterior superior alveolar block. A history of recent dental treatment should suggest this possibility; the use of CT imaging can help delineate the anatomy of the masticator and pharyngeal spaces. Masses involving the mandibular condylar invariably affect the range of motion and need to be included in the differential diagnosis of hypomobility.

Fig. 55.5 Patient with a history of high-dose radiation therapy and subsequent reirradiation for recurrence of nasopharyngeal carcinoma. Note the severe temporal atrophy and the limitation in opening. (Adapted from August [160])

55.2.7 Hypomobility After Radiation Therapy

Mandibular hypomobility is a common sequela of the treatment of head and neck malignancies (Fig. 55.5). The resultant fibromyositis caused by radiation therapy may exacerbate the postsurgical problems caused by large ablative procedures [30]. Goldstein and coworkers reviewed the effects of tumoricidal radiation therapy on restricted mandibular opening and found a linear dose-related effect [31]. Mandibular dysfunction increased as the dose to the pterygoid muscles increased. The authors reported diminution in the opening with doses as low as 15 Gy. Pow and associates reported that 30% of patients treated for nasopharyngeal carcinoma with high-dose radiation therapy had significant trismus compared with age-matched nonradiated control subjects [32]. Radiation therapy for primary tumors of the retromolar trigone was associated with a 12% incidence of long-term trismus. This association, compounded by resultant xerostomia, severely compromises the ability of these patients to maintain oral health.

The efficacy of early interventional physical therapy has been described. Buchbinder and colleagues compared the outcome of unassisted exercise, mechanically assisted exercise with the use of tongue blades, and use the TheraBite System in radiated patients [33]. All patients presented with an interincisal opening of less than 30 mm. The response to each therapy was recorded every 2 weeks over a 10-week period. All groups showed improvement over the first 4 weeks, but the group using a mechanical exercising device (i.e., TheraBite System) continued to demonstrate an improvement of a maximal interincisal opening (MIO) over the full 10-week period that was significantly greater than that of the other two groups.

55.2.8 Post-Craniotomy Hypomobility

Mandibular hypomobility after intracranial surgical procedures is an uncommon yet reported phenomenon (Fig. 55.6) [34, 35]. Mechanistically, this problem is secondary to neurosurgical procedures performed through the temporal bone requiring an incision of the temporalis muscle. Subsequent fibrosis and contracture of the muscle may then result in a limited opening. This problem is best treated with coronoid resection followed by vigorous physical therapy. The incidence of this problem is unknown, but a review by Kawaguchi and cowork-

Fig. 55.6 A 63-year-old female with TMJ hypomobility after craniotomy to resect trigeminal arteriovenous malformation. The patient was treated with left operative TMJ arthroscopy. Frontal **a**, lateral **b**, preoperative mouth opening of 27 mm **c**, postoperative mouth opening of 40 mm **d**, sagittal view of the left condyle **e**, closed sagittal T1 view of the left condyle demonstrating a displaced disc **f**, arthroscopic view of the left joint with appreciable adhesion and hyperemia **g**. (Courtesy of Joseph McCain, DMD, FACS)

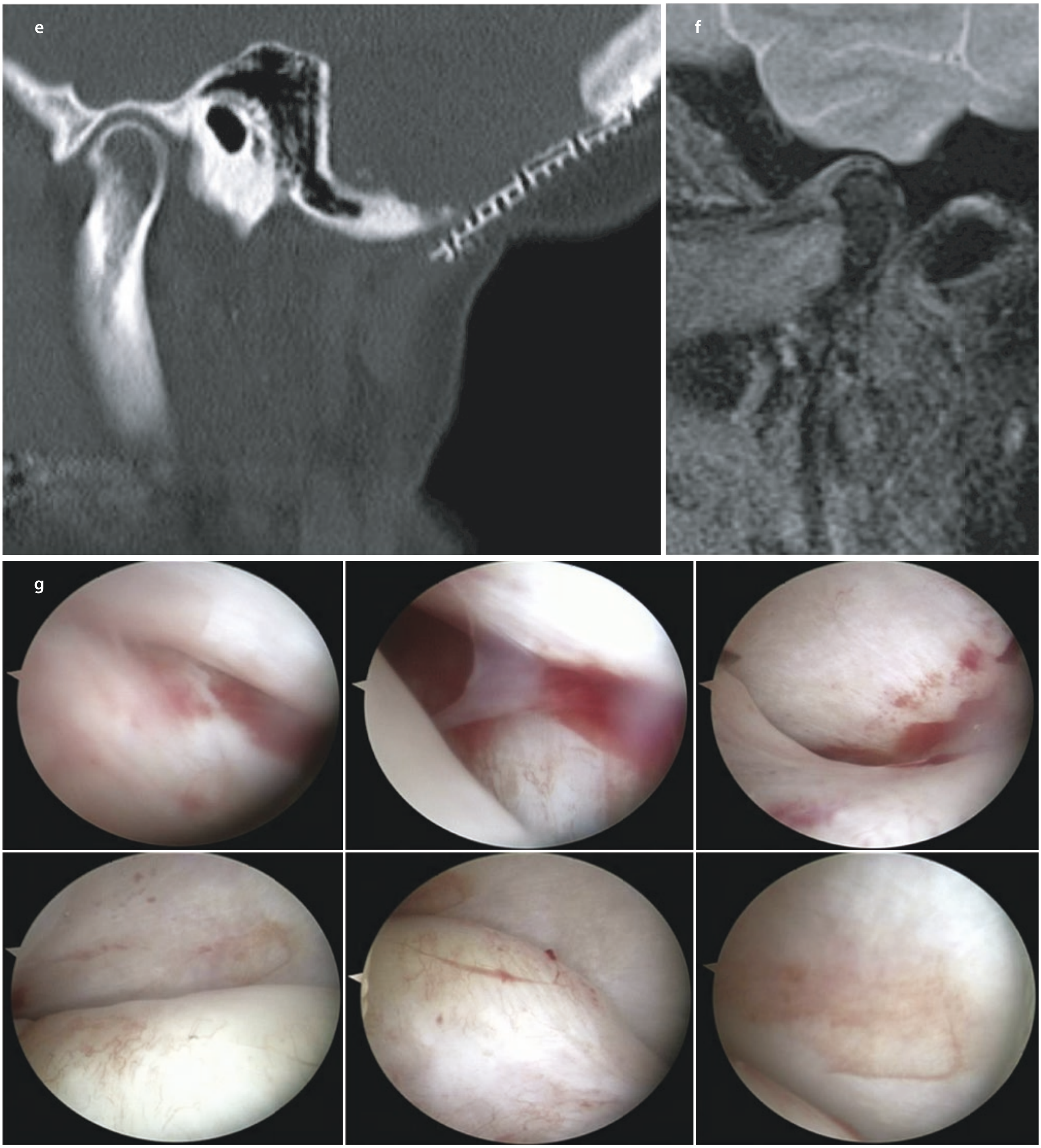


Fig. 55.6 (continued)

ers reported limited mouth opening (less than 25 mm) in as many as 33% of patients 2 weeks after frontotemporal craniotomy procedures [36]. Costa and coworkers reviewed 24 patients undergoing pretemporal craniotomy for refractory epilepsy and demonstrated the association between preoperative bruxism and an increased risk of hypomobility [37]. In both studies, reduced maximal mouth opening improved with time. Although most are self-limiting, persistent hypomobility can severely compromise subsequent airway, and anesthesia management in these patients needs to be recognized. Patients who have undergone skull base surgery may also manifest severe hypomobility postoperatively. If such operation requires the dissection of the temporalis muscle inferior to the zygoma, pseudoankylosis of the mandible may be encountered.

55.2.9 Inflammatory and Rheumatologic Causes

Ankylosing spondylitis (Bekhterev's disease) is a chronic and progressive inflammatory condition most commonly affecting the sacroiliac joints and the spine. The male-to-female ratio of incidence is reported to be 2.4:1, and the severity and extension of the disease in male patients are found to be more severe. TMJ involvement in ankylosing spondylitis has been reported in between 1% and 22% of individuals and can include severe bony deformation and ankylosis [38, 39]. One large prospective study evaluating 50 patients with ankylosing spondylitis did not show any correlation between the bony severity noted in the cervical spine and TMJ abnormalities [40]. These authors reported a 22% incidence of TMJ involvement, either clinical or radiographic. Because the majority of patients reported no pain or limitation in function, the radiographic findings included in this study may well have represented early changes in the disease process.

TMJ involvement in rheumatoid arthritis follows the same destructive path as do other joints. Generally, the severity of joint dysfunction is correlated with the stage of rheumatoid arthritis. Radiographically, the most common findings in the condylar region are sclerosis (75%), erosion (50%), and flattening (30%) [41]. These bony changes commonly result in progressive malocclusion secondary to the loss of ramus/condyle height and subsequent apertognathia. Juvenile rheumatoid arthritis is chronic arthritis diagnosed in childhood before the age of 16 years. It is estimated that greater than 60% of patients with juvenile rheumatoid arthritis manifest TMJ involvement [42]. However, multiple authors point out that despite radiographic and morphologic changes in the joint, a minority of affected children (generally <25%) report pain with function [43, 44]. Svensson and associates report that restricted mouth opening was a more common finding [45]. The duration of active disease and a history of pain with function correlate positively with progressive TMJ dysfunction. With active disease in growing children, abnormalities in facial growth, mandibular hypoplasia, and hypomobility are common problems (◘ Fig. 55.7).

Sclerodermaa (progressive systemic sclerosis) is a disorder of unknown etiology affecting multiple organ systems and characterized by abundant fibrosis of the skin, blood vessels, and visceral organs. Mandibular movement can become severely limited in affected individuals secondary to facial skin fibrosis and atrophy of the muscles of mastication (particularly the masseter and medial pterygoid muscles) [46]. Bony changes in the mandible are also reported and include severe resorption of the angles, condyles, and coronoid processes (osteolysis) [47]. The bony lesions are believed to be of ischemic origin but may be exacerbated by the tightness of the tissue in the region of the mandibular angles causing pressure resorption as well. In addition to the severe limitation in jaw movement, the small mouth orifice and progressive malocclusion make oral function and access to dental care problematic for these patients.

◘ **Fig. 55.7** Adult patient with a history of juvenile rheumatoid arthritis affecting the temporomandibular joints and resulting in a mandibular growth disturbance and hypomobility. (Adapted from August [161])

> A rheumatology consultation is recommended when underlying inflammatory and rheumatologic conditions are suspected.

55.2.10 Hypomobility After Orthognathic Surgery

Hypomobility may ensue orthognathic surgery in rare cases. The correlation between orthognathic surgery and temporomandibular joint disorder is controversial, but patients with preexisting TMJ symptoms are generally predisposed to postoperative dysfunction. Any orthognathic movement may result in hypomobility, but bilateral sagittal split osteotomy appears to be most common [48, 49]. Yazdani and coworkers studied a mandibular range of motion in 150 patients with mandibular prognathism treated with three different mandibular osteotomy techniques: sagittal split osteotomy (SSO), intraoral vertical ramus osteotomy (IVRO), and extraoral vertical osteotomy (EVRO). All three groups experienced a statistically significant reduction in the range of motion; however, SSO had the most reduction in the range of motion while EVRO resulted in the least amount of reduction [50]. Ko and colleagues noted a similar decrease in mandibular ROM following orthognathic surgery, but the majority of patients reported resolution within 6 months [51].

This limited postoperative opening has been commonly attributed to muscle atrophy and soft tissue scar formation. Atrophic muscular changes seem to be exacerbated by prolonged use of maxillomandibular fixation, and the advent of rigid internal fixation appears to have limited this problem. Intra-articular pathology (edema, hemorrhage), as well as condylar torque, may also result in hypomobility. Van Sickels and colleagues have hypothesized that condylar torque at the time of the bilateral sagittal split osteotomy may cause impingement of the condyle against the disc, creating a mechanical impediment to opening [52]. Although rare, extra-articular ankylosis of the mandible has also been reported [53].

Management of hypomobility after orthognathic surgery depends on the underlying cause. Trauma to the muscles of mastication is best managed postoperatively by vigorous physical therapy protocols. Those patients who fail to improve within the first 3 months need to be carefully evaluated for an intra-articular source of the problem. If a mechanical obstruction to an opening is suspected, CT is a helpful diagnosis aid. Condylar torque is best treated by reoperation with appropriate positioning of the proximal segment [54].

> Comprehensive TMJ examination is essential in all orthognathic surgery candidates.

55.2.11 General Treatment Considerations

The treatment goal for all hypomobility states is the restoration of normal and comfortable jaw motion and prevention of disease progression. Reversible causes such as muscular hyperactivity or spasm, infectious and inflammatory causes, and medication-induced limitations must be identified and treated. Restoration of function in cases of ankylosis can be difficult. Proper treatment requires excision of the involved structures and immediate reconstruction.

The gap arthroplasty is a procedure that creates a new area of articulation distal to the fused TMJ and ankylotic segment [3, 55]. Advocates of this procedure describe its simplicity. However, the creation of a pseudoarticulation significantly shortens the ramus height, and the procedure is associated with a high degree of reported re-ankylosis. Development of postoperative malocclusion and a decreased range of motion are the most common problems associated with this procedure as reported by Rajgopal and coworkers [56]. Because of these limitations, the use of the gap arthroplasty to treat ankylosis has been largely abandoned.

TMJ ankylosis is more commonly treated with complete excision of the ankylotic mass and, if required, by subsequent joint reconstruction. The protocol for the treatment of ankylosis follows that documented by Kaban and associates, a sequential protocol for the treatment of TMJ ankylosis that is based on aggressive resection of the ankylotic mass [57]. Wide intraoperative exposure is required, and special attention is directed to the medial aspect of the joint. In addition to this aggressive resection of the bony and fibrous mass, dissection and stripping of the temporalis, masseter, and medial pterygoid muscles followed by ipsilateral coronoidectomy are performed in all cases through the same incision. If the MIO is found to be less than 35 mm, a contralateral coronoidectomy is performed via an intraoral approach to attain the desired level of opening. Commonly, a temporalis fascia flap and costochondral graft are employed to both line the glenoid fossa and create ramus height. Overall results have been excellent with this approach. After 1 year, MIO was maintained at greater than 35 mm in all 18 patients included in the report. Furthermore, the absence of pain with function was reported in all but two patients (Fig. 55.8) [57].

Recently, the Kaban protocol has been modified to substitute ramus/condyle reconstruction using distraction osteogenesis, when possible, instead of costochondral grafting [58]. This protocol has the major advantage of eliminating the donor site operation and allowing for immediate vigorous TMJ mobilization. The surgical procedure for the release of the ankylosis is identical to that described previously. After the release, the jaw is mobilized, and the glenoid fossa lined with a temporalis myofascial flap if the native disc is unavailable. The remaining mandibular stump is reshaped to create a narrow and rounded top. A corticotomy is created distally, leaving sufficient bone to serve as a transport disc. The distraction device is secured, the corticotomy completed, and the mobility of the segments tested.

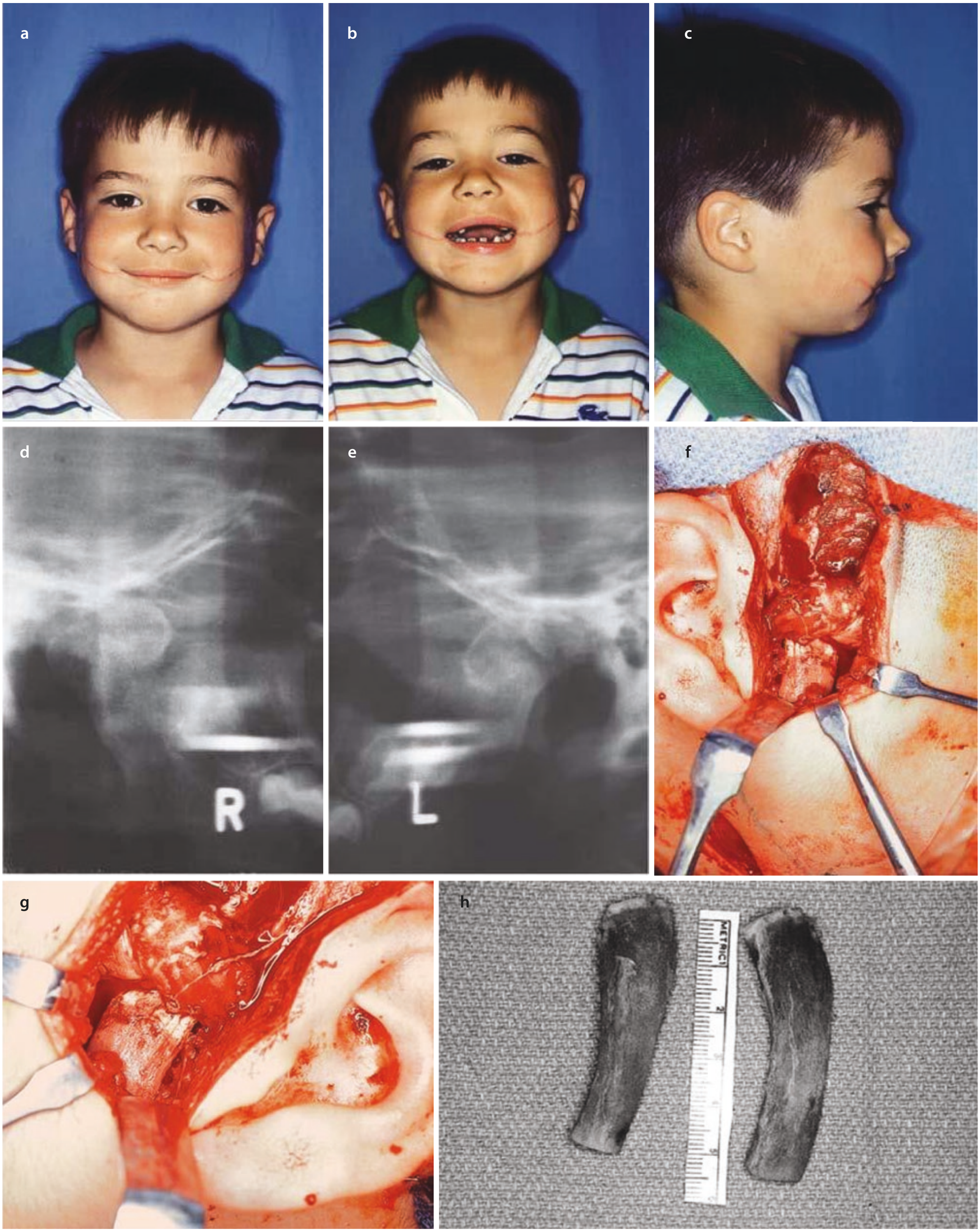


Fig. 55.8 A 3-year-old boy with bilateral bony ankylosis after a motor vehicle accident that also produced bilateral lacerations of the commissures. Frontal photograph **a**, frontal maximal incisal opening MIO; **b**, and lateral photograph **c**. Note the limited opening. Right **d** and left **e** panoramic views of the ankylotic masses of the temporomandibular joints (TMJs). Right **f** and left **g** TMJs exposed after the dissection was completed. **h** Harvested costochondral grafts with 1 to 2 mm of cartilaginous caps. Frontal **i**, frontal opening **j**, and lateral **k** facial views of the patient 11 years postoperatively. Note maintenance of the normal MIO. **l** intraoral views. Right **m** and left **n** panoramic radiographs show remodeling of the costochondral grafts (**a**–**m**, Reproduced with permission from Kaban [162])

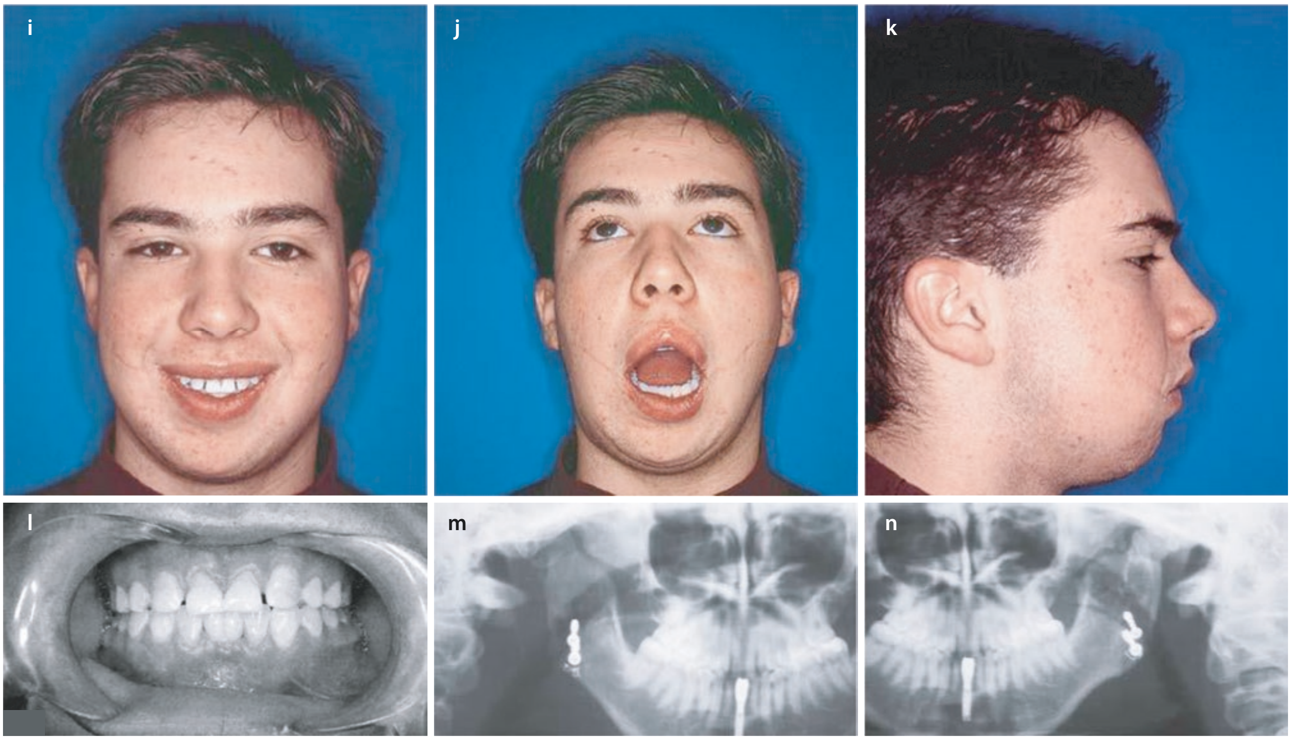


Fig. 55.8 (continued)

Distraction then proceeds at 1 mm/day until the desired length is achieved. The patient begins a program of active jaw motion exercises immediately postoperatively (Fig. 55.9).

The use of total joint prostheses offers two major advantages over autogenous reconstruction: (1) the absence of a donor site and (2) the ability of the patient to return to function more quickly. However, multiple complications have been reported – some with devastating consequences for patients [59–61]. Foreign body reaction to any alloplast may occur. Fragmentation of alloplastic material secondary to function with migration of particles into contiguous tissue and regional lymph nodes has also been reported. Progressive wear may result in a loosening and fracture of the prosthesis. In addition, the lack of growth potential precludes the use of these joint replacement systems in young children.

TMJ reconstruction with a variety of autogenous tissues has been described. When the extent of bony resection does not severely shorten ramus height, autogenous interpositional grafts may be employed. These include the skin, temporal muscle, cartilage, and fascia. A review by Chossegros and colleagues demonstrated superior results (defined by the authors as an interincisal opening of ≥30 mm over a follow-up period of 3 years) using full-thickness skin grafts and temporalis muscle [62]. Various bone grafts (costochondral, sternoclavicular, iliac crest, and metatarsal head) have been used to reconstruct ramus height after the resection of ankylosis. First described in the 1920s, the costochondral graft for TMJ reconstruction was popularized in later years by Poswillo and MacIntosh and Henny [63, 64]. Autogenous tissue (particularly the costochondral graft) has the advantage of being biologically acceptable and possessing growth and remodeling potentials that make it a particularly attractive reconstructive choice in the growing child. Potential problems with its use include fracture, resorption, donor site morbidity, recurrence of ankylosis, and variable growth behavior of the graft in situ.

55.2.12 Complications Associated with Treatment

Various complications have been reported secondary to the treatment of ankylosis. Dolwick and Armstrong caution that a severe limitation of an opening can make the palpation of landmarks difficult and increases the surgical risks [65]. The aggressive bony removal and recontouring that is often required can increase the risk of development of an aural TMJ fistula if the tympanic plate is displaced posteriorly. In addition, stenosis of the

Fig. 55.9 A 13-year-old female with recurrent ankylosis of the left TMJ secondary to trauma sustained in a motor vehicle accident. Frontal **a**, frontal at MIO **b**, and lateral facial **c** photographs of a teenage female with recurrent ankylosis of the left TMJ. **d** Panoramic radiograph before the first operation demonstrates bony ankylosis of the left TMJ. **e** Panoramic radiograph after the patient developed reankylosis. She had had a condylectomy and coronoidotomy at another institution. The TMJ was reconstructed with a costochondral graft. There was no soft tissue lining in the joint. **f** Lateral cephalogram documents the mandibular retrognathism. **g** Diagram of the operative plan the ankylosis release is carried out via a preauricular incision (outlined in dashed blue line). Excision of the ankylotic mass and coronoidectomy is shown by the shaded area. **h** Diagram of the layers of the scalp. **i** intraoperative view after dissection was completed. Note the bony ankylotic mass and the coronoid process with obliteration of the sigmoid notch. **j** Diagram of the bone removed (shaded area) and the proposed reconstruction using a distraction device (Synthes Maxillofacial, Paoli, PA) instead of a costochondral graft. **k** Temporalis flap is outlined with malachite green. The flap is dissected and rotated over the arch **l** and sutured in place **m** and **n**. **o** Specimen: ankylotic mass and coronoid process. Frontal **p**, frontal opening **q**, and lateral **r** photographs at end distraction. The patient was mobilized and started on physical therapy immediately postoperatively. She was comfortable because there was no donor site operation and no period of maxillomandibular fixation. Lateral **s** and anteroposterior (AP); **t** designated as cephalogram and panoramic radiograph **u** at the end of distraction osteogenesis demonstrate the lengthened mandibular ramus. Frontal **v**, frontal opening **w**, and lateral **x** photographs 1 year after completion of treatment. The patient maintained her TMJ motion and will be beginning presurgical orthodontic treatment to correct her preexisting malocclusion. Open **y** and closed **z** intraoral views with the patient opening 39 mm at 1 year. AP cephalogram **aa** and panoramic radiograph **bb** at 1 year. The ramus lengthening is demonstrated by the space between the retained footplates (**a**–**f**, **i**, **k**, **m**, and **o**–**bb**, Reproduced with permission from Kaban [163]; **g**, **h**, **j**, **l**, and **n**, adapted from Kaban [163])

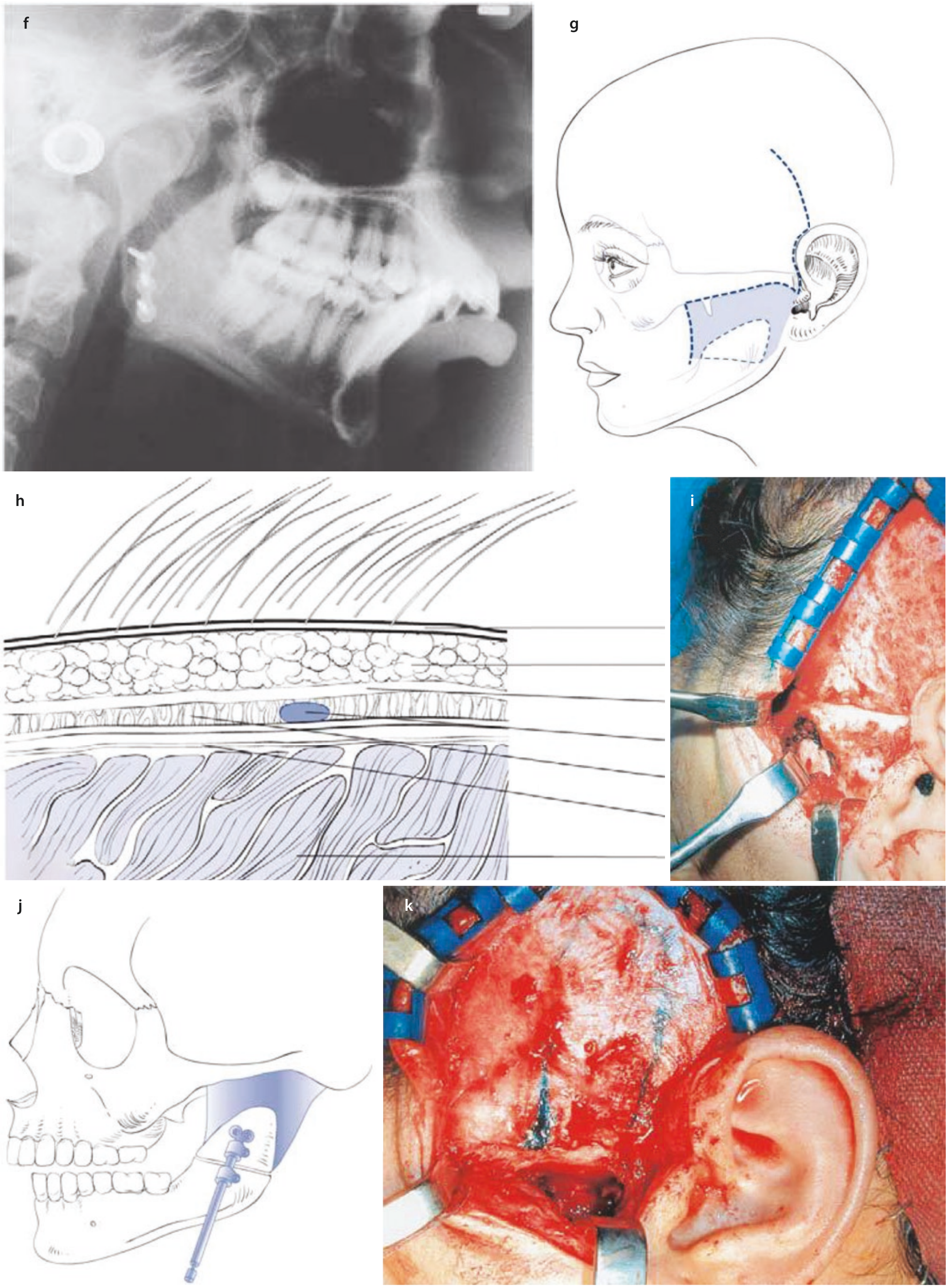
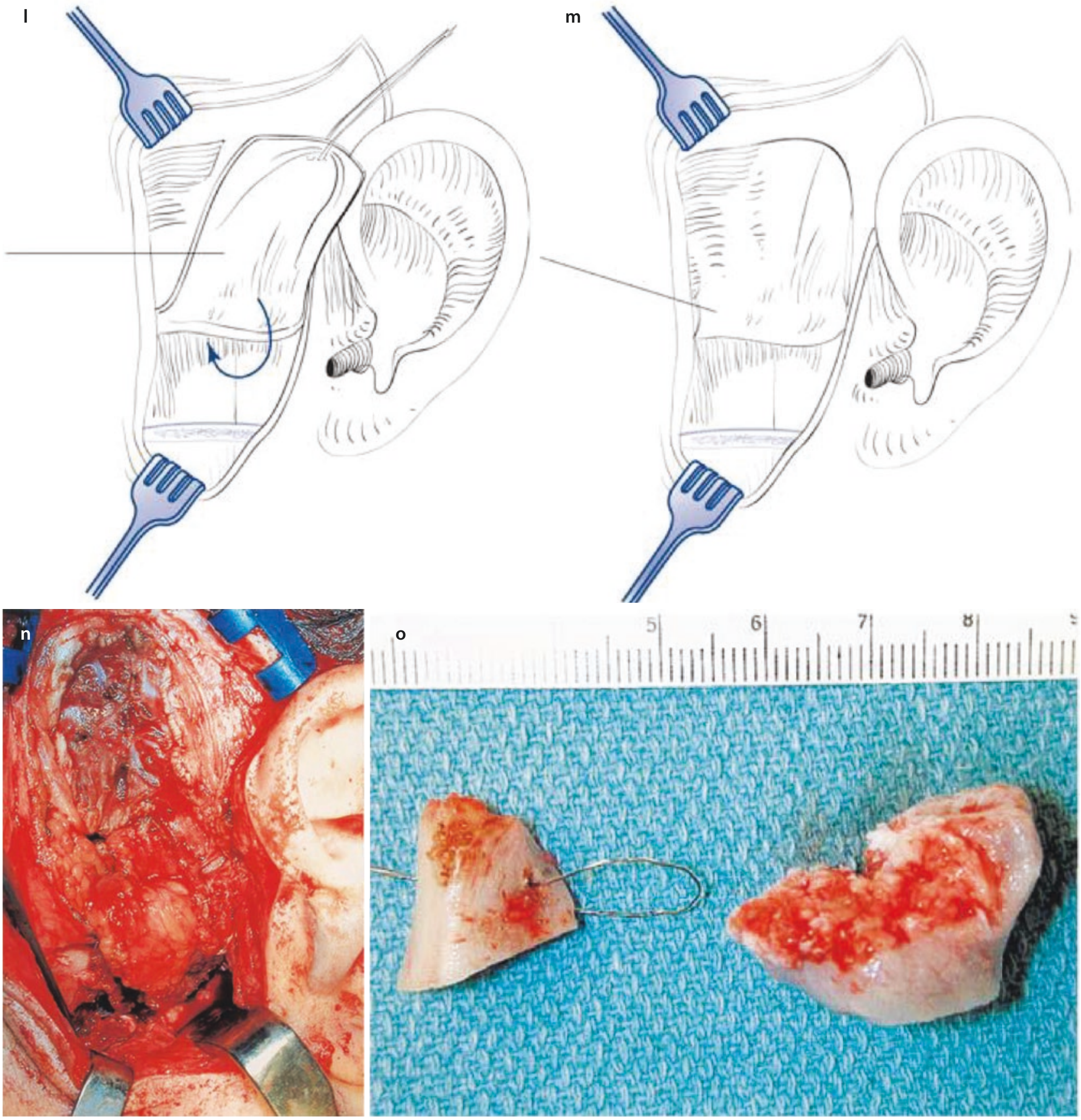


Fig. 55.9 (continued)



■ **Fig. 55.9** (continued)

■ **Fig. 55.9** (continued)

Fig. 55.9 (continued)

external auditory meatus and subsequent hearing impairment may follow tympanic plate displacement.

Recurrent ankylosis may result from inadequate initial treatment. It most commonly occurs on the medial aspect of the condyle where surgical access is most difficult. Maneuvers such as the postoperative use of nonsteroidal anti-inflammatory drugs and vigorous physical therapy may limit problems with recurrent hypomobility [66, 67].

In pediatric patients treated for ankylosis, the expected outcome may be less sanguine [68]. Posnik and Goldstein reviewed the outcome of nine children and demonstrated a mean MIO of 24.8 mm in unilateral cases and 17.5 mm in bilateral cases measured an average of 2 years postoperatively [69]. The authors caution that improvement in bilateral congenital cases is particularly problematic and may be confounded by the associated neuromuscular and atrophic changes found in these patients.

Peripheral nerve injuries are possible sequelae of all TMJ operations, with the upper branches of the facial nerve being the most vulnerable. Parotid gland injury with subsequent sialocele and fistula formation has also been reported.

As previously described, the costochondral graft is the most commonly used autogenous material for TMJ reconstruction. However, its growth pattern can be unpredictable. Linear overgrowth with the subsequent development of asymmetry and malocclusion has been reported by multiple authors [70, 71]. The frequency is more common in the growing patient. Munro and coworkers reported 2 or 22 cases of considerable linear overgrowth with resultant chin deviation and development of a class III malocclusion [70]. Perrott and associates reported 3 of 26 cases of lateral bony overgrowth (tumor-like overgrowth), with an evident preauricular fullness and subsequent limitation of opening [71]. However, no cases of linear overgrowth were found in that series of patients.

55.2.13 Postoperative Physical Therapy

Patients with hypomobility disorders require aggressive physical therapy programs, often in conjunction with surgical treatment, to maintain a functional MIO. Various rehabilitation programs have been described in the literature, and approaches include unassisted exercise, tongue blade, and finger-stretch exercises, manual exercises, and mechanically assisted mandibular motion devices (Fig. 55.10). Manipulation under general anesthesia may also be required in refractory or recurrent cases. Most authors agree that the duration of physical therapy should be prolonged well after the desired MIO is achieved to prevent subsequent relapse [72].

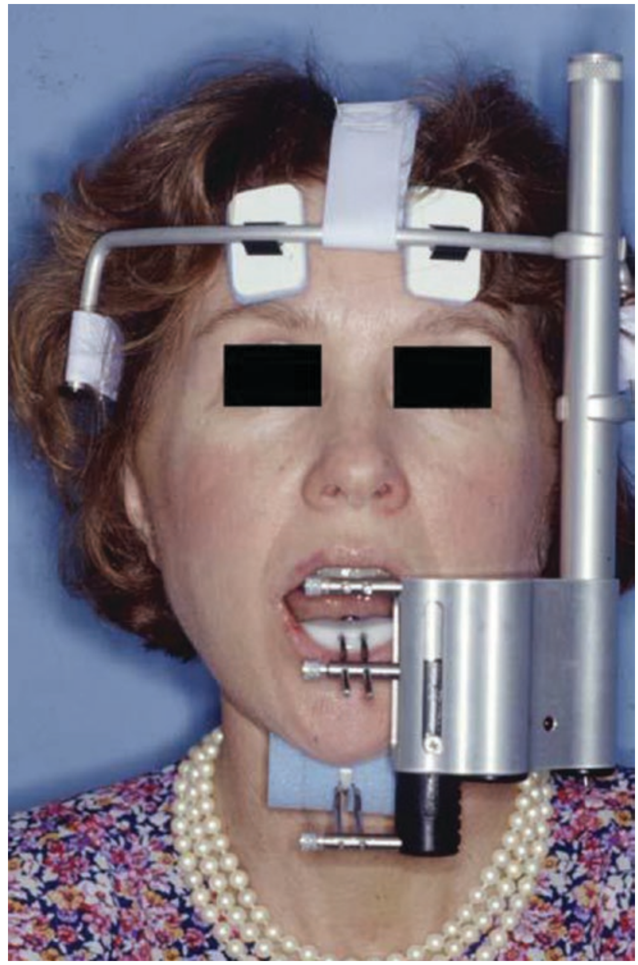


Fig. 55.10 A continuous passive motion device used in the postoperative management of hypomobility. (Adapted from August [164])

Key Points

- Identification and treatment of the etiologic factors are imperative in successful treatment and long-term outcome.
- Trauma is the most common cause of TMJ ankylosis, followed by local or systemic infection.
- Costochondral graft and distraction osteogenesis should be a consideration in reconstruction of TMJ ankylosis especially in skeletally immature patients.
- Success of TMJ ankylosis surgeries relies on postoperative rehabilitation programs.

55.3 Hypermobility

55.3.1 Classification

Temporomandibular joint (TMJ) subluxation is defined as a temporary and partial displacement of the condyle out of the glenoid fossa. This condition often resolves spontaneously or with a minor manual manipulation by the patient. In contrast, TMJ dislocation is characterized by a complete displacement with long-lasting inability to close the mouth. This condition often requires a reduction by a trained medical professional. TMJ dislocation can be further classified as acute, chronic recurrent, and chronic persistent, with the acute dislocation being the most common form [73–75].

Acute dislocation is frequently triggered by mandibular trauma and extreme mouth opening, but dislocation as a result of vomiting, direct laryngoscopy, and upper gastrointestinal endoscopy has been reported [76–78]. Although it is often an isolated event without long-term sequelae, it may progress to a chronic recurrent or habitual condition if dislocations continue [79]. If the patient is left untreated for an extended period, the condition is termed chronic persistent dislocation. Other terminologies, such as protracted, prolonged, and long-standing dislocation, have been used to describe chronic persistent dislocation [80–82]. There is no general consensus on how long the patient must be left dislocated before the condition is labeled chronic persistent dislocation, but this period has been defined in the literature as short as 72 h to 1 month [83, 84]. Although chronic persistent dislocation is rare, early clinical signs can easily be missed in cases of prolonged intubation under sedation, traumatic brain injury, and dementia.

> Chronic persistent dislocation is a rare problem that poses unique treatment challenges.

55.3.2 Etiology

The integrity of the TMJ depends on the bony architecture, surrounding ligaments, and coordination of the masticatory musculature (▶ Box 55.1). When the stability of the joint is disturbed, the simplest daily activities, such as yawning, laughing, and kissing can precipitate a dislocation.

Bony architecture of the joint, such as an abnormal morphology of the condyle and deep glenoid fossa, with a steep articular eminence can precipitate dislocation [85]. Others identify laxity of the primary ligaments surrounding the TMJ as the principal reason for this condition [85–87]. This is well delineated in connective tissue disorders associated with hypermobility, such as Ehlers-Danlos and Marfan syndromes, in which patients present with inherently lax joints [88].

Failure of masticatory musculature coordination can result in dislocation with or without the structural abnormalities described above. Systemic conditions that affect the quality of muscle tissue, such as muscular dystrophy and activation of muscle movement, namely, Parkinson's disease, may be responsible for dislocation [89]. Drug-induced dislocation has been reported with first-generation antipsychotics, such as phenothiazine, and haloperidol, which are primarily dopamine (D2) receptor antagonists [90–93]. However, atypical antipsychotics, such as risperidone and amisulpride, have also been reported to cause TMJ dislocations [94, 95].

> Dopamine antagonists and atypical antipsychotics may contribute to TMJ subluxation and dislocation.

Box 55.1 Causes of Hypermobility

Intrinsic trauma: overextension injury
Yawning
Vomiting
Wide biting
Seizure disorder
Extrinsic trauma
Trauma: flexion-extension injury to the mandible, intubation with general anesthesia, endoscopy, dental extractions, forceful hyperextension
Connective tissue disorders
Hypermobility syndromes
Ehlers-Danlos syndrome
Marfan syndrome
Miscellaneous causes
Internal derangement, dyssynchronous muscle function, contralateral intra-articular obstruction, lost vertical dimension, occlusal discrepancies
Psychogenic
Habitual dislocation
Tardive dyskinesia
Drug induced
Dopamine receptor antagonist
Atypical antipsychotics

55.3.3 Treatment

55.3.3.1 Acute Dislocation

Consultation begins with a thorough review of the patient's history and medications. A review of attempted treatments and administered medications is paramount. Signs and symptoms of acute dislocation may include the inability to close the mouth, depression of the preauricular skin, excessive salivation, tense masticatory muscles, and a severe TMJ pain [96]. An orthopantomogram or facial CT is obtained to confirm dislocation and rule out mandibular fracture.

Once the patient is prepared for a treatment, anxiolytic and/or pain medications can be administered intravenously. Local anesthetics may be administered in the form of auriculotemporal or masseteric nerve blocks or intracapsular injections [97–99]. The administration of local anesthesia may aid in reduction by abolishing the masticatory muscle spasms and counteracting reflexes produced by dislocation [97].

The most common technique for reduction of dislocation is the Hippocratic maneuver, in which the physician's thumbs are placed over the mandibular posterior dentition or external oblique ridge to first apply force caudally and then dorsally to reposition the condyles back into the glenoid fossa (◘ Fig. 55.11). Directing a patient to open the mouth prior to application of pressure may aid in reduction by diminishing the muscle tone in the elevator masticatory muscles through reciprocal inhibition.

Other techniques have been described such as the wrist pivoting and extraoral approach (◘ Fig. 55.11). In the wrist pivoting method, the physician grasps the mandible by placing the thumb on the chin and the rest of fingers on the posterior mandibular occlusal surface. Then, the physician applies upward pressure with the thumb and downward pressure on the occlusal surface of the mandible, while pivoting the wrist [100]. In the extraoral approach, the physician pushes on the coronoid process and anterior border of the ramus on the dislocated side, while pulling the contralateral mandibular angle forward. Reduction of one side often spontaneously reduces the contralateral side in a bilateral case. In a case series of seven dislocated patients treated with the extraoral technique, all patients were treated successfully without the need for sedation or general anesthesia [101]. However, another study demonstrated a higher success rate using the Hippocratic maneuver (86.2%) compared with the extraoral approach (55.2%) [102].

Once the patient is successfully treated, immobilization of the mandible with arch bars, Barton head dressing, compression face wrap, or cervical collar may be considered to allow capsular repair, muscle rest, and prevention of recurrence. The patient is advised to avoid excessive mouth opening and maintain a soft chew diet for 1 week.

55.3.3.2 Chronic Dislocation

If acute dislocation progresses to chronic recurrent dislocation, additional interventions may be required with particular focus on the etiology of the dislocation. Many treatment options exist, but all surgical approaches ultimately prevent dislocation by limiting maximal mouth opening, with the exception of eminectomy, which removes mechanical obstructions to allow smooth translation.

55.3.3.3 Sclerotherapy/Prolotherapy

Sclerotherapy using alcohol was first described by Hacker in 1884 [85]. The use of various sclerosing agents, such as iodine, ethanolamine oleate, tetracycline, cyclophosphamide, and OK-432, has been described in the literature [103, 104]. As the name suggests, injection of sclerosing agents prevents joint hypermobility by means of scar formation, which limits mouth opening. However, this modality failed to gain popularity because caustic injections have been associated with possible risk of facial nerve paralysis and traumatic arthritis.

In the 1950s, Hackett introduced the idea of proliferation therapy, also known as prolotherapy or regenerative therapy [105]. The exact mechanism of prolotherapy remains to be elucidated, but it is believed to promote an inflammatory process and release growth factors that lead to fibroblast proliferation. In turn, a complex restorative process takes place that improves joint laxity and stability. Prolotherapy is similar to sclerotherapy in that an irritating solution is injected around the joint, but the proponents of this technique believe that scar formation does not occur with prolotherapy [106]. The most common agent used for prolotherapy is hyperosmolar dextrose, but glycerin, lidocaine, phenol, and sodium morrhuate have also been used [107–110].

Refai conducted a prospective randomized double-blind trial to study the efficacy of dextrose prolotherapy on 12 patients for symptoms related to TMJ hypermobility. The study group of 6 patients received 10% dextrose with 2% mepivacaine, while the control group of 6 patients received normal saline with 2% mepivacaine. At the 12th postoperative week, patients in both groups reported decreased pain and luxation frequency, but there was no statistical difference between the two groups [111]. Comert and coworker reported a similar result in a randomized clinical trial of the treatment of TMJ hypermobility in 30 patients [110]. General pain level and joint sounds significantly decreased in both study groups without statistical difference. Authors concluded that dextrose prolotherapy is not superior to

Fig. 55.11 Hippocratic maneuver for treatment of acute dislocation **a**. Wrist pivoting method **b**. Extraoral approach **c**

saline injection in treatment of TMJ hypermobility. Refai published another study of 61 patients demonstrating significant and sustained reduction of pain and symptoms related to TMJ hypermobility, but this study lacked a control group [112]. Zhou and Ungor both reported significant and sustained reduction of pain and symptoms related to TMJ hypermobility, but their studies also lacked control groups [113, 114]. Some authors believe that the needle trauma, rather than the proliferants, is responsible for the clinical effects of prolotherapy. At this time, prolotherapy does not appear to demonstrate adequate evidence to show its efficacy in treatment of TMJ hypermobility. Long-term clinical outcome studies with larger populations are warranted to investigate its role in treatment of TMJ hypermobility.

55.3.3.4 Autologous Blood Injection

Treatment of TMJ dislocation using autologous blood injection (ABI) was first described by Brachmann in 1964 [115]. After the introduction of this technique, Schultz and Jacobi-Hermanns reported successful results, but ABI never gained popularity for unknown reasons [116, 117]. Recently, several authors reintroduced this technique, which, as the name suggests, consists of intra-articular and peri-capsular injection of a patient's own blood with or without the use of MMF. Typically, established techniques for arthrocentesis are utilized to ensure intra-articular injection, but injection protocols and the use of MMF vary in the literature.

The technique stems from the idea that hemarthrosis from trauma may lead to fibrous ankylosis of the joint. Autologous blood injection promotes the inflammatory reaction, creating a tissue bed for the formation of joint adhesions and fibrous tissue [118, 119]. There are concerns that even brief exposure of the blood to TMJ may promote chondrocyte apoptosis and cartilage degeneration, leading to the ultimate destruction of the joint [120–122]. However, the advocates of this technique argue that the amount of blood injected is similar to that involved in open-joint surgery [123]. MRI studies that analyzed patients who received ABI for recurrent TMJ dislocation did not demonstrate any adverse findings, but they lack long-term follow-up [124, 125]. It may be prudent to avoid routine use of this technique in young patients and those with preexisting condylar changes until further studies are conducted.

Bayoumi and coworkers reported an 80% success rate in 15 patients treated with ABI without MMF [126]. Machon and colleagues also reported an 80% success rate in 25 patients treated with ABI with the use of head dressing to restrict mouth opening to 20 mm [123]. Hagab and colleagues conducted a prospective randomized, controlled clinical trial for 48 patients with chronic recurrent dislocation. These patients were assigned to three groups: ABI with MMF, ABI alone, and MMF alone. There was no recurrence in the group of patients treated with ABI and 4 weeks of MMF. The group treated only with ABI had 8 recurrences (50% recurrence rate), but further dislocations were all successfully treated with multiple injections. The MMF group had 3 recurrences [127]. The authors concluded that ABI is a simple, safe technique for the treatment of TMJ dislocation in outpatient clinics.

55.3.3.5 Botulinum Toxin Injection

Botulinum toxin (BTX) is a bacterial toxin isolated from *Clostridium botulinum.* Use of BTX has been reported for treatment of facial rhytids, migraine headaches, neuropathic facial pain, sialorrhea, and temporomandibular joint disorder [128, 129]. Specifically, the injection of BTX into the lateral pterygoid muscles has been advocated for a treatment of chronic recurrent TMJ dislocation.

Ziegler and coworkers reported treatment of 21 patients using lateral pterygoid BTX injections. Injections of 50–100 units of Dysport were given utilizing an electromyography (EMG)-controlled application device via an extraoral injection through the sigmoid notch [130]. Patients received up to 5 injections, and only 2 of 21 patients suffered further dislocation. Maritnez-Perez utilized an EMG-guided intraoral technique to administer multiple injections of 20–50 units of BTX-A to 3 patients without further dislocations [131]. Fu and colleagues reported the use of radiographic measurements from a CT to guide lateral pterygoid muscle injections. Five patients were treated with 25–50 units of BTX-A without further dislocations [132].

Duration of action for BTX is between 3 and 6 months; thus, multiple injections are required to achieve prolonged effects. The literature varies, but 25–50 units of onabotulinum toxin A (Botox) is the most popular option for treatment of TMJ dislocation. Providers must bear in mind that popular BTX brands such as Botox, Dysport, and Xeomin vary in potency, so appropriate dose adjustment is warranted. Inappropriate dose and diffusion of BTX into deeper musculature may result in detrimental side effects, including dysphagia and dysarthria, possibly requiring an intubation or feeding tube placement [131].

> Appropriate dose and careful administration of BTX are essential to avoid detrimental side effects.

55.3.4 Surgical Techniques

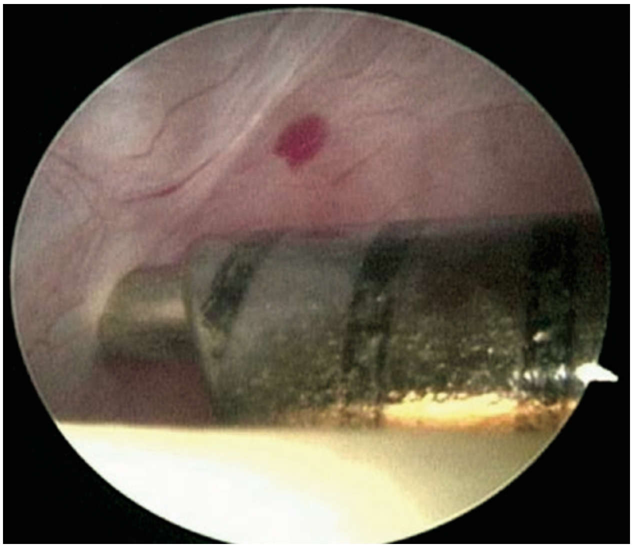
55.3.4.1 Temporomandibular Joint Arthroscopy

The least invasive surgical intervention for the treatment of TMJ hypermobility is TMJ arthroscopy. This technique focuses on the contraction of the retrodiscal tissue to limit mandibular range of motion. Eminoplasty, lateral pterygoid myotomy (◘ Fig. 55.12), and selective deposition of botulinum toxin can be employed concomitantly with TMJ arthroscopy to augment the clinical outcome. Selective deposition of BTX during TMJ arthroscopy may avoid mistakenly injecting adjacent muscles or tissue (◘ Fig. 55.13). Compared to other open approaches, TMJ arthroscopy has a lower incidence of facial nerve injury, pain, dysesthesia, and postoperative arthritic changes [133–135].

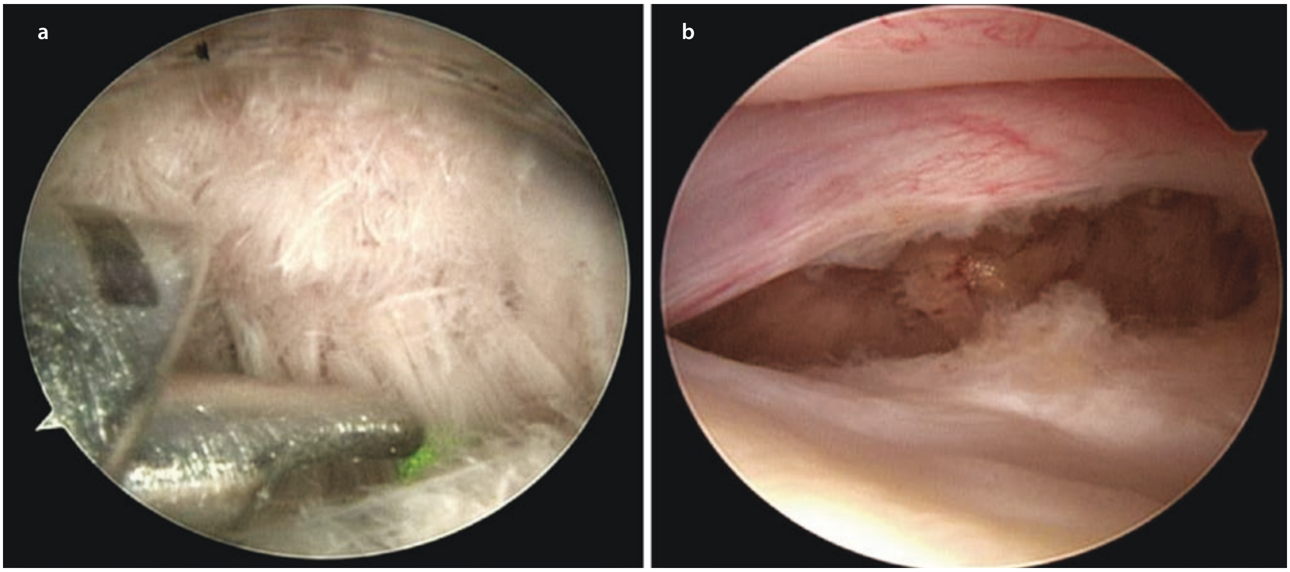
Torres and colleagues reported arthroscopic contraction of the retrodiscal tissue with electrocautery and laser (Hol:YAG). Patients were placed into 6 weeks of postoperative guiding elastics on orthodontic cuspid brackets. Of the 11 patients studied, 9 patients had no further dislocations, and 2 required further open arthrotomy due to continued symptoms [136]. Ybema and coworkers reported similar results when treating 16 patients using the same technique without postoperative guiding elastics. In their study, 15 patients experienced a successful outcome, and one patient continued to subluxate [137]. Segami and colleagues performed an arthroscopic eminoplasty that consisted of a 2–3 mm reduction of articular eminence with an electric motorized shaver and bone files [138]. Of the 11 patients studied, only one continued to dislocate. These studies demonstrate the safety and efficiency of the TMJ arthroscopy as an effective treatment for dislocation patients; however, technical difficulty may limit widespread use of this technique.

55.3.4.2 Eminectomy

Myrhaug first described eminectomy procedure as a treatment for chronic TMJ dislocation in 1951 [85]. This technique focuses on a reduction of the articular eminence to allow unrestrained excursion of the condyle.



◘ **Fig. 55.13** Arthroscopic-assisted Botox injection into the lateral pterygoid muscle. (Courtesy of Joseph McCain, DMD, FACS)



◘ **Fig. 55.12** Arthroscopic assisted lateral pterygoid myotomy. Holmium laser is utilized to excise the superior belly of the lateral pterygoid muscle **a**. Completed lateral pterygoid myotomy. The edges of synovium were polished with Arthrocare **b.** (Courtesy of Joseph McCain, DMD, FACS)

The TMJ is often accessed via an endaural or preauricular approach, and the articular eminence is reduced using a combination of a reciprocating saw and rasp. Although the amount of eminence reduction required for success is a point of debate, removal of the medial aspect of the eminence is deemed important. A concomitant discopexy procedure is a consideration, especially in a setting of internal derangement [139].

Undt and coworkers reported using the eminectomy procedure on 14 patients, of whom 8 patients were diagnosed with a neurologic disorder or psychiatric conditions managed with neuroleptic medication [140]. Of the 14 patients, one experienced a relapse approximately two and a half years after the initial surgery while undergoing high-dose neuroleptic medication that induced muscle rigidity. Vasconcelos and colleagues described no recurrence in a sample of 10 patients treated with bilateral eminectomy [141]. Multiple authors reported similar success rates with eminectomy procedure [142, 143]. Vasconcelos conducted a comparative study of eminectomy and miniplates, reporting less recurrence and articular damage with eminectomy [134]. Higher recurrence with miniplates was associated with the fracture of miniplates.

Concerns regarding the use of eminectomy procedure are similar to those associated with other traditional open approaches to TMJ dislocation. One specific concern is the possible exacerbation of hypermobility due to excessive mouth opening, which may result in further damage to adjacent soft tissue and degeneration of the joint. Another unique consideration of eminectomy is the degree of articular eminence pneumatization, which may result in temporal lobe exposure during the surgery. Prevalence of articular eminence pneumatization has been reported to range from 1.03% to 6.2% [135, 144, 145]. Kulikowski and coworkers reported encountering a pneumatized articular eminence during eminectomy without middle cranial fossa perforation [146]. The defect was repaired by repositioning the previously removed eminence with stainless steel transosseous wires. Because of this anatomic variant, advanced imaging is recommended prior to eminectomy.

> Advanced imaging is recommended prior to eminectomy procedure to identify articular eminence pneumatization.

55.3.4.3 LeClerc/Dautrey Procedure

LeClerc and Girald described a unique surgical solution for chronic recurrent TMJ dislocations in 1943 [147]. The technique consisted of a vertical osteotomy of the zygomatic arch anterior to the eminence and inferior displacement of the osteotomized segment to impede excursion of the condyle. In 1967, Gosserez and Dautrey reported a modification in which an oblique osteotomy was performed in a cranial posterior to caudal anterior direction [148]. Then, the segment was mobilized at the zygomaticotemporal suture and inserted medial to the articular eminence. Although not necessary, some authors have advocated for the insertion of a bony wedge between the osteotomized segments or placement of a miniplate for stabilization [149, 150].

Dautrey reported a successful outcome in a study of 100 patients treated with only one case of recurrence, which was attributed to old age and a resultant anterior zygomatic arch fracture [151]. Sailer and coworkers described no recurrence in 25 patients using the technique [152]. Although decreased from the preoperative measurement, subjects reported a satisfactory mean maximal incisal opening of 44 mm at 1-year postoperative appointments. Lawlor reported only one recurrence among 11 patients, who underwent bilateral Dautrey procedures [153]. Dautrey, Lawlor, and Chausse advocated that the procedure always be performed bilaterally to ensure success, but Ilzuka and colleagues experienced no failure after performing the procedure only on the affected side in their study of 12 patients [154–156]. Undt and coworkers described 10 patients, who were treated with Dautrey procedure with 3 recurrent dislocations. Interestingly, all 3 patients were successfully treated with subsequent eminectomy [157].

Specific concerns over the Dautrey procedure include anterior zygomatic arch fracture and resorption of the mobilized segment. Lawlor noted that the Dautrey procedure may be unsuitable for patients over 31 years of age due to reduced bone elasticity [154]. Cautious mobilization of the osteotomized segments and conservative elevation of the arch periosteum are essential to prevent the fracture. The Dautrey procedure may be associated with increased incidence of pain and clicking compared to the eminectomy [157]. However, it is an excellent alternative treatment for recurrent mandibular dislocation especially in patients with pneumatization of the articular eminence [150].

Key Points
- Acute dislocation is the most common form of dislocation and it is often an isolated event.
- Chronic dislocations often require surgical intervention.
- Surgical approach must focus on the etiology of dislocation.
- Unlike treatment of hypomobility, physical therapy may be limited in hypermobility.

Conclusion

This chapter summarizes the spectrum of mobility problems that can affect the TMJ and contiguous structures. The varied etiologic factors associated with hypomobility and hypermobility have been reviewed; an understanding of the etiology in each particular case is imperative for appropriate treatment to be rendered. Fortunately, improved imaging techniques, including three-dimensional CT, can be invaluable adjuncts to the history and physical examination. In cases of ankylosis, the extent and nature of the problem is best appreciated with these CT images. Altered anatomy and the extent of bony bridging can be assessed preoperatively. In addition to operative intervention, long-term success in the management of ankylosis requires aggressive physical therapy programs and longitudinal follow-up.

Hypermobility (both subluxation and dislocation) is similarly reviewed. There are myriad surgical options for treatment of hypermobility, but minimally invasive procedures must be considered. Again, a clear understanding of the causative factors helps one to focus the treatment plan and minimize problems with recurrence.

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