# Temporomandibular Joint Dysfunction

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**Anatomy**

- The temporomandibular joint (TMJ) is a ginglymoarthrodial joint with translational movement in the superior joint space and rotational movement in the inferior joint space (Fig. 2.1).
- The capsular ligament or joint capsule is a functional ligament that surrounds the joint (attaching to the temporal bone and surrounds the condylar head/neck circumferentially).
- The capsular ligament is lined by the synovium, which functions to provide nutrition and immunosurveillance and lubricates the joint.
- The other two functional ligaments are the collateral ligaments and the temporomandibular ligaments.
- The accessory ligaments are the sphenomandibular and the stylomandibular ligaments.
- The articular disk is composed of fibrocartilage. It has three zones (anterior band, intermediate band, and posterior band). Posterior to the disk are the retrodiscal tissues, which are highly vascular and innervated.
- Primary joint movement is determined by the muscles of mastication (masseter, lateral pterygoid, medial pterygoid, and temporalis) and the inframandibular accessory muscles serve to impact mandibular function secondarily.
- The vascular supply of the TMJ is primarily from branches of the superficial temporal, maxillary, and masseteric arteries.
- The nerve supply of the TMJ is predominantly from branches of the auriculotemporal with contributions from the masseteric and posterior deep temporal nerve.

## Myofascial Pain Dysfunction (MPD)

Definition – non-articular TMJ disorder that manifests itself as dull regional masticatory myalgia that worsens with function and can lead to a decreased range of motion. It can involve the muscles of mastication and any combination of the supramandibular and inframandibular muscle groups. This is the most common TMJ disorder.

**Etiologies**

- Parafunctional habits such as bruxism, nail biting, clenching, or gum chewing.
- Life stressors.
- Apertognathia and/or overjet greater than 6 mm.
- Lack of posterior dentition leading to muscle hyperactivity.

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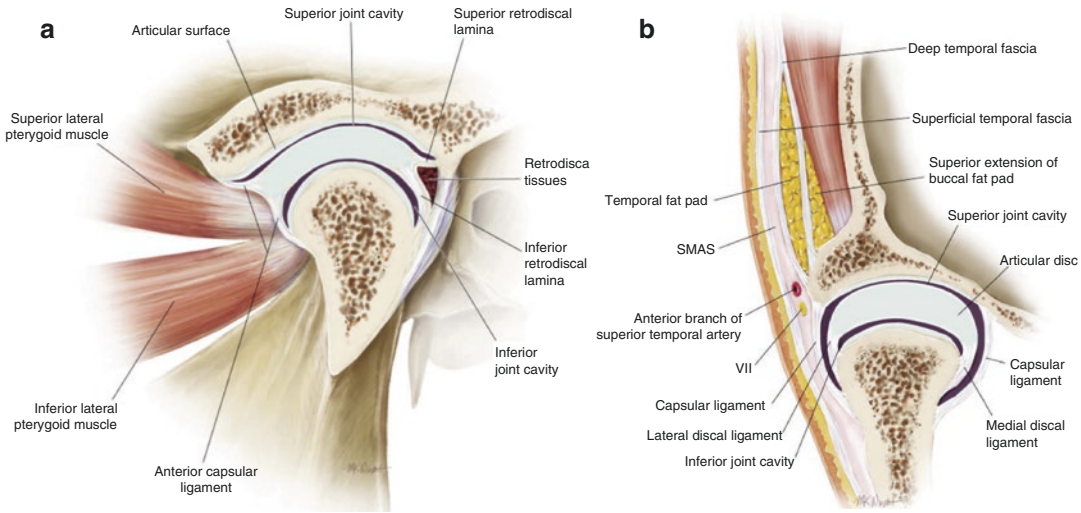


**Fig. 2.1** Temporomandibular joint anatomy. (**a**) Lateral view. (**b**) Sagittal view. (Reprinted with Permission from Kadenami and Patel [9])

**Clinical Manifestations**

- Jaw pain with tenderness of the muscles of mastication and/or supramandibular and infrahyoid muscles.
- May see wear facets of the dentition.
- Scalloping of the tongue.
- Morsicatio buccarum, laborium, or linguarum.
- Patients may complain of sore teeth.
- Decreased range of motion.
- Buccal exostoses (Wolff's law states that bone responds to the pressure exerted on it by an osteoblastic response).
- Patients often will complain of pain on the side of their face as opposed to pointing to the preauricular region. Pain is usually diffuse and involves the muscles of mastication (DDx of MPD-trigeminal neuralgia, atypical facial pain, fibromyalgia).

**Treatments**

- NSAIDS to reduce pain and inflammation (e.g., ibuprofen 600 mg QID × 2 weeks, naproxen 500 mg BID × 2 weeks, Mobic 7.5–15 mg daily for 2 weeks)
- Occlusal appliances
- Soft diet
- Muscle relaxants:
  - Cyclobenzaprine 5–10 mg daily QHS, baclofen 5–10 mg TID (Some advocate for prescribing these medications TID. There is concern for dizziness/sedation, which is why some surgeons choose to prescribe it QHS.)
- Warm compresses
- Occlusal equilibration
- Trigger point injections
- Botox intramuscular injections
- Replacing the posterior dentition
- Physical therapy

## Degenerative Joint Disease

Definition – a chronic inflammatory arthritis within the TMJ resulting in degradation of articular cartilage with remodeling of the subchondral bone.

**Non-inflammatory Degenerative Joint Disease (aka Osteoarthritis)**

- Due to an imbalance between catabolic and anabolic processes. This leads to expression of catabolic cytokines (TNF-alpha, IL-1, IL-6), initiating liberation of collagenases and proteases that result in degradation of the articular

cartilage. Osteoarthritis of the TMJ can be preceded by internal derangement and trauma and can also develop in patients that have had orthognathic surgery.

**Inflammatory Arthritis**

- Joint destruction due to an inflammatory arthritic process (e.g., rheumatoid arthritis (RA), juvenile rheumatoid arthritis, psoriatic arthritis, gout, pseudogout, ankylosing spondylitis, reactive arthritis).

**Treatment**

- Depends on the extent and the level of life disruption. May include medications, physical therapy, or steroids or disease-modifying drugs.
- For mild cases failing conservative treatments, consider arthrocentesis and arthroscopic procedures.
- More advanced cases may require arthroplasty or total joint replacement.

## Internal Derangement of the Temporomandibular Joint

Definition – disorder of the TMJ in which the articular disk is in an abnormal position as it relates to the condyle and fossa when the teeth are in occlusion. Malposition of the disk may lead to pain, instability, decreased range of motion, and abnormal mobility of the mandible.

**Etiologies**

- Trauma
- Joint laxity
- Parafunctional habits
- Altered joint lubrication system
- Anchored disk phenomenon (disk adhesion to articular fossa)
- MPD

**Diagnosis**

- Look for decreased maximal incisal opening (MIO), deviation, deflection, palpable clicks (reciprocal), and crepitus. Patients often will complain of pain in the preauricular region as opposed to pointing to the side of the face.
- Diagnosis by MRI-T1 and T2. Disk is normally displaced in an anteromedial vector. Can see osseous changes and abnormal contours of the disk.
- Disk displacement with reduction – patient opens the mouth with an accompanying click that is produced when the condyle passes over the posterior portion of the disk. During opening, the disk returns to its normal anatomical position in relation to the fossa and condylar head. During closing, a second click can be appreciated as the condyle passes back over the thickened posterior portion of the disk.
- Disk displacement without reduction – patient attempts to open but the condyle cannot pass over the posterior band of the disk. May see deflection to the ipsilateral side and decreased excursion to the contralateral side. This results in limitation of opening.
- Wilkes classification classifies the degree of internal derangement and provides guidance in relation to treatment options (Table 2.1).

**Table 2.1** Wilkes classification of internal derangement

| Wilkes classification [1] | | | |
|---|---|---|---|
| Stages | Clinical findings | Radiographic findings | Surgical findings |
| Stage I | Painless clicking No pain or locking | Anterior disk displacement noted. Disk contour remains normal with no osseous changes | Normal disk noted and displaced anteromedially |
| Stage II | Occasional painful clicking with intermittent locking | Anterior disk displacement noted with reduction on opening Mild disk deformity with no osseous changes | The disk appears thickened and displaced anteromedially. |

(continued)

**Table 2.1** (continued)

| Wilkes classification [1] | | | |
|---|---|---|---|
| Stages | Clinical findings | Radiographic findings | Surgical findings |
| Stage III | Frequent painful clicking with severe limitation in range of motion Joint tenderness noted | Anterior disk displacement noted without reduction Moderate disk deformity with no osseous changes | The disk is deformed and displaced anteromedially Adhesions may be appreciated |
| Stage IV | Restricted range of motion with chronic pain and joint crepitus | Anterior disk displacement noted without reduction Marked disk deformity with osseous changes | The disk is perforated with noted osseous changes of the condylar head and the fossa |
| Stage V | Joint pain and crepitus | Disk is displaced Marked disk deformity with severe osseous changes | The disk is perforated with noted severe osseous changes of the condylar head and the fossa |

**Treatment**

- Conservative treatment as previously mentioned (if appropriate).
- Intra-articular injections with a local anesthetic/steroid mixture.
- Those unresponsive would benefit from arthrocentesis with or without arthroscopy, arthroplasty with repositioning, or meniscectomy with or without graft/replacement, or modified condylotomy.
- Postoperative management – physical therapy/range of motion exercises.

## Disorders of Hypomobility and Hypermobility

Hypomobility can be due to intra-articular factors or extra-articular factors (pseudoankylosis).

**Fig. 2.2** Ankylotic mass extending from the medial aspect of the ramus to the mandibular fossa over a previously placed prosthetic temporomandibular joint. (Image courtesy of Dr. Damian Findlay)

**Extra-Articular Causes**

- Muscle fibrosis secondary to radiation, myofascial pain, tumors, infection, hysteric trismus, myositis ossificans.
- Fractures involving the condyle, zygomatic arch, or coronoid process.

*True ankylosis* (Fig. 2.2) – intra-articular fusion within the joint space resulting in hypomobility:

- Can be bony, fibrous, or fibro-osseous.
- Can be complete vs. incomplete.
- Can be caused by trauma, infection, otitis media, rheumatoid arthritis, psoriatic arthritis, prolonged immobilization, and previous TMJ or orthognathic surgery.
- Based on radiographic findings, two commonly accepted classifications have been adopted. Topazian based on three classes and Swahney has four classes (Table 2.2).

**Workup for Ankylosis**

- Clinical exam – decreased MIO, inability to appreciate translation of the condylar head.
- Orthopantogram – can see a radiodense mass, overall bony morphology, and coronoid hypertrophy.

**Table 2.2** Sawhney and Topazian classifications of ankylosis

| Classification of ankylosis [2] | |
|---|---|
| Sawhney (1986) | Topazian (1984) |
| Type 1 – flattened condylar head with close approximation to joint space<br>Type 2 – flattened condyle close to glenoid fossa, bony fusion on outer aspect of articular surface. No fusion of the medial joint space<br>Type 3 – bony block bridging the mandibular ramus and zygomatic arch<br>Type 4 – wider bony block bridges the mandibular ramus and zygomatic arch, completely replacing the architecture of the joint | Stage 1 – only condyle involved<br>Stage 2 – extends to sigmoid notch<br>Stage 3 – entire condyle, sigmoid notch, and coronoid |

- CT with contrast – defines the extent of the heterotopic bone/ankylotic mass. It also delineates the relationship of the mass to vital structures (foramen ovale, foramen spinosum, carotid canal, jugular foramen, pterygoid plexus). CT also aids in fabrication of a custom TMJ prosthesis in the setting of immediate reconstruction.

*Treatment Options* – requires excision of the mass with reconstruction. The goal of MIO is 35 mm and greater. In an adult, the reconstruction is more commonly achieved with a prosthetic joint, which is described later in text (other options include costochondral graft (CCG) or fibula free flap).

**The Seven-Step KABAN Protocol** [3]
Dr. Kaban described a protocol for the treatment of TMJ ankylosis in pediatric patients:

- Aggressive resection of the fibrous and/or bony ankylotic mass.
- Coronoidectomy on the affected side and measure MIO intraoperatively.
- Coronoidectomy on the contralateral side if you cannot achieve an MIO >35 mm and/or to the point of dislocation of the unaffected TMJ.
- Lining of the TMJ with a temporalis myofascial flap or the native disk (if salvageable).
- Reconstruction of the ramus condyle unit with either distraction osteogenesis (DO) (activate 2–4 days) or CCG and rigid fixation (10 days of MMF (Maxillary-Mandibular Fixation). If DO is used to reconstruct the ramus condyle unit, reshape the native bone narrowed and rounded. A corticotomy is then created distally to serve as transport disk. The distraction is set at 1 mm/day. Mobilization begins the day of the operation. In patients who undergo CCG reconstruction, mobilization begins after 10 days of MMF. DO takes advantage of the fibrocartilaginous cap that forms on the advancing front of the distracted bone heading toward the fossa.
- Early mobilization of the jaw.
- Aggressive physiotherapy.

**Treatment Options for Fibrous Ankylosis**
- Can be treated more conservatively.
  - Lysis of adhesions and fibrosis.
  - Diskectomy.

**Postoperative Management**
- Aggressive physical therapy is paramount in the treatment.
- Frequent follow-up.
- Consider radiation therapy (20 Gray in 10 fractions) to prevent recurrence and consider when using autogenous grafting, as the risk of recurrence is higher.

**Costochondral Graft**
- The CCG is commonly used in the growing child. It offers many advantages including ease of adaptation and remodeling, low morbidity at the harvest site, low rate of infections, and reduced relative cost. It does, however, increase operating time. In adults 12–17 cm of rib can be harvested and 7–10 cm in children within the borders of the lateral edge of the latissimus dorsi and costochondral junction.
- Ribs 4–7 may be harvested as they have a direct cartilaginous connection to the sternum. Rib 6 is the most commonly harvested as the incision falls in the inframammary crease creating a better cosmetic outcome (fusion of the rectus and pectoralis major forms an avascular plane.) It is common practice to harvest the right rib, as it is least likely to be confused with cardiogenic pain. Many advocate the rib

contralateral to the side of the defect to allow appropriate curvature of the harvested rib.

**Rib Harvest Technique** [4]

- A sharp incision is made in the inframammary crease (5 cm long).
- Dissection is carried through the subcutaneous tissue, fascia, and the plane between the pectoralis major and rectus abdominis.
- Two fingers are used to straddle the fifth and sixth intercostal space to prevent slipping of instruments. A sharp incision is cut through the periosteum down to the outer cortex of the rib.
- A molt periosteal now can be used to dissect in a subperiosteal plane around the rib. Some surgeons used the Doyen rib stripper, but its usage is known to be associated with parietal pleural tears.
- A sharp blade is used to make the cartilaginous incision. In children it is important to harvest no more than 3 cm (no less than 1 cm) to avoid overgrowth of the rib and to prevent separation of the cartilaginous cap.
- The rib is pulled laterally and a protected rib cutter is now used to section the length of desired rib.
- Check for pleural tears by filling the cavity with normal saline and have the anesthesiologist perform a Valsalva maneuver to check for bubble formation.
- The periosteal sleeve is now closed with 3-0 polyglactin (this may promote de novo regeneration of the missing rib in the child patient).
- The fascia between the rectus and pectoralis major is closed with a 3-0 resorbable suture, followed by subcutaneous tissue and finally skin.
- Post-operatively a chest X-ray is ordered to rule out a missed pneumothorax or hemothorax. The patient may return to normal activity post-op day 7, but any strenuous activity is withheld for 6 weeks.

## Complications

- *Cartilaginous Cap Has Separated from Harvested Rib* – this is a highly debated question and the opinion of the authorities appears to be diverse. One approach is to drill a hole through the width of the rib and tie a non-resorbable suture to secure the cap. Another approach is to simply harvest the second rib above and start fresh. The rib directly above is preserved to prevent a cosmetic defect.
- *Pneumothorax* – occurs when air is trapped between the visceral and parietal pleural cavity. The condition develops when there is a one-way valve allowing air to enter and not escape. This condition can rapidly progress to respiratory insufficiency and cardiovascular collapse. Clinically the patients will have labored (tachypneic) breathing, chest pain, tachycardia, hyperresonance of chest wall on the affected side with diminished breath sounds. Late findings include cyanosis, distension of neck veins, tracheal deviation, and a decreased level of consciousness. Radiographically can appreciate tracheal deviation, loss of pleural lines, and loss of vascular markings (Fig. 2.3). Treatment firstly is 100% oxygen therapy to reduce the alveolar concentration of nitrogen, effectively increasing the difference in concentration of oxygen between tissue capillary and pneumothorax space, leading to rapid absorption by the surrounding vasculature. A pneumothorax 10% or less in size can be left to reabsorb and serial chest X-rays are indicated. If it does not resolve


**Fig. 2.3** Right sided pneumothorax. (Reprinted with permission from Fontaine and Page [5])

in 1 week, a tube thoracostomy is required. Estimation is provided by using a crude method by using a correlation that a 2.5-cm margin of gas peripheral to the collapsing lung corresponds to a pneumothorax of about 30%. Complete collapse of the lung is a 100% pneumothorax. If immediate pressure release is required, needle decompression can be done by placing an IV catheter at the second intercostal space along the mid-clavicular line and listen for rush of air. This procedure will normally buy time for tube thoracostomy. Tube thoracostomy requires a 2–3 cm incision that is marked at the fifth intercostal space just above the top of the sixth rib. Local anesthetic is infiltrated in the skin and tissues. A proximal end of a thoracotomy tub is clamped and advanced over the sixth rib, avoiding the neurovascular bundle on the inferior border of the fifth rib. The tube is placed on water-sealed suction drainage.

- *Pleural Tear* – air bubbles may be appreciated during the Valsalva maneuver indicative of a pleural tear. A suction catheter is placed into the wound and a purse string suture through the tear. The suction catheter is removed under suction while tightening the purse string simultaneously.

## Hypermobility/Dislocation

Mandibular subluxation resulting in an inability to close from the patient's maximal incisal open position. This results in the condylar head being anterior to the articular eminence causing what is known as an open lock.

**Etiologies**

- Excessive yawning
- Excessive opening/prolonged opening (e.g., dental appointment)
- Seizure disorder
- Intubation
- Tardive dyskinesia
- Phenothiazine treatment – causes involuntary oromandibular movements
- Connective tissue disorders (e.g., Ehlers-Danlos and Marfan syndromes)

**Acute Treatment**

- Reduction by bimanual mandibular manipulation in a downward and posterior vector. Consider sedation beforehand.
- Wrap the head with a Barton bandage after reduction to limit jaw movements for a week (this allows stretched tissues to heal).

**Treatment for Chronic Dislocation**

- Noninvasive measures include intra-articular injections of a sclerosing agent such as alcohol or autogenous blood in the superior joint space.
- Botox has also been used in the lateral pterygoid.
- LeClerc/Dautrey procedures (zygomatic arch osteotomies), eminectomy, lengthening the articular eminence with a bone graft (calvarium, symphysis, ramus).

## MRI Imaging of the Joint

- Ordering an MRI should be done with T1- and T2-weighted images in 3 mm serial cuts in the coronal, sagittal, and axial views for both open and closed mouths.
- A normal MRI will have the junction of the posterior band and the posterior attachment at the 12' O clock position in a closed mouth.

**T1 Imaging** (Fig. 2.4)

- Fat is bright and will appear white.
- Better for anatomy evaluation.
- The marrow fat in the condyle will have a high T1 signal intensity. An easy way to identify a T1-weighted image is if the condyle is white and the gyri of the brain do not show white banding or the orbits appear gray.
- On both T1- and T2-weighted image, the disk and cortical bone will appear black due to low proton density.
- Of note, in avascular necrosis, T1 marrow will be black and T2 will be bright due to necrosis.

**T2 Imaging** (Figs. 2.4 and 2.5a)

- Water is bright and fat is dark.
- Brain appears gray.

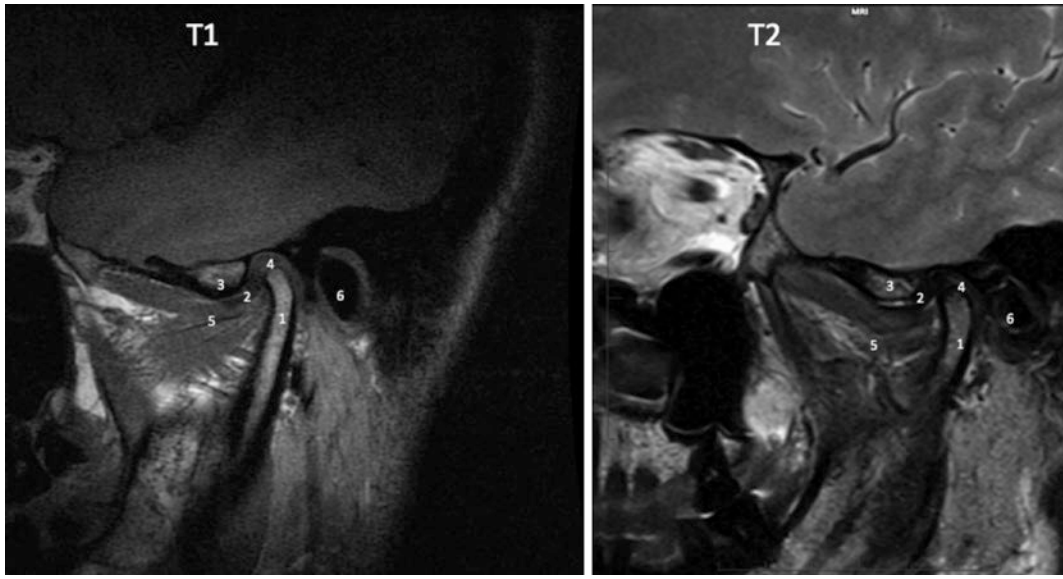


**Fig. 2.4** (1) Condyle, (2) disk, (3) articular eminence, (4) posterior attachment, (5) lateral pterygoid, (6) auditory canal. (Image courtesy of Dr. Robert Reti)

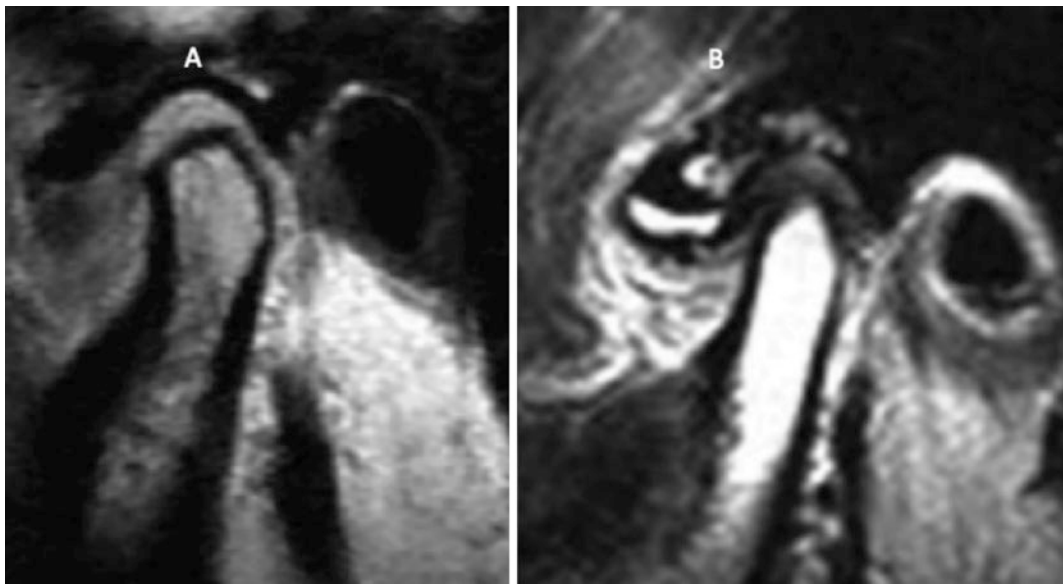


**Fig. 2.5** (**a**) Example T1-weighted image sagittal view of TMJ in a closed mouth position with anterior disk position. (**b**) T2-weighted sagittal view of the TMJ in a closed mouth position with an effusion of the superior disk space. (Image courtesy of Dr. Robert Reti)

- Better to look for effusions and pathology (trauma/pathologies normally accompanied by edema) (Fig. 2.5b).
- The bone marrow is less bright (hence the condyle looks gray).
- Easy to identify whether you see a bright signal from gyri of the brain.

## Approach to the Facial Pain/ Temporomandibular Joint Section

CC – Always ask the patient to expound on the chief complaint.

- *HPI* (HPI – Use the OLD CARTS acronym)
- *O*nset – when did the issue start? Was there a history of trauma?
- *L*ocation – where is the issue anatomically? For example, have the patient point to the region of discomfort.
- *D*uration – how long has the pain or decrease in opening been going on?
- *C*haracter – describe the character of the pain (throbbing, sharp, or dull).
- *A*ggravating/associated symptoms – is there anything that makes it worse? Do you have headaches, bruxism, clenching, gum chewing, nail biting, tinnitus, neck pain, or ear pain? Does your bed partner report any nocturnal bruxing? History of open or closed locks? Does your bite feel normal?
- *R*elieving – is there anything that makes the issue better?
- *T*iming – has this happened before? Any recent increase in life stressors? Does the pain improve during the day (nocturnal bruxism discomfort regularly improves during the day) or in the evening (arthritic joints tend to have more pain with continued function)?
- *S*everity – on a scale from 1 to 10, how severe are the symptoms? Is function impaired? Is there difficulty with mastication? Is there difficulty with speech due to pain? How has this affected your quality of life?

**Physical Exam/Workup**

- *Inspection* – look for gross asymmetry of the face (chin point and preauricular region). Look for signs of occlusal trauma such as wear facets, abfractive lesions, broken/worn restorations, exposed dentin, and missing teeth. Loss of posterior teeth can lead to MPD and overloading of the TMJ, which can cause intra-articular degenerative changes. Cheek bite marks or tongue scalloping. Look for premature contacts.
- *Palpate* – palpate the muscles of mastication (temporalis, masseter, pterygoids) and cervical musculature (SCM and trapezius). Palpate in the preauricular region to assess for masses and if movement of the condylar head can be appreciated. The condylar head may not move in cases of mechanical obstruction (i.e., ankylosis or neoplasm involving the TMJ).
- *Assess the Mandibular Gait* – check for maximal incisal opening (normal ~42–55 mm), lateral excursive (normal ~10–12 mm), and protrusive movements (normal ~8–11 mm). Look for deflection and deviation (possible signs of internal derangement) and the length of opening on occurrence.
- *Other Physical Exam Maneuvers*
  - Can you elicit Mahan's sign? Working side is loaded by placing tongue blades on the contralateral canines. If there is ipsilateral preauricular pain, then there is an internal derangement of the ipsilateral joint.
  - Joint auscultation to assess for clicks and crepitus.
- *Radiographic Imaging*
  - Orthopantogram – is it of diagnostic quality? Can both TMJs be visualized? Are the condyles in the fossae? Are there degenerative changes of the condylar head? Is there loss of joint spacing? Subcortical cysts? Chondromatosis (joint mice)? Subchondral eburnations (sclerosis)? Osteophytes? Are there radiodense changes or coronoid hypertrophy indicative of ankylosis? Is there condylar hyperplasia, hypoplasia, or agenesis? Are there any signs of hemiman-

dibular hypertrophy or condylar hyperplasia? Is there adequate penetration to visualize structures clearly? Look for fractures, third molars, caries, periodontitis, and sinus pathology.
- TMJ MRI – get T1- and T2-weighted (non-contrast) open and closed mouth views to assess disk position with function, disk integrity, and condition of the condyles. T1 gives better detail of joint anatomy. T2 useful for inflammatory changes and effusions. Look for the position of the disk and whether there is deformation. Remember in T1 fat is bright, T2 water is bright. Can look at the brain in T2 and note the brightness of the gyri and periorbital tissues.
- TMJ arthrogram – plain film of the TMJ that uses contrast. Good to visualize the position of the disk and good to assess for perforations.
- CT with contrast of the TMJs – look for ankylotic masses, neoplasms, mechanical obstruction, or infectious causes of trismus. Contrast helps to delineate the proximity of blood vessels to an ankylotic mass or if there is a collection that could be indicative of an infection (i.e., temporal space infection leading to trismus).

## Arthrocentesis

Indications are for acute closed lock, previous surgery with continued discomfort, TMJ arthralgia, Wilke's classification 1, 2, and 3.

- Contraindications – ankylosis, overlying skin infection, and inability to appreciate the regional anatomy (i.e., obese patients).
- Can be done under local anesthesia or sedation.

**Arthrocentesis Technique**

- Use a marking pen to draw out the canthaltragal line (aka Holmlund-Hellsing line): First point is 10 mm ahead of the line and 2 mm below. Second point is 20 mm ahead (10 mm anterior to the first line) and 10 mm below. First point corresponds to the deepest point of the glenoid fossa and second point corresponds to the height of the articular eminence.
- Prepare skin with antiseptic solution.
- Use local anesthetic without epinephrine to anesthetize the area. This allows early evaluation if concern for traumatic versus anesthetic palsy of facial nerve. Additionally, if planning for diagnostic arthroscopy, epinephrine may mask erythema, rendering findings inaccurate.
- Manipulate the jaw to open the joint space.
- Insufflate superior disk space with a 27-gauge needle with lactated ringers.
- Using an 18-gauge needle, aim the needle at a 45-degree angle superiorly and anteriorly to reach the lateral aspect of the zygomatic arch, then walk the needle off the bone to enter the superior joint space. This will be your anterior port. (Joint entry with needle on average is 25 mm from skin.) Average superior joint space is around 3 cc.
- Place posterior port in similar manner with 18-gauge needle (of note a Shepard cannula can also be used which has an entry and exit port).
- Irrigate with lactated ringers (at least 100 ml). Lavaging the joint can break up adhesions, which can allow the disk to recapture into its premorbid position. This also irrigates out inflammatory mediators.
- Remove anterior port and inject a single agent or combination of steroid (Kenalog 40 mg/ml), hyaluronic acid (10 mg/ml), local anesthesia (bupivacaine 0.5% with 1:200 K epi), and morphine (10 mg/ml).
- Manipulate joint under anesthesia and check opening under sedation.
- Postoperative management includes aggressive range of motion exercises, NSAIDS, splints.

## Disk Reposition Procedure

- Surgical procedure to manually reposition the disk into its premorbid position.
- Indications are failure of conservative therapy, Wilkes 2–5.

**Preauricular Approach/Disk Reposition Technique**

- Incision is marked in the preauricular crease (may consider the Al-Kayat extension to increase access).
- The incision is made through the skin and subcutaneous tissues for the entire length.
- Attention is then directed to the superior portion of the incision. Dissect through temporoparietal fascia (TP) and auricularis anterior muscle down to the temporalis fascia layer (which is recognized by the glistening white color). The TP fascia is attenuated in this region and not as thick as its superior counterpart (Galea). Remember the temporal branch of the facial nerve runs within the TP fascia anywhere from 8 mm to 35 mm (average 20 mm) from the bony anterior extent of the external auditory meatus. The remaining intervening tissues are dissected down to the level of the temporalis fascia using a nerve monitor/stimulator to avoid the course of the nerve (Fig. 2.6).
- Palpate the zygomatic arch. Incise through the attached periosteum. Dissect subperiosteally until you appreciate the joint capsule.
- Insufflate the joint with local anesthesia or saline. Make an incision into the joint capsule to enter superior joint space.
- Mobilize the disk. Assess for perforations (repair if small perforations/remove disk if the perforation is large). Disk can be plicated in a posterolateral vector to the disk capsule or temporalis fascia with non-resorbable suture or a Mitek® anchor.
- Close in layers.

## Complications

*Otitis Externa* – Infection of external auditory canal. Patient will complain of pain on movement or pressure of ear. Otoscopy will reveal edematous EAC with possible discharge. Treatment includes topical fluoroquinolone otic products (to cover pseudomonas – most common bacteria implicated in otitis externa).

*Otitis Media* – inflammation of the middle ear structures. Patient will complain of ear pain, difficulty hearing, and fever. Otoscopy shows full or bulging tympanic membrane or possible purulence (if there is perforation of tympanic membrane). Treatment includes antibiotics such as amoxicillin. Consider consult with ENT for myringotomy tubes.

*Broken Instrument During Arthroscopy/Arthrocentesis* – if you are able to visualize the fragment, and having arthroscopic training, attempt removal arthroscopically. If you cannot visualize, then obtain radiographs in multiple planes for identification. If these failed or not trained, convert to an open approach.

*TMJ Rupture/Hemotympanum* – otoscopy to examine for TM rupture or hemotympanum. Consult ENT for intra-op examination if this is

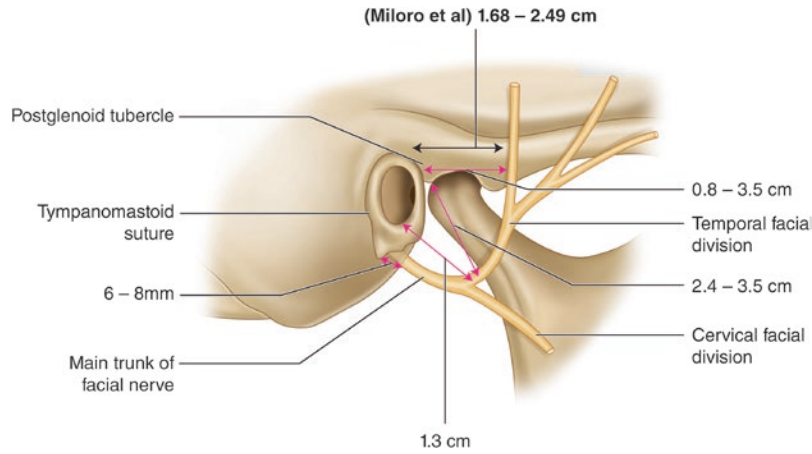


**Fig. 2.6** Facial nerve as measured from the lowest point of the external bony auditory canal. Bifurcation of facial nerve: 1.5–2.8 cm. Facial nerve crossing zygomatic arch: 0.8–3.5 cm (average 20 mm). (Reprinted with permission from Miloro M, Redinger S, Peddington D, Kolodge T. JOMS 2007; 65(12):2466–2469)

noted. If EAC is damaged, place an antibiotic impregnated sponge dressing. This is sutured to maintain opening of the EAC, thereby, preventing stenosis. Some physicians will place on antibiotic-hydrocortisone suspension for 14 days post-op and monitor for granulation tissue formation. This granulation tissue can be removed with bipolar cautery or silver nitrate.

*Violation of the Middle Cranial Fossa* – keep in mind that the fossa is approximately only 0.9 mm thick. If a large perforation is noted, an intraoperative neurosurgical consult is recommended (as it may be able to be treated immediately). If you suspect CSF leak postoperatively, then obtain a CT scan/MRI. A tracer study should also be taken. (Neurosurgery should be consulted and should advise on the desired imaging.) The patient is placed on bed rest, with the head of the bed raised greater than 30 degrees. Some advocate administration of antibiotics such as cotrimoxazole as this is bactericidal and enters CSF. The overwhelming majority of small leaks spontaneously heal within 1 week.

*Damage to the Temporal Branch of the Facial Nerve* – the temporal branch of the facial nerve on average is 2 cm anterior to the bony external auditory canal. The classic study of Al-Kyat and Bramley identified a range of 0.8 cm to 3.5 cm [6]. The temporal branch of the facial nerve innervates the frontalis, orbicularis, and corrugator supercilii. Most injuries resolve in 3–6 months and, therefore, observation is warranted. Treatment should be reserved for those who are symptomatic. Ophthalmologic consult is indicated. Lubrication and taping of the eye at night are necessary to prevent keratoconjunctivitis. Physical therapy with electrical stimulation may aid in maintaining muscle tone while awaiting recovery. Gold weights implants can be placed in the upper eyelid for more permanent defects.

*Auriculotemporal Nerve Syndrome (Frey Syndrome)* – signs and symptoms include gustatory sweating, flushing, and warmth over the temporal and preauricular areas. It results when there is auriculotemporal nerve damage and occurs most commonly with arthroscopy. It usually is temporary and will resolve within 6 months.

**Author's Note*. The patient is to be evaluated with the Minor test (starch-iodine). A solution of 3 g iodine, 20 g castor oil, and 200 ml absolute alcohol is applied to both preauricular regions of the face. Gustatory sweating is elicited by having the patient chew on a lemon drop. A positive test is conversion of the yellow mixture to a dark blue. Case reports have shown that 16–80 IU of botulinum A subcutaneous injection has resulted in resolution within 1 week. Other treatments are application of scopolamine ointment (anticholinergic properties) and surgical transection of the innervation.

*Bleeding During Condylotomy* – during the condylotomy, the concern for bleeding is from the internal maxillary artery (IMA) and its branches. The IMA runs 3 mm medial from the mid-sigmoid notch and 20 mm below the condylar head. A commonly damaged vessel, as the cut is made through the sigmoid notch, is the masseteric artery.

*Bleeding During Diskectomy* – many times during a diskectomy, the bleeding may be also originating from the retrodiscal tissues or the lateral pterygoid muscle. The most commonly damaged vascular structure is the middle meningeal artery. It is found on average 31 mm medial the zygomatic arch and an average of 2.4 mm anterior from the height of the glenoid fossa. The first step to managing bleeding is to establish visualization. Attempt to identify any vessels for cauterization or ligation. If no obvious source, then apply firm pressure with a moistened gauze packed tightly into the wound. Additional hemostatic measures include thrombin-soaked gauze, flowable hemostatic agents, collagen sponges, or tissue adhesives. The inferior border of the mandible is then displaced superiorly to aid in pressure hemostasis (holding pressure for at least 5 minutes). Interventional radiology for embolization is warranted immediately if bleeding is not controlled by local hemostatic measures.

**Author's Note.* Some surgeons advocate carotid artery cut down for uncontrollable bleeding. Some question its efficacy due to contralateral circulation. In this approach, the neck incision is extended (a horizontal incision 5 cm in length) 2 cm below the inferior border of the

mandible, over the sternocleidomastoid muscle (SCM). The SCM is retracted posteriorly, and with blunt dissection parallel to the vessels, the carotid sheath should be identified. The SCM is carefully dissected from the sheath and the sheath is carefully entered. The internal jugular vein should be retracted posteriorly to reveal the common carotid. Dissection to the bifurcation aids in identification. The hypoglossal nerve will cross the arteries above this bifurcation and should be identified to prevent damage. Ligation should be above the facial branch, third of the anterior branches. Blood flow has been found to be reduced by 73%, when ligated at this position [7].

## Total TMJ Joint Replacement

Total joint replacement (TJR) indications:

- Failed previous TMD surgeries
- Severe arthritic joint
- Loss of vertical mandibular height and occlusal relationship
- Pathology
- Ankylosis – either bony or fibrotic
- Condylar agenesis

**Two Approved TJR Prosthetics in the USA**

1. Biomet®
   - Stocked with multiple sizes
   - Chromium cobalt alloy for condylar component and ultra-high molecular weight polyethylene for fossa component.
   - Pseudotranslation possible (if unilateral placement due to push of contralateral TMJ).
   - Chromium cobalt mandibular prosthesis is offered in three sizes (45 mm, 50 mm, and 55 mm) and in three styles (standard, narrow, and offset).
   - Chromium cobalt may contain nickel (a consideration in those with a nickel allergy).
2. TMJ Concepts®
   - Custom made w/CT scan and stereolithography.
   - Pure titanium for condylar component.
   - Pure titanium with ultra-high molecular weight polyethylene for the fossa component.

**Surgical Technique for TJR**

- Requires a preauricular and submandibular/retromandibular approach.

**Preauricular Approach**

- Standard preauricular approach to joint capsule (see above).
- Make an incision in the periosteum of the lateral aspect of the condylar head, in a T shape fashion, to expose the lateral aspect of the condyle. Of note, the anatomy may be distorted due to an ankylotic mass and, therefore, recognizable anatomical landmarks should be used as a reference for the dissection.
- Dissect subperiosteally to expose the anterior and posterior regions of the condylar neck.
- Pack site and direct attention to the submandibular region.

**Submandibular Approach**

- Mark mandible 2 cm below inferior aspect of the mandible.
- Inject vasoconstrictor.
- Make an incision approximately 6 cm long.
- Dissect through skin and subcutaneous tissue to the level of the platysma.
- Undermine skin flap in all directions.
- Sharp dissection through platysma exposing superficial layer of the deep cervical fascia. Dissect through this layer with the aid of nerve stimulator/monitor testing for marginal mandibular nerve, which is within or deep to the fascia.
- (Don't forget Dingman and Grabb [8] study – 19% of the time, the marginal mandibular nerve passed below the inferior border of mandible until it crossed facial artery 1 cm below the inferior border of the mandible).
- Marginal mandibular nerve has two branches 61% of the time and 21% it is a single branch.
- Dissect out facial artery and vein; isolate and clamp and tie vessels.
  - Hayes-Martin maneuver – ligation of facial vein (posterior to facial artery) at the lower

border of the mandible aiding in reflection of the superficial layer of the deep cervical fascia preserving the marginal mandibular nerve.
- Divide the pterygomasseteric sling along the inferior border of the mandible (the most avascular portion of sling). Redirect attention to the preauricular region.

**Condylar Resection (Condylectomy)**
- Condyle retractors placed to isolate the neck of the condyle (may not be possible in large ankylotic masses).
- Resect exposed condyle (a minimum of 15 mm of clearance for condyle and fossa component) if additional condyle neck requires removal, may place bone clamp on inferior border and displace ramus superiorly, further exposing condyle neck into preauricular/endaural incision.
- Inadequate removal may lead to impingement of ramus remnant on fossa prosthesis when MMF placed.

**Fossa Preparation**
- Removal all soft tissues from tympanic plate to remnant articular eminence.
- TMJ Concepts® – if necessary, reproduce any fossa contouring noted on preoperative model. TMJ concepts will require verification of seating by using the fossa-seating tool.
- BIOMET® stock joint requires manipulation of a specially designed diamond rasp or burr to modify the articular eminence. This allows positioning of fossa component. The surgeon must choose the appropriate fossa from sizers to ensure tripod stability. Note, the articulating surface of the fossa component stays constant and the amount of screw hole positions over the arch increases with size.
- Secure fossa component (make sure to apply firm pressure with fossa seating tool from TMJ concepts).
- Place only two screws for securing the prosthesis to allow check for the range of motion/interferences and to avoid damage to bone stock if repositioning is required.

**Condyle Component**
- Place patient in MMF.
- Biomet®, choose correct mandibular component from the sizers.
- Contour bone of the lateral ramus (rarely needed with TMJ concepts due to it having a custom fit) to allow passive fit of BIOMET sizer.
- Secure with two screws at this time.

**Final Screw Securement**
- Cover open wound sites, enter oral cavity, and remove MMF. (Consider paralysis at this time for freedom of movement).
- Ensure ROM is at least 32–35 mm.
  - If cannot achieve ROM, perform coronoidectomy (first ipsilateral and if not bilateral).
  - Note: If this is an ankylotic case, a coronoidectomy is required per Kaban protocol.
- Place final screws, at least four screws for fossa component and six in ramus.
- Irrigate sites and close.
- Consider fat graft around fossa to prevent ankylosis.

**Post-op**
- Post-op radiographs to confirm position and alignment.
- Post-op exercises and soft diet.
- Consider physical therapy for 4–6 weeks.

## TMJ Case

**Authors Note.* There are many ways to treat TMD. The goal is to explain the way you will be treating this patient. Do not deviate from your algorithm or explain how other surgeons would approach this. The goal of this portion is to guide you down a path to a surgical procedure. Be prepared to talk about open joint procedures, which could include disk manipulation or total joint replacement.

A 35-year-old female presents to your office with a chief complaint of diffuse, increasing left

side facial pain for 2 months. She reports morning headaches occasionally.

Medical History

- PMHx – asthma
- Rx – albuterol
- Allergy – NKDA
- PSurgHx – appendectomy
- PSocHx – attorney by profession, alcohol socially, denies tobacco and recreational drug use.
- *What do you want to know?*
  HPI (OLD CARTS) (*note above).
- *She has noticed that the pain started 3 months ago when she made partner at her law firm. She reports increased stress due to her promotion. She wakes up with morning headaches and her husband says that she grinds her teeth when she sleeps. What is your next step?*
  I would perform a physical exam – inspect, palpate, auscultate. Evaluate for facial asymmetries. Palpate muscles of mastication, denoting any pain. Palpate and auscultate TMJ for joint noises and crepitus. Evaluate maximal incisal opening and freedom of movement. I would note any irregular jaw movements and at what length of opening. Exam dentition for signs of attrition and compensatory hyperuption, overall dental condition, and premature contacts, and look for morsicatio buccarum and linguarum. I would try to elicit a Mahan sign.

*Pertinent findings on clinical exam* – Maximal incisal opening of 36 mm. No deflection or deviation noted. Anterior wear facets noted. Tenderness to palpation of the left masseter and temporalis muscles was appreciated. Prominent morsicatio buccarum (cheek biting) was also appreciated.

- *What imaging would you order?*
  I would order an orthopantogram.
- *Describe what you see on the orthopantogram* (Fig. 2.7).
  This is a diagnostic orthopantogram. Impacted third molars are present. Slight degenerative changes of both condylar heads noted. Even spacing of the TMJs noted. Condyloramal units appear congruent. No subcortical cysts noted. A full complement of teeth is appreciated. No other gross dental or bony pathology appreciated.
- *What is your diagnosis?*
  Myofascial pain disorder/early DJD.
- *How would you treat this patient?*
  Conservative therapy/non-surgical therapy would be the first-line treatment. This would include warm moist heat, NSAIDS/anti-inflammatories, soft diet, and an orthotic dental splint. A trial of low-dose anxiolytics may also be appropriate with this patient if the source of her parafunctional habits is stress related (e.g., alprazolam 0.25mg q8 hours). This also may warrant consultation with a PCP/psychologist for long-term care.

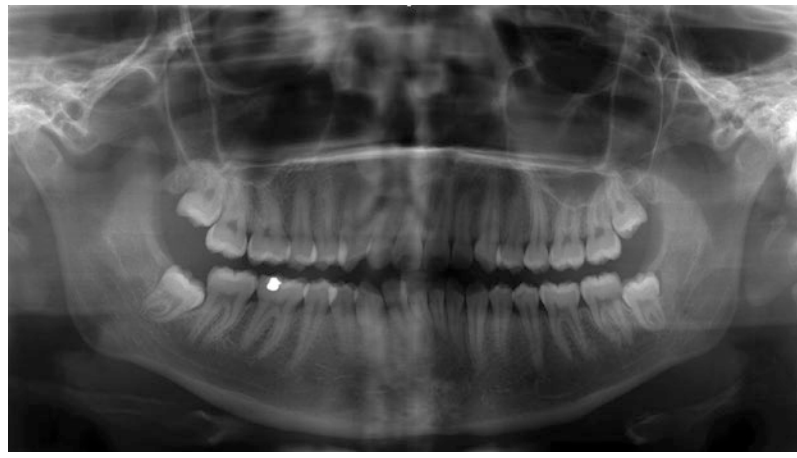

**Fig. 2.7** Orthopantogram of TMJ case. (Image courtesy of Dr. Damian Findlay)

- *The patient returns 8 months later with complaint of a frequent clicking sound whenever she opens her jaw and now has limitation of opening. How do you proceed?*
  Review any recent events associated with recent changes in symptoms: trauma, dental work, changes in medications, etc. Conduct a new complete head and neck exam. Evaluate new maximal incisal opening, deviations/deflections, symmetry in lateral excursive movements, new myositis, palpable/audible clicks.
- *New pertinent findings* – maximal incisal opening of 26 mm with a left sided click. *Would you order any imaging?*
  An MRI would be beneficial at this point to examine the disk position and condition.
- *Does this patient have any contraindications for taking an MRI*?
  No. MRIs should not be taken with patients with implanted ferromagnetic metals. These include AICD and clips to treat aneurysms. Dental materials such as braces, dental implants, cobalt chromium prostheses, and amalgam fillings are not contraindications.
- *What do you see on this MRI* (Fig. 2.8)*?*
  This is a T1 image sagittal slice closed mouth image. The MRI shows the disk to be anteriorly displaced. The disk shows only mild deformity.
- *How do you proceed?*
  I would discuss the different treatment options for the patient including arthrocentesis and arthroscopy.

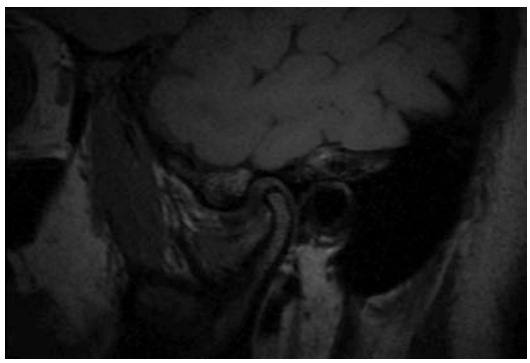

**Fig. 2.8** MRI of TMJ case

- *You decided with the patient you would like to continue treatment with arthrocentesis. Can you describe the procedure?*
  See arthrocentesis procedure in text.
  Board Guidance Point – You may also consider arthroscopy for diagnosis purposes. Arthroscopic surgery of the TMJ is a subspecialty that few surgeons do. Unless you are trained on this procedure, it would be best not to mention it as your option of choice to treat the patient.
- *What fluid do you use? How much?*
  Lactated ringers.
  – 100 mL: probable minimum for therapeutic lavage
  – 200 mL: reduces protein, bradykinin, IL-6
  – 300–400 mL: no detectable protein, bradykinin

  *Author's Note.* Lactated ringers is a crystalloid solution containing calcium chloride, potassium chloride, and sodium lactate. It is close to human serum in makeup; therefore, it is best tolerated by the tissues.
- *What do you inject into the joint after?*
  One regiment is 2 cc mixture of 10 mg/ml hyaluronic acid and 10 mg/ml of morphine. (Some surgeons in place of HA will use a 2 cc mixture of Kenalog® 40 mg/ml and bupivacaine 0.5%).
  **Author's Note.* Recall the joint space is 2–3 cc. HA mimics the glycosaminoglycan made by synovial cells. It is a viscous, high molecular weight substance that lubricates and protects joint articulating surfaces by preventing phospholipid destruction. It has been found to be effective with degenerative joint disease and anterior disk displacement with and without reduction and provides prolonged pain relief.
- *You are seeing the patient for her 3-month follow-up. She reports that she has been compliant with her post-op physical therapy and soft diet. She reports a tremendous amount of pain and a decreased range of motion. Exam reveals severe left-sided preauricular tenderness with a maximal incisal opening of 20 mm. After reexamining the patient, you discuss the option of an arthrotomy* versus *a condylotomy.*

*What are the options to manage a malposed disk during arthrotomy?*
Once the disk is exposed, you may plicate the disk in a posterior lateral vector. The disk can be plicated to the temporalis fascia using a non-resorbable suture. The other option is a mini Mitek anchor placed into the most posterior, superior, lateral condylar neck. You may repair a disk perforation if it is less than 3 mm. Diskectomy should be considered if the disk appears fragmented, if the perforation is large, or if the disk is balled up.
**Author's Note.* Mitek anchors are cylindrical pins with wings measuring 1.8 mm in diameter and 5 mm in length. Body is a titanium alloy (90% titanium, 6% aluminum, and 4% vanadium) and the wings are nickel-titanium alloy (Nitinol). There are two strands of single O suture attached to any eyelet to allow anchoring of the disk.

- *The patient opts for a condylotomy. What is the rationale for it use?*
  The goal is to increase the joint space and unload the disk to relieve pain by allowing some condylar sag. It is accessed like an IVRO with medial pterygoid muscle release to allow for condylar sag. The posterior cut is made 6–8 mm from the posterior border and 10 mm from the sigmoid notch. The amount of sag is assessed by looking at the inferior border and the tip of the proximal segment. The goal is to achieve 3–4 mm of sag.
- *What is your post-op protocol for a condylotomy?*
  - Post-op orthopantogram
  - 7 days of IMF (unilateral) for 14–21 days (bilateral)
  - Elastics and physical therapy
  - Remove arch bars off in 7 weeks
- *Patient is lost to follow-up and returns 10 years later with inability to open. You get a CT and you see this* (Fig. 2.9). *What would you expect to see on exam?*
  Painful muscles of mastication as they continually attempt to open the ankylotic joint. With this you might also see masseteric hypertrophy. A firm preauricular swelling from the mass may be appreciated. On orthopantogram, you may see prominent antegonial notching and coronoid hypertrophy.
- *What imaging would you like?*
  A medical grade-contrast enhanced CT of the maxillofacial region. This scan will aid in identifying the extent of the mass and in identifying vascular structures like the external carotid branches. It can also be used if a custom CAD-CAM generated joint is part of the treatment plan.
- *What are the different types of ankylosis?*
  False ankylosis – limited movement of joint due to extra-articular fibrosis or pathological condition.
  True ankylosis – fibrous or bony fusion or intra-articular joint structures.
  Two Subtypes of True Ankylosis:
  - Fibrous ankylosis – fibrous adhesion between condyle and fossa.
  - Bony ankylosis – formed by a bony mass between articular surface and the condyle.
- *How would you treat this case?*
  I would offer resection of the ankylotic mass with reconstruction, using a TMJ prosthesis.
  Author's Note. Other options for reconstruction include a costochondral graft or fibula-free flap.

**Fig. 2.9** Bilateral hyperdense masses noted in the condylar regions consistent with ankylosis. (Image courtesy of Dr. Damian Findlay)

- *What are indications for total joint replacement?*
  - Failed previous surgeries
  - Severe arthritic joint
  - Loss of vertical mandibular height and occlusal relationship
  - Pathology
  - Ankylosis – either bony or fibrotic
  - Condylar agenesis
- *What are the two approved TMJ TJR options in North America?*
  Biomet® and TMJ Concepts®
- *Describe briefly how to place a TMJ concepts or BIOMET stock joint?*
  See above surgical approach section.
- *You have completed a total joint replacement. On post-op day 2, you decide to round on the patient. The patient opens wide and now is stuck open. What are you concerned about and what do you do?*
  The concern is that the condylar head has slipped out of the fossa. This requires immediate return to the OR for manipulation. If unsuccessful, the incisions may need to be reopened to reposition the condylar component.
- *Patient after total joint replacement returns with a red and swollen preauricular region. What do you do?*
  Examine external auditory canal for concern of perforation. If a superficial infection is suspected, remove some sutures to establish drainage, obtain cultures, and prescribe a short course of oral antibiotics. If no improvement or recurrence, get a CT image with contrast to rule out deeper infection (a return to OR for aggressive debridement and/or removal of components may be indicated).
  **Author's Note.* In the event of an acute infection (5 days or less), open incisions, debride wound, and get a tissue sample for culture. The wound should be irrigated with antibiotic irrigation. The wound should be irrigated on a q 4 hour basis. Consider Infectious Disease consult for IV antibiotics via PICC line. For a late-stage infection (>1 month), remove hardware and debride surrounding soft tissue. Place an antibiotic-impregnated orthopedic spacer/tobramycin spacer to fight infection and prevent tissue in growth. An Infectious Disease consult is indicated (patient may require PICC line with 6 weeks of antibiotic infusion). Polyethylene components get discarded and all pure metal components can be cleaned and autoclaved. All screws get replaced. Of note, not all patients may require reconstruction if the occlusion, function, and range of motion are acceptable. Consider elastic training and physical therapy if the patient does not wish to undergo another alloplastic joint replacement.
- *How can you reduce the incidence of heterotopic bone formation?*
  Most cases occur 2–3 months after surgery. Most important it is to regain range of motion as soon as possible. Total radiation dose of 10 Gy to 20 Gy has been reported via fractionated daily doses in the immediate post-op phase. Wolford reported use of fat graft around the joint to decrease heterotopic bone formation.

  Indomethacin, a non-selective COX inhibitor, has been compared to radiation treatment in prevention of heterotopic bone formation in hip arthroplasty and found to be equally effective. It is given in 75 mg doses for 6 weeks (along with pantoprazole).

## Mnemonic for External Carotid Branches

**Some Anatomists Like Freaking Out Poor Maxillofacial Surgeons**

- S: superior thyroid artery
- A: ascending pharyngeal artery
- L: lingual artery
- F: facial artery
- O: occipital artery
- P: posterior auricular artery
- M: maxillary artery
- S: superficial temporal artery

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