Surgical Pathways to the Temporomandibular Joint

3

A. Abdullakutty and A. J. Sidebottom

Abstract

Evidence-based management of TMJ problems is limited with few randomized control trials. Although TMJ diseases were managed surgically, this is changing, and the vast majority is medical/non-surgical or minimally invasive. The management of temporomandibular joint conditions is an established area of subspecialization as they are common, and they contribute to a substantial workload in oral and maxillofacial units. Initial management with non-surgical or medical treatment is successful in most cases, as a result of advances in analgesia and the introduction of botulinum toxin injections. Since the pioneering work by Ohnishi, initial surgical management has largely changed from open operations on the joint to the use of arthroscopy for therapeutic and diagnostic benefit. Increasingly multidisciplinary approaches to TMJ treatment have more structure and science to their planning. Open surgical approaches to TMJ diseases have specific indications and should be done at specialist centres. To that end, this chapter details anatomic pathways that are used for open surgical access to the joint and related structures.

3.1 Introduction

Evidence-based management of TMJ problems is limited with few randomized control trials. Although TMJ diseases were often managed surgically, this is changing, and the vast majority is medical/non-surgical or minimally invasive [1]. The management of temporomandibular joint conditions is an established area of

Electronic Supplementary Material The online version of this chapter (https://doi.org/10.1007/978-3-319-99909-8_3) contains supplementary material, which is available to authorized users.

A. Abdullakutty · A. J. Sidebottom (✉)
Nottingham University Hospitals, Queens Medical Centre, Nottingham, UK
e-mail: anwer@doctors.org.uk; ajsidebottom@doctors.org.uk

S. T. Connelly et al. (eds.), *Contemporary Management of Temporomandibular Disorders*, https://doi.org/10.1007/978-3-319-99909-8_3

sub-specialization as they are common, and they contribute to a substantial workload in oral and maxillofacial units. Initial management with non-surgical or medical treatment is successful in most cases, as a result of advances in analgesia and the introduction of botulinum toxin injections [2]. Since the pioneering work by Ohnishi [3], initial surgical management has largely changed from open operations on the joint to the use of arthroscopy for therapeutic and diagnostic benefit. Increasingly multidisciplinary approaches to TMJ treatment have more structure and science to their planning [4]. Open surgical approaches to TMJ diseases have specific indications and should ideally be done under specialist guidance.

This chapter will provide an overview of the workup and approaches to surgery of the TMJ which will be covered in more detail elsewhere in this book.

3.2 Surgical Anatomy of TMJ

The temporomandibular joint (TMJ) is formed of the craniomandibular articulation [5].

The TMJ is a ginglymoarthrodial joint that is made of superior and inferior joint spaces separated by the meniscus. The articulatory system also consists of capsule, ligaments, masticatory and accessory muscles and teeth. Most sensory and motor branches are supplied by trigeminal nerve and partly by facial nerve.

3.3 Bony Boundaries

3.3.1 Glenoid Fossa

Anterior—articular eminence
Posterior—post glenoid tubercle
Medially—spine of sphenoid
Laterally—root of the zygomatic process
Superiorly—temporal bone
Presence of air cells in the arch and eminence (Fig. 3.1)

3.3.2 Mandible

The condylar process articulates with the glenoid fossa. It is broad laterally and narrower medially. The articular part of the condyle is covered by fibrocartilage.

3.3.3 Capsule

The capsule is made of thin sleeve of fibrous tissue investing the joint completely. It forms the anatomic and functional boundary of the TMJ, which originates from the periosteum of the mandibular neck, then envelops the articular disc and attaches to eminence and glenoid fossa.

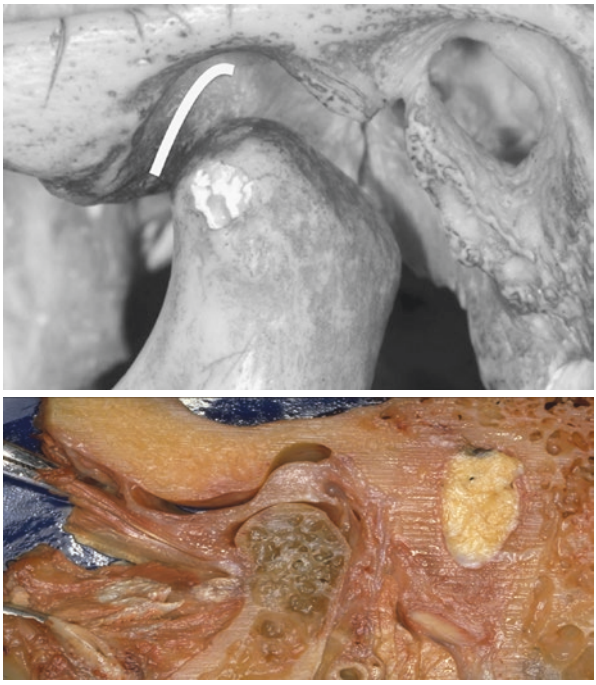


Fig. 3.1 Anatomical location of the Upper Joint Space below the articular eminence

3.4 Articular Disc

This is an oval-shaped fibrous biconcave tissue, which divides articular space into two compartments. The inferior compartment lies between the condyle and the disc. This space is rarely accessed in arthrocentesis or with an arthroscope, most often by accident or perforation (iatrogenic or disease related).

The superior disc is mostly accessed for therapeutic and diagnostic reasons, which is between the disc and the glenoid fossa. The disc is formed of three zones, posterior, intermediate and anterior. The intermediate zone being thinner is prone to perforation. The disc blends medially and laterally with the capsule, which in turn is attached to the medial and lateral poles of the condyle [6].

The posterior attachment of the disc (retrodiscal tissue) is vascular and can stretch leading to pain and clicking and also bleeding during discectomy. It may also thicken in response to repetitive trauma again leading to clicking. The vascularity of the retrodiscal tissue also permits suturing and repositioning of the disc. This area can be injected with HIGH concentration dextrose IN THE MANAGEMENT OF disc displacement or recurrent dislocation.

Volumes

Superior space, 1.2 mL

Lower space, 0.9 mL

The synovial fluid maintains the integrity of the disc (Fig. 3.2).

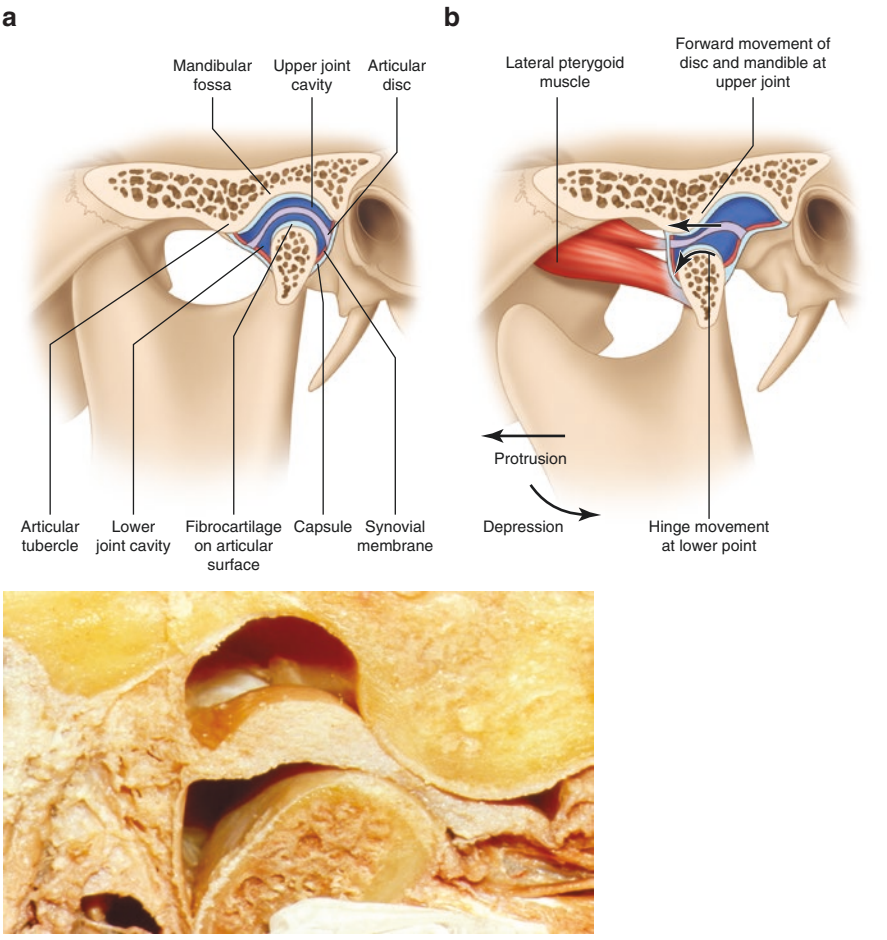


Fig. 3.2 This diagram illustrates the stylised anatomy of the TMJ and the Rotational movement which occurs in the lower joint space and the gliding movement which occurs in the upper joint space

3.5 Ligaments

3.5.1 Sphenomandibular Ligament

The sphenomandibular ligament arises from the sphenoid spine running downwards and medially to attach to the medial aspect of the ramus.

Surgical importance: maxillary artery and auriculotemporal nerve lie between the ligament and condylar neck. It has also been reported to have calcified and caused limitation of mandibular motion, which improved on its release [7].

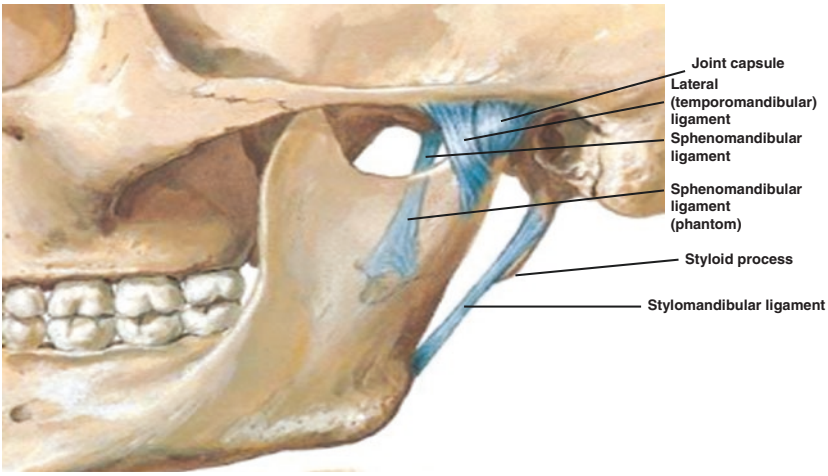


Fig. 3.3 Ligaments surrounding the TMJ

3.5.2 Stylomandibular Ligament

This is a condensation of deep cervical fascia extending from the styloid process to the mandibular angle. It may help to maintain stability of the joint but is of little surgical relevance.

3.5.3 TMJ or Lateral Ligaments

These reinforce the TMJ capsule. They extend from the articular eminence posterolaterally to the condylar neck, also called "the check ligament" as they help to prevent anterior and posterior dislocation (Fig. 3.3).

3.6 Blood Supply to TMJ

The superficial temporal artery and internal maxillary artery supply the TMJ via the deep auricular, posterior auricular and masseteric branches (Figs. 3.4 and 3.5).

3.7 Nerve Supply to TMJ

The TMJ is mainly innervated by THE auriculotemporal nerve supplying the posterior, medial and lateral aspect of the joint. Masseteric and deep temporal nerve SUPPLY the anterior part of the joint. The large bulk of the auriculotemporal nerve lies deep to the joint; hence the use of cryoanalgesia to the lateral capsule will not affect this part of the nerve [8] (Figs. 3.6 and 3.7).

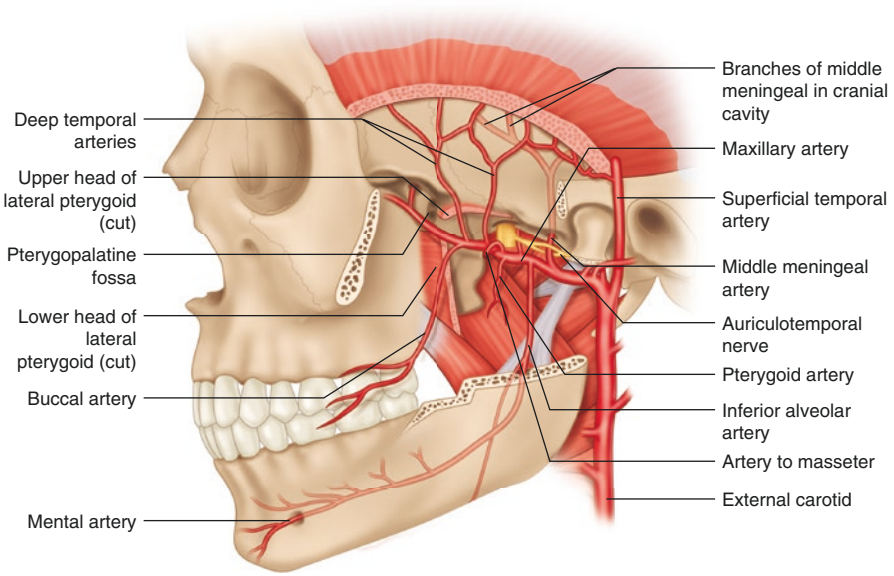


Fig. 3.4 Anatomical schematic showing the blood supply surrounding the TMJ. This is mainly via the terminal branches of the external carotid artery - superficaial temporal and maxillary arteries

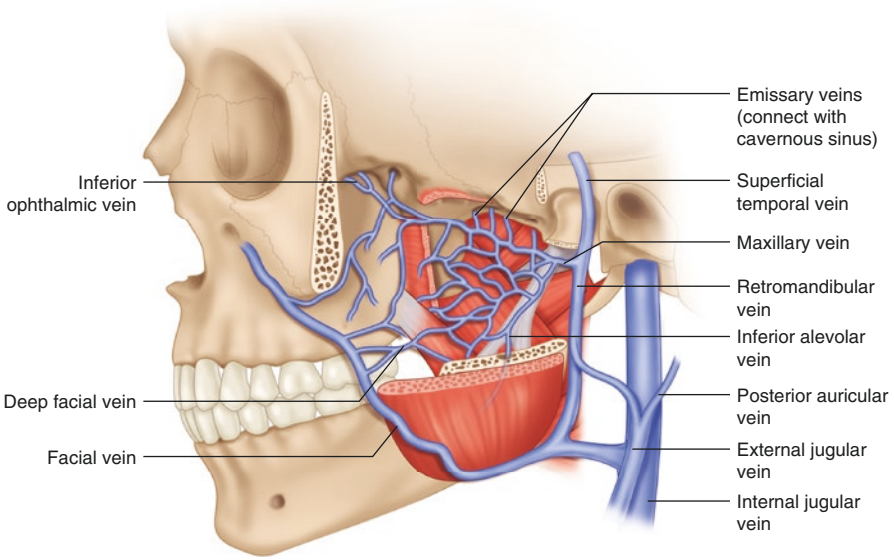


Fig. 3.5 Schematic diagram showing the venous structures surrounding the TMJ

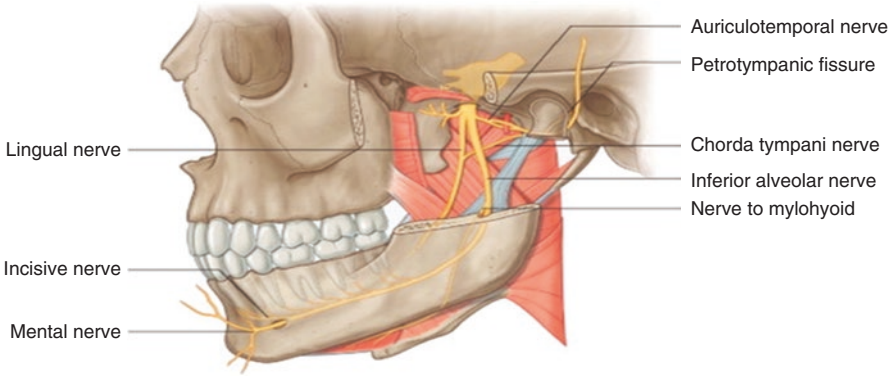


Fig. 3.6 Nerve relations to the TMJ

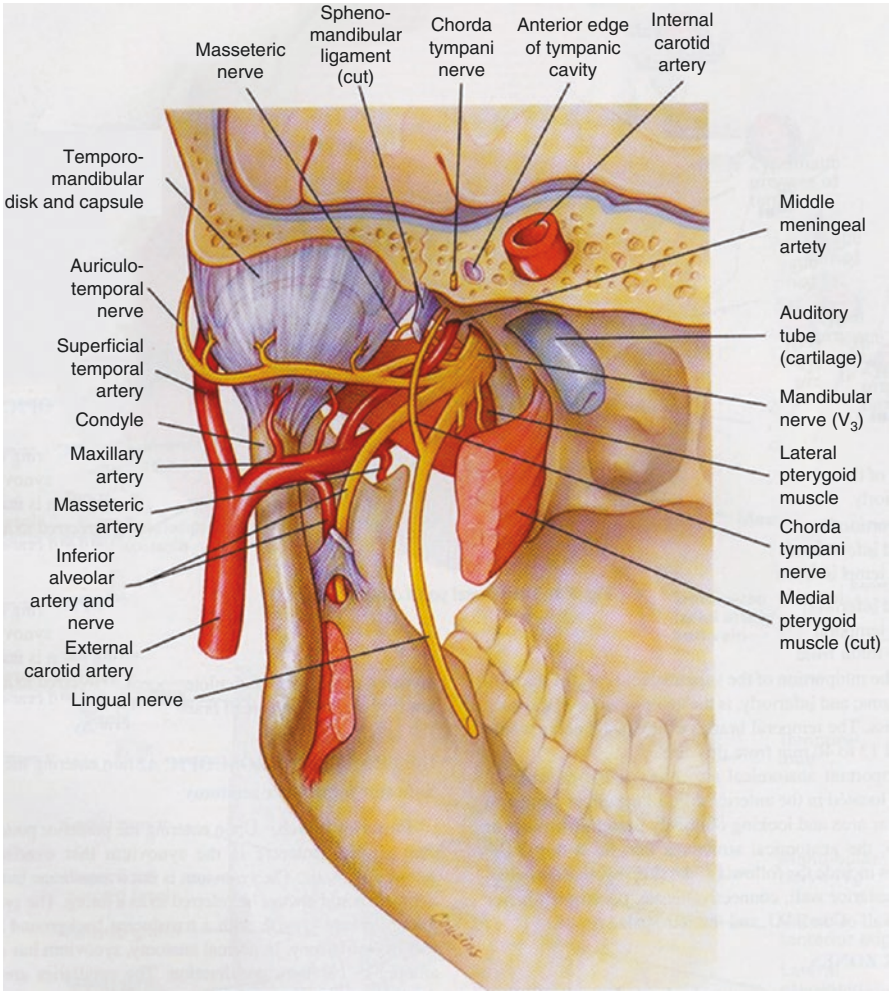


Fig. 3.7 Schematic view of the deep structures around the TMJ viewed from behind

3.8 Facial and Nerve and Its Surgical Importance in TMJ Surgery

The facial nerve lies deep to the condylar neck after emerging from the petrotympanic fissure. It divides into its five terminal branches, and the two most at risk during surgery to the TMJ are the frontal (temporal) and marginal mandibular branches, although injudicious retraction or too deep dissection may occasionally compromise the full nerve.

The frontal branch crosses the condylar neck within the SMAS layer and comes to lie superficial to the SMAS crossing the zygomatic arch between 8 and 28 mm anterior to the tragus[c]. Subperiosteal dissection from the root at the zygomatic arch carries this in the superficial tissues and helps to prevent traumatic neurotmesis.

The marginal mandibular branch passes through the parotid gland dividing it into superficial and deep lobes with the zygomatic, buccal and cervical branches [5, 6]. Transparotid dissection usually encounters this nerve lying on or near to the masseteric epimysium, and it can be retracted either superiorly or inferiorly to carry it out of the surgical wound.

3.9 Maxillary Artery and Its Surgical Importance

The course of the maxillary artery is relevant to surgical approaches which involve dissection deep to the head of the condyle as in joint replacement and discectomy. In particular the artery may be encountered passing through an ankylotic mass, the middle meningeal vessels lies just deep to the medial discal attachment and the masseteric vessels traverse the sigmoid notch.

3.10 Common TMJ Problems

3.10.1 Conservative Management

The temporomandibular joint is a load-bearing joint associated with teeth/dentures. The use of orthopaedic principles used in the management of other injured joints is therefore similarly applicable.

The mainstay of conservative management is rest, occlusal splints (offload the joint) and systemic or topical NSAIDS. Ice can help with pain, but compression and elevation are not possible (RICE). These statements are supported by Cochrane and other meta-analysis of the existing data.

Meta-analysis: Topical vs. systemic NSAIDs [8, 9]

- Splints [10]
- Occlusal modification [11]and later studies of Axelsson [12].

Seventy percent of secondary care patients in the UK can be effectively managed conservatively. Differentiating myofascial pain from joint problems is important, and local anaesthetic injections into trigger points can aid in diagnosing myofascial pain. This can subsequently be managed using either muscle relaxant medication or botulinum injections [13].

Subsequent management of joint-related pain (the diagnosis of which can be confirmed with intra-articular local analgesic injection) initially in the uncomplicated joint can be considered with either arthrocentesis or arthroscopy. This should be omitted in patients with ankylosis (the joint cannot be accessed) or joint collapse with occlusal derangement (condylar resorption) unless the primary aim is purely pain relief. These cases should be considered for joint reconstruction with alloplastic joint replacement.

1. Arthrocentesis [13, 14]
   (a) Indications [23, 24]
   - Acute closed lock (acute severe restriction of opening or "anchored disc phenomenon")
   - Inflammatory and degenerative conditions giving rise to joint pain

   (b) Technique
   - The authors advocate a two-needle technique with step-down from the zygomatic arch to avoid penetration of the floor of the fossa [14].

2. Arthroscopy
   (a) Indications
   - Clinical and/or radiological evidence of degenerative disease.
   - To rule out disc pathology.
   - Therapeutic management of joint pain, restriction and locking.
   - Arthroscopy gives a better diagnostic accuracy than MRI and arthrocentesis with the added benefit of therapeutic improvement over MRI alone.

   (b) Technique
   - Scope diameter varies from 1.2 to 2.1 mm.
   - Zero-degree need for direct access further anteriorly than 30-degree and hence failure to access the anterior recess is common.
   - Similarly a step-down technique is favoured to reduce the risk of penetration of the fossa floor into the middle cranial fossa.
   - A second portal is required either as a needle outlet for the fluid or for arthroscopic surgery where this is indicated. This requires significant arthroscopic skills to master.

3.11 Acute Severe Restricted Opening (Acute Closed Lock): Diagnosis/Management

Acute severe restriction of opening more commonly occurs in adolescents and young adults with an equal sex predilection, which should be treated early [15]. This condition presents as painful and limited mouth opening less than 26 mm. This is a result of reversible restriction of gliding motion of the joint due to disc adherence to the fossa in the upper joint space. Conservative measures and arthrocentesis with or without manual unlocking is effective in managing over two third of the cases. The remaining one third may progress to chronic features with partial improvement [10, 15]. The "stuck disc" is released as a result of lavage in arthrocentesis is effective in releasing 90% of anchored disc phenomenon cases in the studies of Nitzan and others. 2/3 is a VERY conservative estimate [16–18]. The use of intracapsular medications such as steroids and hyaluronic acid has not been found to be effective in a randomized study [19] although some case series with repeated injections and anecdotal evidence have occasionally shown benefit. Above 70% success rate has been reported in large studies after arthrocentesis [11] with similar outcomes following arthroscopy [14, 20] (Figs. 3.8, 3.9, 3.10, 3.11, 3.12, and 3.13).

Open approach

- Expose joint
- Capsule divided
  - Disc
  - Joint space(s)
- Repair at end
- capsule
- temporalis fascia

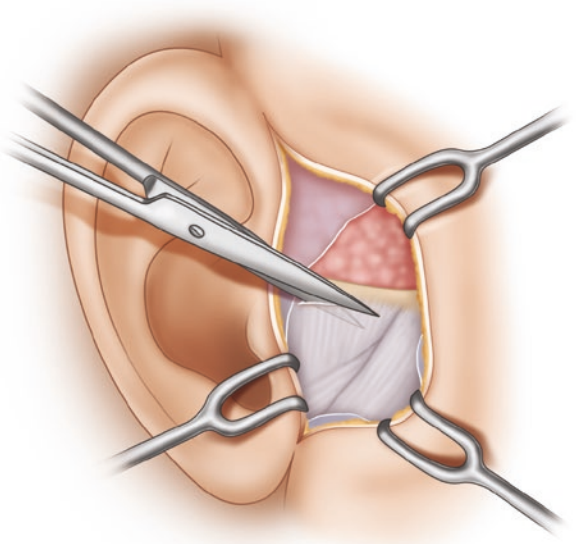


Fig. 3.8 Summary of technique for open TMJ surgery showing division of the superficial temporal fascia with exposure of the arch and eminence and subsequent opening of the capsule. These layers should be repaired on closure

RELATIONS

Laterally –

Skin and fascia
Parotid gland
Temporal branches of facial nerve

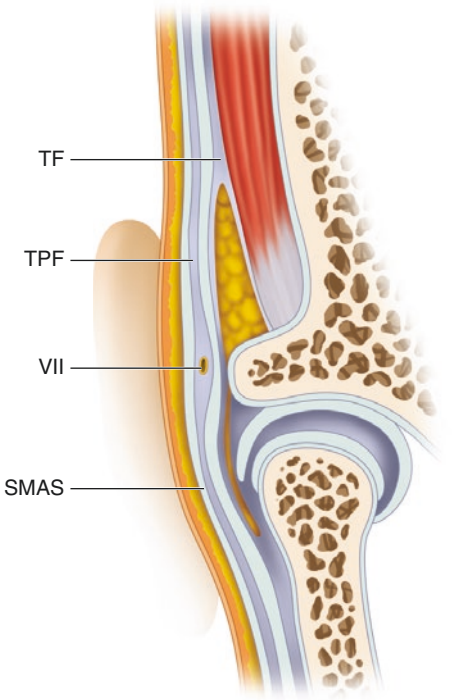


Fig. 3.9 Superficial relations of the TMJ. *TF* temporalis fascia; *TPF* superficial layer of temporalis fascia; *VII* temporal branch of facial nerve; *SMAS* superficial musculoaponeurotic system

Open approach

- Critical anatomy
  - "Splitting of outer layer of superficial temporalis fascia"
  - Incise fascia
  - Raise ABOVE thin fat layer
  - Turn forward and down
  - VII Temporal protected

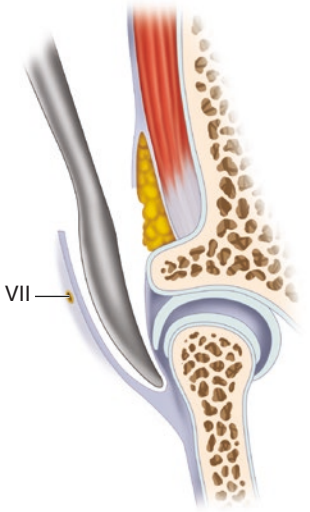


Fig. 3.10 Preservation of the temporal branch of facial nerve is acheived by dividing the temporalis fascia from the base of the zygomatic arch and extending this incision 45 degree superoanteriorly then carrying out subperiosteal exposure of the arch

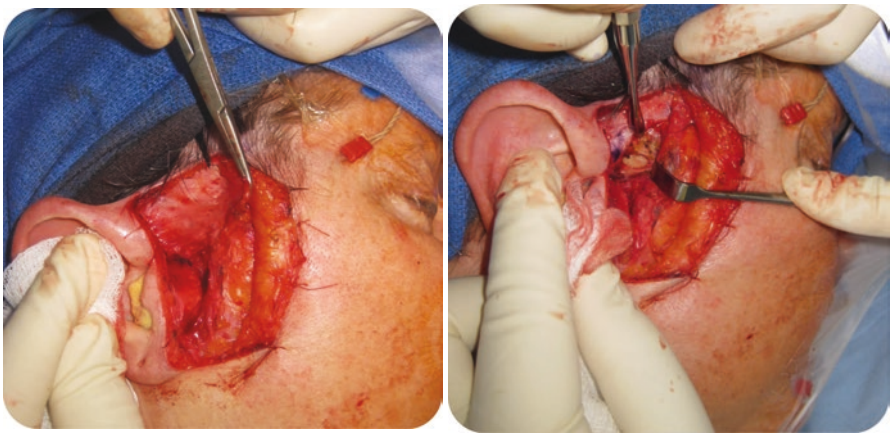


Fig. 3.11 Division of the temporalis fascia from the base of the arch as above with subperiosteal exposure of the zygomatic arch

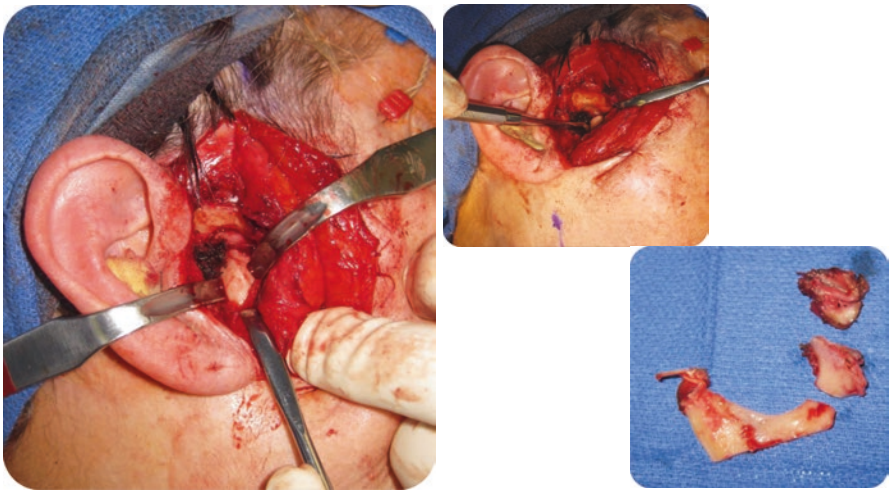


Fig. 3.12 Capsule opened and exposure of the condylar neck

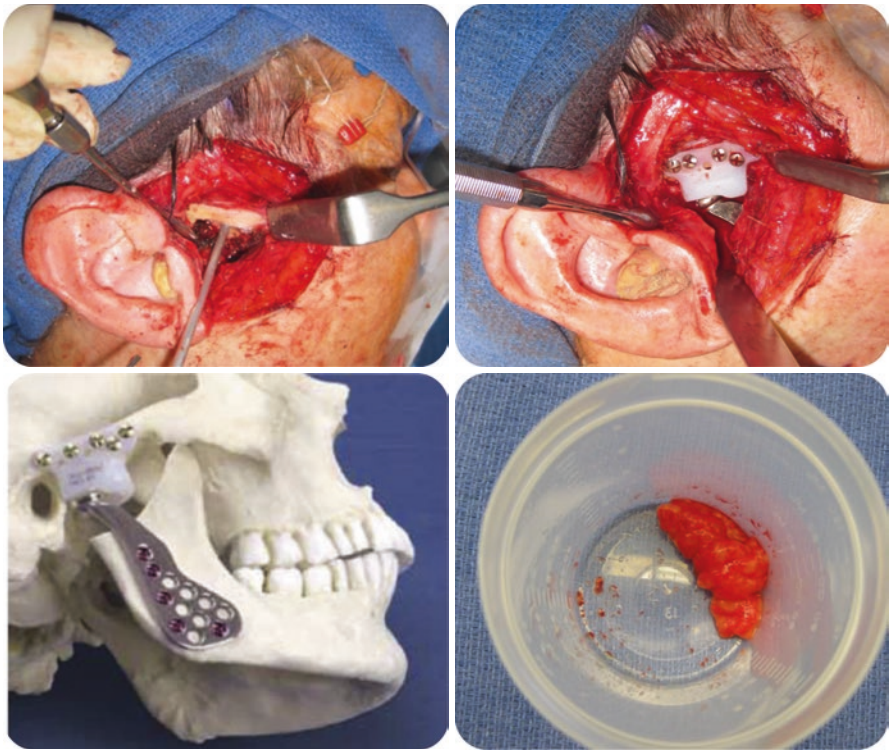
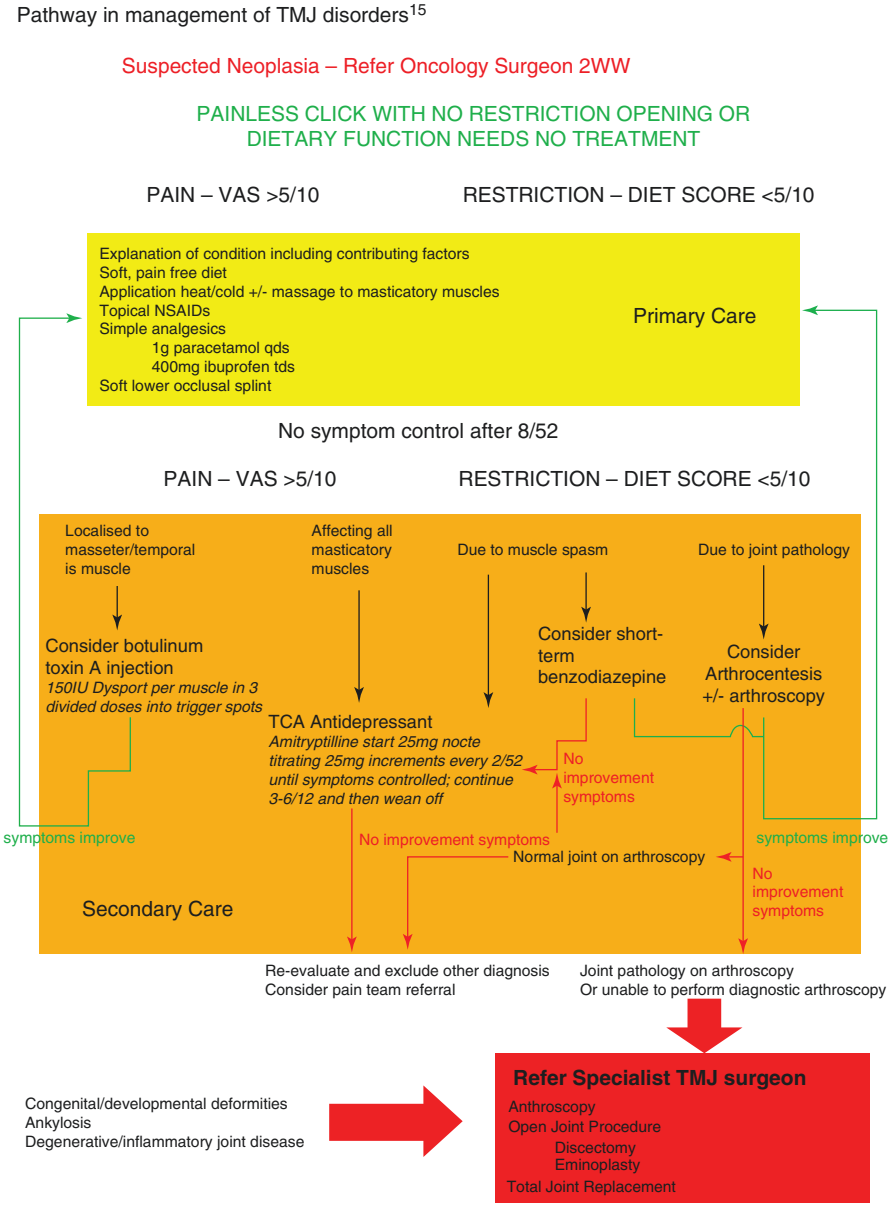


Fig. 3.13 Fossa and eminence are trimmed to accommodate stock Biomet polyethylene fossa which is then fixed with at least 3 screws. A fat graft may be packed around the articulation, particularly in cases where ankylosis is the indication for alloplastic replacement

3.12 Pathway in Management of TMJ Disorders [21, 25]

Pathway in management of TMJ disorders[15]



3.13 Surgical Management

Open surgery of the joint should only be considered where arthroscopy has failed and there was clinical evidence of pathology at arthroscopy.

Open joint procedures (for discectomy/repair or repositioning, condylar shave, condylectomy and eminoplasty) (see clinical photographs of this approach)

The authors do not believe that eminectomy can truly be performed as the eminence extends significantly medially along the skull base, and therefore the term eminoplasty is more appropriate.

- Preauricular approach to joint is common although endaural and postauricular incision has been described in the literature.
- Preauricular region is prepared with appropriate antiseptic cleaning agents and draped with provisions to manipulate the mandible (urology drape). The ear canal should also be prepared, and if the mouth is to be accessed at any stage, then a preoperative chlorhexidine mouth rinse should be employed.
- Incision is marked with or without temporal extension (Al-Kayat/Bramley [22]).
- Local anaesthetic infiltration.
- The temporalis fascia is identified higher up along the incision and then the plane of the fascia is defined. The skin incision is then deepened in the relatively avascular plane immediately adjacent to the tragal cartilage until the base of the zygomatic arch is located.
- The temporalis fascia is incised carefully at the base of the arch keeping in mind the anatomy of the temporal branch of the facial nerve, and this incision is then continued through the temporalis fascia in a line 45° anterosuperiorly (see diagrams above).
- The root of the zygomatic arch is identified, and periosteum is swept anteriorly along the arch till adequate exposure of the capsule anteriorly (to the front of the eminence) and inferiorly to develop the plane superficial to the capsule (this can usually be achieved in previously unoperated joints by blunt dissection but may need sharp dissection in previously operated cases). Using this plane sweeps the temporal branch above the plane of dissection and prevents incision. The capsule is then defined by blunt and sharp dissection in the same plane just below the arch.
- The capsule is incised vertically, and superior and inferior joint spaces are approached carefully not to cause any iatrogenic disc perforation by horizontal incision. The upper and lower joint spaces and disc are inspected.
- The disc is now mobile and can be inspected for any lateral perforation that can be trimmed and moved off the articulating surface. The disc can be repositioned laterally or posteriorly if the diagnosis reveals anterior displacement.
- If the disc is irreparably damaged, discectomy is performed. Starting posteriorly the disc is mobilized carefully diathermying the retro discal tissues to avoid bleeding and dissection carried out anteriorly (again using diathermy to remove the lateral pterygoid attachment) and medially.
- It is important not to leave any disc remnants, and good inspection is possible after downward displacement of the mandible.

- Consideration for autogenous interposition at this stage although the evidence suggests this is not necessary and causes an additional site for morbidity
- If the condylar surface is eroded or osteophytic, then smoothing of the surface can easily be performed through the lower end of the capsular incision.
- The Dunn-Dautrey's retractor is useful to insert posterior and anterior to the condylar neck to isolate the condyle.
- If the eminence is eroded, osteophytic, overlarge or overhanging laterally (lateral impingement), then it can be smoothed (eminoplasty).
- Combining the above steps, discectomy, high condylar shave and condylectomy and eminoplasty can be carried out to re-establish the joint equilibrium and permit functional healing. The joint is then copiously irrigated with isotonic saline.
- Closure with PDS to the capsule and temporalis fascia and superficial fascia with resorbable Vicryl, and then the skin is closed with monofilament. Drainage is not usually necessary if adequate haemostasis has been maintained throughout.

3.14 TMJ Replacement

Total TMJ replacement has evolved considerably in the recent past and there is a choice of stock and custom-made prosthesis.

Indications for TMJ prosthesis [18, 26] are:

Prerequisite: Failed conservative management (including arthroscopy if possible)

Diagnosis: Computed tomogram or MRI as a minimum (not just plain radiograph)

Diseases involving condylar bone loss:

- Degenerative joint disease (OA)
- Inflammatory joint disease (e.g. rheumatoid arthritis, ankylosing spondylitis, psoriatic)
- Ankylosis
- Post-traumatic condylar loss or damage
- Postoperative condylar loss (including neoplastic ablation)
- Previous prosthetic reconstruction
- Previous costochondral graft
- Serious congenital deformity
- Multiple previous procedures

Indications (usually a combination of the following):

- Dietary score of <5/10 (liquid scores, 0; full diet scores, 10)
- Restricted mouth opening (<35 mm)
- Occlusal collapse (anterior open bite or retrusion of mandible)
- Excessive condylar resorption and loss of height of vertical ramus
- Pain score >5 out of 10 on VAS (combined with any of the others)
- Other QOL issues

Contraindications:

- Local infective process
- Severe immunocompromise
- Severe coexistent diseases (ASA III)

Surgical indications for hemiarthroplasty (fossa-eminence prosthesis):

This procedure has been abandoned in the UK as many patients subsequently develop degenerative disease of the condylar head.

Indications:

- Painful or dysfunctional internal derangement after failed conservative and surgical treatment and a healthy condyle on computed tomogram or MRI
- Associated QOL issues as with TPR

Contraindications:

- Disruption of the condylar surface
- AVN
- Presence of osteophytes

Surgical technique:

- Preparation of the site includes pre-operative oral rinsing with chlorhexidine, ear canal preparation and adequate hair removal with surgical clippers to avoid hair in the wounds.
- The oral and skin sites should be strictly separated to reduce the risk of cross-contamination and infection.
- Placement of arch bars or IMF screws to aid intraoperative occlusion.
- Preauricular with temporal extension and retromandibular approach.
- Antibiotic prophylaxis and antiseptic preparation of the incision areas.
- Joint exposure similar to open approach as described above.
- Fossa is cleared of disc, debris and periosteum.
- Condylectomy is carried out via a preauricular approach to start with to aid in fossa component try-in. The remaining part of condylar neck and ramus is resected as per the surgical plan executed via the retromandibular approach or by pushing the condylar neck into the wound and carrying out second-stage resection.
- Retromandibular incision (see clinical photographs of the approach) through to the platysma, and blunt dissection to the lower border/angle of the mandible is done.
- The marginal mandibular nerve is often found lying on the masseteric epimysium and should be mobilized gently and retracted out of the wound superiorly or inferiorly.
- Release of the pterygo-masseteric sling along the lower border and lower ascending ramus facilitates superior dissection.

- Masseter muscle is then gently stripped subperiosteally, and the ramus is exposed on the lateral part to aid in further resection and condylar prosthesis try-in.
- The sigmoid notch can be the site of placement of the Dunn-Dautrey retractor which facilitates the view of the condylar neck for second-stage ostectomy, and a similar retractor can be placed over the anterior portion of the coronoid to facilitate coronoidectomy if required.
- The prosthetic components are soaked in antibiotic-containing and the wound sites are irrigated with antibiotic containing solution.
- The fossa prosthesis is fixed as per the surgical plan using at least three screws.
- Ensure adequate freedom of movement of the mandible below the fossa prosthesis.
- The ramus prosthesis is then tried in (or the trial prosthesis if this is used).
- Once try-in is satisfactory, the patient is placed in an intermaxillary fixation ensuring no cross-contamination from the mouth to the skin wounds. This will achieve the desired occlusion that may be different to the pre-operative occlusion. If both side joints are being replaced, then the second side resection should be completed prior to achieving the final occlusal position.
- It is important to re-scrub at this point to keep the surgical field aseptic.
- The condylar component is now fixed via the retromandibular approach with the screws supplied ensuring adequate positioning in the fossa. The most important screws are the most proximal screws to maintain biomechanical stability. At least six screws should be used paying attention to avoid the position of the inferior alveolar canal in stock cases.
- IMF is released and occlusion checked by the assistant keeping the surgical field aseptic.
- Check for dislocation of the prosthesis, and if this occurs, 1 week of LIGHT elastic intermaxillary fixation will prevent this in the post-operative period.
- The authors suggest placing only 3 screw initially prior to releasing the IMF to check the occlusion and articulation of the prosthesis. If this needs to be repositioned then there are less screw holes causing issues.
- Antibiotic containing solution is washed over the surfaces of the prosthesis. Placement of an abdominal fat graft is optional but is considered desirable in ankylosis and revision surgery cases.
- A drain is inserted through the superior wound into the inferior wound and should be removed at 24 h to reduce the risk of infection.
- Closure is in layers after drain is inserted.
- Mouth-opening exercises should be started following surgery.

3.15 Conclusion

The temporomandibular joint is a complex joint which should be managed using a team-based approach aimed at determining whether the main issues relate to the joint or muscles. Operative intervention should be reserved for specific indications and preferably following a stepwise approach involving conservative management

followed by minimally invasive arthrocentesis or arthroscopy. Long-term prospective clinical trials with appropriate study designs will help determine the best treatment options for a specific pathology.

References

1. Laskin DM, Greene CS, Hylander WL, editors. Temporomandibular disorders: an evidence-based approach to diagnosis and treatment. Berlin: Quintessence Publishing Company; 2006.
2. Kurtoglu C, Gur OH, Kurkcu M, Sertdemir Y, Guler-Uysal F, Uysal H. Effect of botulinum toxin-A in myofascial pain patients with or without functional disc displacement. J Oral Maxillofac Surg. 2008;66(8):1644–51.
3. Ohnishi M. Arthroscopy and arthroscopic surgery of the temporomandibular joint (TMJ). Rev Stomatol Chir Maxillofac. 1990;91(2):143–50.
4. Ahmed N, Matthews NS, Poate T, Nacher C, Pugh N, Cowgill H. The TMJ MDT clinic—the King's experience. Br J Oral Maxillofac Surg. 2012;50:S17–8.
5. Standring S, editor. Gray's anatomy e-book: the anatomical basis of clinical practice. Amsterdam: Elsevier; 2015.
6. Gray RJ. A clinical approach to temporomandibular disorders. 1. Classification and functional anatomy. Br Dent J. 1994;176:429–35.
7. Salha R, Shah J, Sidebottom AJ. Sphenomandibular ligament calcification causing progressive restriction of mouth opening: case report and literature review. Oral Surg. 2014;7(3):184–6.
8. Sidebottom AJ, Carey EC, Madahar AK. Cryoanalgesia in the management of intractable pain in the temporomandibular joint: a five-year retrospective review. Br J Oral Maxillofac Surg. 2011;49(8):653–6.
9. Weinberg S, Kryshtalskyj B. Facial nerve function following temporomandibular joint surgery using the preauricular approach. J Oral Maxillofac Surg. 1992;50(10):1048–51.
10. Al-Ani MZ, Davies SJ, Gray RJ, Sloan P, Glenny AM. Stabilisation splint therapy for temporomandibular pain dysfunction syndrome. Cochrane Database Syst Rev. 2004;1(1):CD002778.
11. Koh H, Robinson PG. Occlusal adjustment for treating and preventing temporomandibular joint disorders. Cochrane Database Syst Rev. 2003;1(1):CD003812.
12. Holmlund A, Gynther G, Axelsson S. Efficacy of arthroscopic lysis and lavage in patients with chronic locking of the temporomandibular joint. Int J Oral Maxillofac Surg. 1994;23(5):262–5.
13. Sidebottom AJ, Patel AA, Amin J. Botulinum injection for the management of myofascial pain in the masticatory muscles. A prospective outcome study. Br J Oral Maxillofac Surg. 2013;51(3):199–205.
14. Ahmed N, Sidebottom A, O'Connor M, Kerr HL. Prospective outcome assessment of the therapeutic benefits of arthroscopy and arthrocentesis of the temporomandibular joint. Br J Oral Maxillofac Surg. 2012;50(8):745–8.
15. Vos LM, Slater JH, Stegenga B. Arthrocentesis as initial treatment for temporomandibular joint arthropathy: a randomized controlled trial. J Craniomaxillofac Surg. 2014;42(5):e134–9.
16. Nitzan DW, Marmary Y. The "anchored disc phenomenon": a proposed etiology for sudden-onset, severe, and persistent closed lock of the temporomandibular joint. J Oral Maxillofac Surg. 1997;55(8):797–802.
17. Nitzan DW, Samson B, Better H. Long-term outcome of arthrocentesis for sudden-onset, persistent, severe closed lock of the temporomandibular joint. J Oral Maxillofac Surg. 1997;55(2):151–7.
18. Nitzan DW, Dolwick MF, Martinez GA. Temporomandibular joint arthrocentesis: a simplified treatment for severe, limited mouth opening. J Oral Maxillofac Surg. 1991;49(11):1163–7.

19. Bouloux GF, Chou J, Krishnan D, Aghaloo T, Kahenasa N, Smith JA, Giannakopoulos H. Is hyaluronic acid or corticosteroid superior to lactated ringer solution in the short-term reduction of temporomandibular joint pain after arthrocentesis? Part 1. J Oral Maxillofac Surg. 2017;75(1):52–62.
20. Weedon S, Ahmed N, Sidebottom AJ. Prospective assessment of outcomes following disposable arthroscopy of the temporomandibular joint. Br J Oral Maxillofac Surg. 2013;51(7):625–9.
21. Dimitroulis G, Dolwick MF, Martinez A. Temporomandibular joint arthrocentesis and lavage for the treatment of closed lock: a follow-up study. Br J Oral Maxillofac Surg. 1995;33(1):23–7.
22. Al-Kayat A, Bramley P. A modified pre-auricular approach to the temporomandibular joint and malar arch. Br J Oral Surg. 1979;17(2):91–103.
23. Al-Belasy FA, Dolwick MF. Arthrocentesis for the treatment of temporomandibular joint closed lock: a review article. Int J Oral Maxillofac Surg. 2007;36(9):773–82.
24. Hosaka H, Murakami K, Goto K, Iizuka T. Outcome of arthrocentesis for temporomandibular joint with closed lock at 3 years follow-up. Oral Surg Oral Med Oral Pathol Oral Radiol. 1996;82(5):501–4.
25. Rajapakse S, Ahmed N, Sidebottom AJ. Current thinking about the management of dysfunction of the temporomandibular joint: a review. Br J Oral Maxillofac Surg. 2017;55(4):351–6.
26. Sidebottom AJ. Guidelines for the replacement of temporomandibular joints in the United Kingdom. Br J Oral Maxillofac Surg. 2008;46(2):146–7.

Further Reading

Dimitroulis G. Fortnightly review: temporomandibular disorders: a clinical update. Br Med J. 1998;317(7152):190.
Shorey CW, Campbell JH. Dislocation of the temporomandibular joint. Oral Surg Oral Med Oral Pathol Oral Radiol Endodontol. 2000;89(6):662–8.