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TMJ Internal Derangement. Part 2: Surgical Management. A Narrative Review

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Abstract

Surgical treatment of TMJ derangement is controversial and confusing due to the wide range of pathologic changes associated with the term TMJ internal derangement (as discussed in part 1, non-surgical treatment). The most important question is, when to shift from the non-surgical to surgical interventions to prevent the disease progression?

The failure of non-surgical treatment doesn't give a green light for surgical treatment rather than gives red light on the possible undiagnosed cause of TMJ internal derangement that required re-evaluation and treatment.

The concept of system failure with functional rehabilitation as a primary goal of treatment should be considered while dealing with TMJ internal derangement patients.

Arthrocentesis and arthroscopy can achieve predictable results and can be successfully associated with non-surgical treatment modalities such as splint.

Open joint surgery as a first line of treatment should be limited to TMJ ankylosis, joint tumor, growth abnormalities and absolute indication for ORIF of condylar fracture.

Keywords: Surgical treatment; TMJ arthroscopy; Diskectomy; Ankylosis; Total joint replacement

Introduction

Assessment of the surgical outcome of TMJ internal derangement mainly focused on the improvement of the joint pain and function with increase of the mouth opening. This is given a support for the rationale of non-surgical treatment in terms of, if we can improve the joint pain, function and mouth opening through the non-surgical treatment so there is no indication for the surgical treatment modalities. The main goal of treatment of TMJ internal derangement painless functional rehabilitation, enhancement of adaptation and cessation of disease progression.

The indication for TMJ surgery can be classified into absolute and relative indication. The absolute indications include TMJ ankylosis, joint tumor, growth abnormalities and absolute indication for ORIF of condylar fracture. While the relative indications include failure of conservative treatment, joint adhesion, advanced degenerative joint diseases, chondrocalcinosis, synovitis, and synovial chondromatosis. The open joint surgery is limited to the first group of indication (absolute indication) while the minimally invasive TMJ surgeries are limited to the relative indications.

Table 1 represent the different surgical treatment modalities for treatment of TMJID.

TMJ Arthroscopy

Prior to the era of arthroscopy, the patients with TMJ internal derangement who were fulfilment the criteria of surgical intervention underwent a variety of surgical procedures. The outcome of the surgical procedures was unacceptable due to the sequelae of these procedures frequently lead to disease progression in the operated joint such as joint ankylosis & total joint replacement. The complications associated with the open joint surgery motivated the authors to search for less invasive procedures.

The introduction of TMJ surgical arthroscopy in 1980 by Ohnishi in Japan allowed arthrocentesis with direct visualization of the joint and additional options for advanced procedures using an additional port. With time, TMJ arthroscopy was considered as the first minimally invasive surgical treatment modality for treatment of the TMJ internal derangement [1,2].

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In 1982, Murakami and Hoshino developed the nomenclature of TMJ arthroscopic anatomy [3]. Since been introduced by McCain [4,5], many modifications and new arthroscopy techniques have been proposed by Sanders [6], Holmlund and Hellsing [7], Nitzan et al. [8], Koslin [9] and others, with the overall goal of establishing a safe and accurate diagnosis, effectively reducing pain and joint pathologies, and providing a favorable joint environment for ideal function restoration [1].

The American Association of Oral and Maxillofacial Surgeons (AAOMS) established the following main indications for arthroscopy of the TMJ: Internal derangement of TMJ, mainly Wilkes stages II, III, and IV; degenerative joint disease (osteoarthritis, OA); synovitis; painful hypermobility; hypomobility caused by intra-articular adherences; inflammatory arthropathies (systemic arthritis); and articular symptoms subsidiary to orthognathic surgery [11-13].

The arthroscopy technique is contraindicated in cases of severe fibrous or osseous ankylosis presence of tumor or metastasis in the TMJ and skin infection over the puncture [14].

Even though the MRI represent the gold standard for diagnosis of TMJ internal derangement, the TMJ orthoscopy has superior diagnostic ability in some of the TMJ pathologic changes associated with the internal derangement such as, joint adhesion, fibrillation, disk perforation and disk tear [15,16].

Postoperative complications include risk of damage to the VII cranial nerve, damage to the VIII cranial nerve, perforation of the glenoid fossa, risk of damage to the auriculotemporal nerve, scuffing of fibrocartilage, damage to vessels and hemarthrosis [17,18].

Table 2 represent the parameter, main indication, skill required, duration of operation, number of punctures, number of working cannulas, risk for facial nerve injury, effectiveness is pain relief, effectiveness is mouth opening improvement, advantage, disadvantage, and level of arthroscopy with different types of TMJ arthroscopy.

Arthrocentesis

Arthrocentesis procedure falling between the non-surgical and surgical treatment modalities. The term of "arthrocentesis" is derived from Greek, *i.e.*, "arthros" means joint and "kenesis" means irrigation. Murakami et al. in 1987 reported the recapturing the persistent anterior displaced disk by mandibular manipulation after pumping and hydraulic pressure to the upper joint cavity of the temporomandibular joint [19].

The success reported with arthroscopic management of internal derangements ultimately led to the introduction of arthrocentesis by Nitzen et al. in 1991 using two needles introduced into the upper joint space [8].

With increase the popularity, arthrocentesis of the TMJ is considered by many authors as the first-line surgical treatment for patients who do not respond to conservative treatment.

The indications of arthrocentesis are acute or chronic pain with limited range of motion due to disk displacement (with or without reduction). Nitzan et al. reported long-term success on 39 out of 40 patients who presented with acute closed lock and were treated with arthrocentesis [20].

Arthrocentesis should be considered as first-line therapy after failure of the nonsurgical treatment and the procedure is contraindicated in cases of fibrous or bony ankylosis. The procedure can be repeated without complication and better outcomes results can be obtained by using arthrocentesis with splint therapy. Although frequently used to relieve pain and increase mouth opening in patients with internal derangement and inflammation of the TMJ, lavage treatment is associated with a 13.3% failure rate [21,22].

Ringer lactate solution or physiologic saline is used to remove all catabolites from the joint, with volume ranged from 40 ml to 400 ml (average 200 ml) under adequate pressure (around 150 mmHg) to free the joint adhesion. While some authors found that this minimum fluid volume is 109 ml [23,24].

Technical Advice

When first needle tip enters the upper joint compartment, Lactated Ringers solution is injected to do joint distension of the joint capsule which facilitates the entry of the second needle. Rebound of the syringe plunger as the fluid fills the upper joint compartment confirm the proper position of the needle within the upper joint space. In cases of anchored disc phenomenon/joint adhesion, it's better to start the procedure of arthrocentesis with joint injection of 2 ml of HA in every joint to achieve a joint distension which helped in release of the stuck disk. This is followed by mandibular manipulation to release the joint adhesion and ensure better mandibular movements.

The study conducted by Hegab et al. demonstrated that intra-articular injection of a combination of PRP+HA was superior to intra-articular injection of HA or PRP independently in terms of increasing the MVMO, decreasing the VAS, and improving the joint sound. This study showed that HA had short-term clinical efficacy in the treatment of TMJ-OA; however, its 12-month postoperative efficacy decreased when compared to that of PRP or the combination of PRP+HA. Twelve months after injection, PRP combined with HA remained significantly effective clinically with clear advantage over independent use of PRP. The MRI of the cases included in the study shows significant reparative remodeling of the condylar head and articular disk with improvement in the joint space [25].

Open Joint Surgery

The most important question is, when to shift from the non-surgical to surgical interventions to manage and prevent the disease progression?

General therapeutic goals for TMJ open surgery are improve function and form, limited period of disability, improved range of jaw motion, and improved quality of life. Based on these goals, the open joint surgery represents the last in the line of treatment modalities of the TMJ internal derangement. Functional rehabilitation can be obtained in the most of TMJ internal derangement patients with conservative or minimally invasive surgery and only few numbers of patient (up to 10% required open joint surgery). Besides, the need for open joint surgery has been decreased with the increase in the use of TMJ arthroscopy [26].

Disk Plication and Disc Repositioning (Discopexy)

An intact disc with adequate mobility for repositioning is a good candidate for this technique. Discopexy can be performed arthroscopically or by open surgery, and in both cases good clinical outcomes have been reported for this technique, although arthroscopy

offers less morbidity.

Regarding open surgery and discopexy, several authors have reported a high clinical success rate over 80% (80-94%) and stable results at long-term follow-up [27].

Subsequent studies have reported variations in disc repositioning technique, with success rates ranging from 82% to 94%, as determined over follow-up periods of 11 months to 8 years [27].

In 1887, Annandale was the first to perform the surgical disc plication to treat a displaced TMJ disc [28]. In 1979, McCarty and Farrar introduced a surgical technique for disc repositioning as a treatment option for TMJ ID with 94% success rate over a 6-year period [29]. Other studies have presented variations in the technique, with improved symptoms and different follow-up periods [27]. However, despite these reports, many surgeons have indicated that the reposed disc does not last long in its new position and the high success rate reported in the original study could not be achieved [30].

McCain and Hossameldin [1] were the first to describe the technique of arthroscopic disc fixation, placing titanium screws and, later, resorbable pins [31].

Recently, Sato and Tralli [32] analyzed the clinical outcome of a new arthroscopic discopexy technique using metal anchors. The follow-up period was 6 months, and they observed a significant improvement in MIO and decreased pain similar to previously cited studies.

Abdelrehem et al. [33] compared the clinical outcomes between arthroscopic and open discopexy. The authors then concluded that arthroscopy was more suitable for early Wilkes stages.

Mitek Anchor Technique

Mitek anchors were first developed for orthopedic surgery [34,35]. The Mitek mini anchor is a suitable size for TMJ disc stabilization, and successful utilization of the anchor for TMJ disc repositioning has been reported by Wolford et al. [36,37]. The anchor consists of a titanium alloy shaft with a 2-0 Ethibond® braided polyester suture threaded through its eyelet and wings. The composition and structure of the MITEK mini anchor are known to contribute significantly to the osseointegration of the anchors in the condyle, proper positioning of the TMJ disc, and long-term stability of the surgery [38,39].

The goal of corrective surgery for TMJ ID is to improve biomechanical function in terms of pain and function. However, long-term radiological and clinical assessments studies are required to confirm the validity of its effectiveness [40].

Discectomy

Discectomy is the surgical removal of the articular disc, and it was first described by Lanz in 1909 in two case reports [41] and later by Pringle in 1918 [42]. Currently, TMJ discectomy by itself or with a fat graft is the surgical choice of many practitioners for patients who have not responded to non-surgical treatments and where the disc is deformed and cannot be adequately repositioned [43].

From all the open surgery techniques, TMJ discectomy without interposal material is probably one of the most popular procedures [44]. Recently, Ângelo et al. [45] showed that bilateral discectomy, preserving condyle and temporal fibrocartilage can induce severe imaging and histopathologic TMJ changes in black Merino sheep. Besides, the degenerative changes in the condyle, functional masticatory changes were not observed [46]. In a different preclinical study, disc and fibrocartilage removal resulted in traumatic TMJ ankylosis [47].

The need for replacement of the removed disc is significantly argued and the importance of preservation of the disc has yet to be determined conclusively. However, various replacement options exist including autologous, allogeneic, and alloplastic disc replacement materials. These include autologous fat with or without dermis, temporalis fascia with or without muscle (myofascial) flaps, cartilage (autologous or allogeneic), bovine pericardium, and temporary silastic implants [48].

The use of interposition material (such as fat graft) can be used for reduction of pain and decrease the postoperative complication such as ankylosis. The interpositional fat graft tend to resorb within 2 to 3 weeks. While TMJ discectomy without replacement as the primary treatment for internal derangement after failure of nonsurgical therapy could be led to bony ankylosis.

Arthroplasty

Arthroplasty is a term that encompasses procedures that alter the shape of the cartilaginous and osseous articular surfaces of the temporomandibular joint. When performed as an isolated surgical procedure, arthroplasty may involve an eminectomy procedure and/or reshaping of the condyle, glenoid fossa, and articular eminence in order to increase joint space and allow spontaneous or assisted disc repositioning.

Eminectomy

Eminectomy, a procedure generally advocated for recurrent TMJ dislocation can be performed to correct closed lock. The rationale behind eminectomy is this that if the articular eminence is resected, the condylar head can move freely. The same logic can be applied in the treatment of closed lock. The disc which was dislocating anteromedially and irreducible because of the presence of articular eminence would become reducible by eliminating the obstruction (the eminence) in its path of return [49,50].

Contraindications includes cases with shallow articular eminence & radiological evidence of a pneumatized eminence (increased risk of infection as a result of communication between the joint space and the mastoid air cells).

Condylotomy (Vertical Oblique Osteotomy)

The origin of the condylotomy procedure for treating the painful TMJ with a reducing disc is not clear. Both Sir Terrence Ward (consultant oral surgeon) and William Campbell (consultant radiologist) were involved in the development of condylotomy at the Plastic Surgery and Jaw Injuries Centre at East Grinstead, Sussex, England. The first literature reference to condylotomy, however, attributes the idea to L.J. Brown [51].

Nickerson is credited with the introduction of a number of important technical modifications of the original closed condylotomy, and he renamed the changed operation the modified condylotomy [52].

The primary purpose of the procedure is to increase joint space by allowing the mandibular condyle to move inferiorly with respect to both the articular disc and eminence. This disc relationship can be achieved in many patients by allowing the condyle to move anteriorly

in addition to inferiorly.

The main advantages of the procedure over arthroplasty are the extra-articular approach that avoids entry into the temporomandibular joint, the short duration of the procedure. The use of modified condylotomy in patients with an existing anterior open bite or a class II malocclusion is not recommended because of the potential for worsening of the anterior open bite or class II dental relationship [53].

High Condylar Shave (Walker Repair)

The technique includes high condyloplasty (removal 2-4 mm of the superior surface) of the condylar head and disc repositioning over the trimmed condyle to provide space for the articular disc between the condyle and temporal fossa, give freedom of joint movement, eliminate pain by preventing compression of the bilaminar zone. This technique is a modification of high condylectomy. The technique can be used alone or with Meniscorhaphy. Osseous changes, occlusal discrepancies, short term results with disease progression are the main drawbacks of the technique [54].

Gap Arthroplasty

TMJ ankylosis can resulted as a sequel of TMJ open joint surgery specially discectomy and high condylar shave. Treatment of this condition is equally challenging and aims primarily at establishing function and aesthetics with adequate measures to prevent re-ankylosis. Among the different treatment modalities, interpositional gap arthroplasty followed by aggressive jaw physiotherapy is considered most popular technique.

To prevent re-ankylosis, two surgical protocols were proposed. The first was Kaban protocol consisted of 7 steps. The protocol is widely adapted protocol but having the risk of risk of re-ankylosis [55].

The second protocol is Hegab protocol consisting of 10 steps. The protocol based on the pathogenesis of ankylosis and re-ankylosis with no risk of re-ankylosis but with risk of developing open bite due to delayed TMJ reconstruction [56,57].

Alloplastic Reconstruction of the Temporomandibular Joint

The indications for total joint reconstruction include idiopathic condylar resorption, condylar hyperplasia, failed autogenous or alloplastic TMJ reconstruction, heterotopic bone and ankylosis, congenital anomalies or absence of the TMJ, tumors and failed previous multiple joint surgeries.

In alloplastic TMJ replacement, osseointegration of an implant fixation into the bone is needed for long-term stability and success. The condyle ramus component is fixated with screws into the lateral ramus of the mandible, while the fossa component is mounted with screws to the zygomatic process of the temporal bone [58].

With advancement of the technology, custom TMJ TJR devices became more popular. However, the custom TMJ TJR is supposed to be more costly than stock TJR with extra operating room time and more required equipment. Here are some recommendations for TMJ alloplastic replacement; the designed fossa should be inclined postero-anteriorly about 5 to 10 degrees to provide false translation movement which lead to subsequent increase the range of mouth opening. Disinfection of the operative site with clindamycin solution

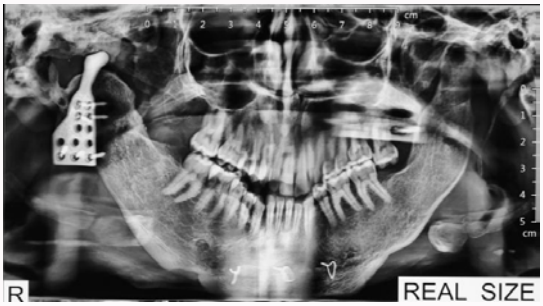

Figure 1: Preoperative panoramic image for failed unilateral stock TJR without glenoid fossa prosthesis. The patient underwent joint replacement for treatment of ankylosis and developed postoperative infection which resulted in loosing of the screws and displacement of the joint prosthesis with subsequent ankylosis to the articular eminence and re-ankylosis of the condylar stump posteriorly to the alloplastic joint. The patient had unoperated ankylosis of the left side which minimized the postoperative physiotherapy.

Figure 2: Preoperative PA image showing facial asymmetry with chin deviation.

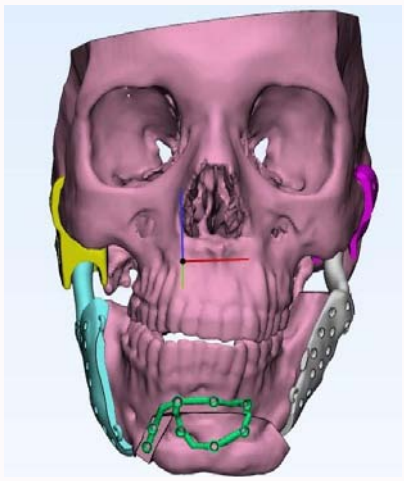

Figure 3: Computer guided 3D planning for the surgery.

to prevent infection and subsequent failure of the joint replacement. Isolate the operative field by covering the mouth by adhesive occlusive dressing. Use fat graft around the head of the alloplastic joint to prevent the dead space and possibility of infection, beside the fat graft decreases the risk of postoperative heterotopic bone formation [59-62]. As a prophylaxis, nonsteroidal anti-inflammatory drug, such as

Figure 4: Postoperative PA image showing bilateral total joint replacement with genioplasty and correction of facial asymmetry and chin deviation.

indomethacin has been recommended in divided doses that depended on perioperative weight for 2 weeks (*i.e.*, 1 week before surgery and another week after surgery) early mobilization might provoke reactionary bleeding and create a large hematoma that delays healing and increases the likelihood of wound breakdown, and heterotopic bone formation. The use of suction drain proposed by Hegab (2015), could be prevent the formation of the hematoma postoperatively and during first days of physiotherapy and mandibular mobilization [56].

The most common failure of the replacement is due to heterotopic bone formation. However, concern for infection, material hypersensitivity, device longevity and screws loosening issues still exists.

Figures 1 to 4 represent a case of failed alloplastic joint with re-ankylosis treated with bilateral total joint replacement and genioplasty.

Conclusion

The concept of system failure with functional rehabilitation as a primary goal of treatment should be considered while dealing with TMJ internal derangement patients. Arthrocentesis and arthroscopy can achieve predictable results and can be successfully associated with non-surgical treatment modalities such as splint. Open joint surgery as a first line of treatment should be limited to TMJ ankylosis, joint tumor, growth abnormalities and absolute indication for ORIF of condylar fracture.

References

1. McCain JP, Hossameldin RH. Advanced arthroscopy of the temporomandibular joint. Atlas Oral Maxillofac Surg Clin North Am. 2011;19(2):145-67.
2. Ohnishi M. Clinical application of arthroscopy in the temporomandibular joint diseases. Bull Tokyo Med Dent Univ. 1980;27(3):141-50.
3. Murakami K, Hoshino K. Regional anatomical nomenclature and arthroscopic terminology in human temporomandibular joints. Okajimas Folia Anat Jpn. 1982;58(4-6):745-60.
4. McCain J. Arthroscopy of the human temporomandibular joint. J Oral Maxillofac Surg. 1988;46(8):648-55.
5. McCain JP. Principles and practice of temporomandibular joint arthroscopy. St. Louis: Mosby; 1996.
6. Sanders B. Arthroscopic surgery of the temporomandibular joint: Treatment of internal derangement with persistent closed lock. Oral Surg Oral Med Oral Pathol. 1986;62(4):361-72.
7. Holmlund A, Hellsing G. Arthroscopy of the temporomandibular joint: an autopsy study. Int J Oral Maxillofac Surg. 1985;14(2):169-75.
8. 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.
9. Koslin MG, Martin JA. TMJ arthroscopic surgery. Clinical results in 79 cases. J Ala Dent Assoc. 1990;74(1):26-31.
10. González-García R, Gil-Díez Usandizaga JL, Rodríguez-Campo FJ. Arthroscopic anatomy and lysis and lavage of the temporomandibular joint. Atlas Oral Maxillofac Surg Clin North Am. 2011;19(2):131-44.
11. Barkin S, Weinberg S. Internal derangements of the temporomandibular joint: The role of arthroscopic surgery and arthrocentesis. J Can Dent Assoc. 2000;66(4):199-203.
12. American Association of Oral and Maxillofacial Surgeons. Position paper on TMJ arthroscopy 1988. In: Thomas M, Bronstein S, editors. Arthroscopy of the temporomandibular joint. Philadelphia: WB Saunders; 1991. p. 347-50.15.
13. Israel H. Arthroscopy of the temporomandibular joint. In: Peterson L, Indresano T, Marciani R, editors. Principles of oral and maxillofacial surgery. Philadelphia: JB Lippincott; 1992. p. 2015-40.
14. Yan YB, Liang SX, Shen J, Zhang JC, Zhang Y. Current concepts in the pathogenesis of traumatic temporomandibular joint ankylosis. Head Face Med. 2014;10:35.
15. Tzanidakis K, Sidebottom AJ. How accurate is arthroscopy of the temporomandibular joint? A comparison of findings in patients who had open operations after arthroscopic management failed. Br J Oral Maxillofac Surg. 2013;51(8):968-70.
16. Hegab AF, Hameed HIA, Karam KS. Classification of temporomandibular joint internal derangement based on magnetic resonance imaging and clinical findings of 435 patients contributing to a nonsurgical treatment protocol. Sci Rep. 2021;11(1):20917.
17. McCain JP, Kim K. Endoscopic oral and maxillofacial surgery. In: Bryan Bell R, Khan HA, editors. Current therapy in oral and maxillofacial surgery. 1st Ed. St. Louis: Elsevier; 2012.
18. González-García R, Gil-Díez Usandizaga JL, Rodríguez-Campo FJ. Arthroscopic anatomy and lysis and lavage of the temporomandibular joint. Atlas Oral Maxillofac Surg Clin North Am. 2011;19(2):131-44.
19. Murakami Kl, Iizuka T, Matsuki M, Ono T. Recapturing the persistent anterior displaced disk by mandibular manipulation after pumping and hydraulic pressure to the upper joint cavity of the temporomandibular joint. Cranio. 1987;5(1):17-24.
20. 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.
21. Kurita K, Goss AN, Ogi N, Toyama M. Correlation between preoperative mouth opening and surgical outcome after arthroscopic lysis and lavage in patients with disc displacement without reduction. J Oral Maxillofac Surg. 1998;56(12):1394-7.
22. Silva PA, Lopes MT, Freire FS. A prospective study of 138 arthroscopies of the temporomandibular joint. Braz J Otorhinolaryngol. 2015;81(4):352-7.
23. Zardeneta G, Milam SB, Schmitz JP. Elution of proteins by continuous temporomandibular joint arthrocentesis. J Oral Maxillofac Surg. 1997;55(7):709-16.
24. Zhu P, Lin H, Zhou Q, Lv J, Zhang Z, Xu Y. Dynamic evaluation of lavage efficacy in upper compartment of the temporomandibular joint. J Oral Maxillofac Surg. 2017;75(2):276-83.

25. Hegab AF, Hameed HIAA, Hassaneen AM, Hyder A. Synergistic effect of platelet rich plasma with hyaluronic acid injection following arthrocentesis to reduce pain and improve function in TMJ osteoarthritis. J Stomatol Oral Maxillofac Surg. 2023;124(1S):101340.

26. Randolph CS, Greene CS, Moretti R, Forbes D, Perry HT. Conservative management of temporomandibular disorders: A posttreatment comparison between patients from a university clinic and from private practice. Am J Orthod Dentofacial Orthop. 1990;98(1):77-82.

27. Renapurkar SK. Discectomy versus disc preservation for internal derangement of the temporomandibular joint. Oral Maxillofac Surg Clin North Am. 2018;30(3):329-33.

28. Annandale T. On displacement of the inter-articular cartilage of the lower jaw, and its treatment by operation. Lancet. 1887;129(3313):P411.

29. McCarty WL, Farrar WB. Surgery for internal derangements of the temporomandibular joint. J Prosthet Dent. 1979;42(2):191-6.

30. Anderson DM, Sinclair PM, McBride KM. A clinical evaluation of temporomandibular joint disk plication surgery. Am J Orthod Dentofacial Orthop. 1991;100(2):156-62.

31. Wouters DB, Burgerhof JG, de Hosson JT, Bos RR. Fixation of osteochondral fragments in the human knee using meniscus arrows. Knee Surg Sports Traumatol Arthrosc. 2011;19(2):183-8.

32. Sato LF, Tralli G. Arthroscopic discopexy technique with anchors for treatment of temporomandibular joint internal derangement: Clinical and magnetic resonance imaging evaluation. J Craniomaxillofac Surg. 2020;48(5):501-7.

33. Abdelrehem A, Hu YK, Yang C, Zheng JS, Shen P, Shen QC. Arthroscopic versus open disc repositioning in management of temporomandibular joint internal derangement. Int J Oral Maxillofac Surg. 2021;50(10):1351-60.

34. Pederson B, Tesoro D, Wertheimer SJ, Coraci M. Mitek anchor system: A new technique for tenodesis and ligamentous repair of the foot and ankle. J Foot Surg. 1991;30(1):48-51.

35. Obrist J, Genelin F, Neureiter H. Bankart operation with the Mitek anchor system. Unfallchirurgie. 1991;17(4):208-12.

36. Mehra P, Wolford LM. The Mitek mini anchor for TMJ disc repositioning: Surgical technique and results. Int J Oral Maxillofac Surg. 2001;30(6):497-503.

37. Wolford LM. Temporomandibular joint devices: Treatment factors and outcomes. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1997;83(1):143-9.

38. Fields RT Jr, Cardenas LE, Wolford LM. The pullout force for Mitek mini and micro suture anchor systems in human mandibular condyles. J Oral Maxillofac Surg. 1997;55(5):483-7.

39. Fields RT Jr, Wolford LM. The osseointegration of Mitek mini anchors in the mandibular condyle. J Oral Maxillofac Surg. 2001;59(12):1402-6.

40. McCain JP, Hossameldin RH, Srouji S, Maher A. Arthroscopic discopexy is effective in managing temporomandibular joint internal derangement in Wilkes stage II and III patients. J Oral Maxillofac Surg. 2015;73(3):391-401.

41. Lanz A. Discitis mandibularis. Zentralbl Chir. 1909;36:289-91.

42. Pringle JH. Displacement of the mandibular meniscus and its treatment. Br J Surg. 1918;6(23):385-9.

43. Rai S. Autogenous fat as an ideal interpositional material in temporomandibular joint surgery. J Maxillofac Oral Surg. 2021;20(4):527-33.

44. Eriksson L, Westesson PL. Long-term evaluation of meniscectomy of the temporomandibular joint. J Oral Maxillofac Surg. 1985;43(4):263-9.

45. Ângelo DF, Morouco P, Monje Gil F, Mónico L, González-Gárcia R, Sousa R, et al. Preclinical randomized controlled trial of bilateral discectomy versus bilateral discopexy in Black Merino sheep temporomandibular joint: TEMPOJIMS - Phase 1- histologic, imaging and body weight results. J Craniomaxillofac Surg. 2018;46(4):688-96.

46. Ângelo DF, Gil FM, González-García R, Mónico L, Sousa R, Neto L, et al. Effects of bilateral discectomy and bilateral discopexy on black Merino sheep rumination kinematics: TEMPOJIMS - phase 1 - pilot blinded, randomized preclinical study. J Craniomaxillofac Surg. 2018;46(2):346-55.

47. Wang HL, Liu H, Shen J, Zhang PP, Liang SX, Yan YB. Removal of the articular fibrous layers with discectomy leads to temporomandibular joint ankylosis. Oral Surg Oral Med Oral Pathol Oral Radiol. 2019;127(5):372-80.

48. Dimitroulis G. The use of dermis grafts after discectomy for internal derangement of the temporomandibular joint. J Oral Maxillofac Surg. 2005;63(2):173-8.

49. Chakraborty SK. Eminectomy for the management of closed lock of temporomandibular joint. Med J Armed Forces India. 2007;63(4):384-5.

50. Elmadawy A, Hegab A, Alahmady H, Shuman M. Clinical and electromyographic assessment of facial nerve function after temporomandibular joint surgery. Int J Oral Maxillofac Surg. 2015;44(10):1275-80.

51. Staz J. The treatment of disturbances of the temporomandibular articulation. J Dent Assoc S Afr. 1951;6:314.

52. Nickerson JW Jr, Veaco WS. Condylotomy in surgery of the temporomandibular joint. Oral Maxillofac Surg Clin of North Am. 1989;1:303.

53. Mohanty S, Vijayaragavan R, Sharma P, Chaudhary Z, Verma A, Rathaur A. Is modified Condylotomy a better surgical option compared with high-condylar shave with Eminectomy in improving symptoms of internal derangement of temporomandibular joint? J Oral Maxillofac Surg. 2022;80(7):1158-73.

54. Walker RV, Kalamchi S. A surgical technique for management of internal derangement of the temporomandibular joint. J Oral Maxillofac Surg. 1987;45(4):299-305.

55. Sharma R, Sinha R, Menon PS. Meniscopexy for internal derangement of temporomandibular joint. J Maxillofac Oral Surg. 2010;9(3):261-5.

56. Kaban LB, Bouchard C, Troulis MJ. A protocol for management of temporomandibular joint ankylosis in children. J Oral Maxillofac Surg. 2009;67(9):1966-78.

57. Hegab AF. Outcome of surgical protocol for treatment of temporomandibular joint ankylosis based on the pathogenesis of ankylosis and re-ankylosis. A prospective clinical study of 14 patients. J Oral Maxillofac Surg. 2015;73(12):2300-11.

58. Hegab A. Botulinum toxin as an adjunctive in treatment of TMJ ankylosis: Step no 10. J Dent Health Oral Disord Ther. 2016;4(6):154-5.

59. Hegab A. Botulinum toxin as an adjunctive in treatment of TMJ Ankylosis: Step No 10. J Dent Health Oral Disord Ther. 2016;4(6):154-155.

60. Sinno H, Tahiri Y, Gilardino M, Bobyn D. Engineering alloplastic temporomandibular joint replacements. Mcgill J Med. 2011;13(1):63.

61. Mercuri LG. Avoiding and managing temporomandibular joint total joint replacement surgical site infections. J Oral Maxillofac Surg. 2012;70(10):2280-9.

62. Mercuri LG. Alloplastic temporomandibular joint replacement—what does the future hold? Front Oral Maxillofac Med. 2020.