Temporomandibular Joint Disorders, Diseases, Deformities and their Surgical Management

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By

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CHAPTER 1

THE HISTORY OF TEMPOROMANDIBULAR JOINT SURGERY

DR J N KHANNA

The history of temporomandibular joint (TMJ) surgeries enriches our understanding of contemporary surgical principles. It is crucial to appreciate the accomplishments of our surgical predecessors in developing approaches to the TMJ, a joint that had not been well imaged, and ideas about its normal structure and function were largely speculative at the time.

The operation used to be performed on patients under anesthesia with an open cloth soaked in chloroform. Thomas Annandale is credited with the first published description of TMJ disc repair in 1887. He detailed two cases of TMJ dysfunction characterized by locking or painful clicking. By surgical disc repositioning, he correctly hypothesized that the issue stemmed from the interarticular cartilage of the TMJ being torn suddenly or stretched. Annandale opted for a minimally invasive approach involving a small incision rather than a more invasive method.

In 1895, the *Stimson Manual of Operative Surgery* described the excision of the condyle through a T-shaped incision. This incision involved a horizontal arm approximately 1 1/4 inches in length along the inferior aspect of the zygoma and a vertical arm measuring 1 inch in length. During the procedure, the parotid gland, nerves, and blood vessels were carefully retracted inferiorly to prevent injury.

The early TMJ surgeons in the United States, Great Britain, and Europe were pioneers who developed innovative approaches and procedures to enhance TMJ function. They were highly skilled anatomists and well-rounded surgeons who meticulously studied the relatively unknown pathologies of the TMJ and applied their knowledge creatively to solve patient issues. Drawing from their extensive experience in other surgical procedures and diseases related to the TMJ, they introduced novel and insightful approaches.

These surgeons were familiar with each other's work, often citing and referencing each other's contributions. They frequently referenced Thomas Annandale's seminal article from a quarter century earlier, which laid foundational knowledge about TMJ pathologies. They also drew insights from earlier cases of jaw dysfunction, even though these insights had limited applicability in surgical therapy at the time.

In 1914, John Murphy from Chicago published a detailed report on nine cases of TMJ ankylosis treated by arthroplasty. His surgical technique involved rotating an interpositional flap of temporalis fat and temporalis fascia. Murphy's incision was L-shaped, with the base along the superior aspect of the zygomatic arch and the vertical arm extending upwards 1 1/2 inches at the posterior end. He placed the horizontal incision above the zygomatic arch to avoid branches of the facial nerve, a critical consideration in his approach.

In 1918, Behan published a detailed and well-illustrated description of TMJ arthroplasty, utilizing a vertical preauricular approach. This approach aimed to provide optimal access to the TMJ for surgical intervention.

Around the same time, in Boston, John Blake noted the challenges associated with accessing the TMJ. The joint is deeply situated beneath the surface, surrounded by substantial arteries and nerves. Achieving a clear, dry surgical field is challenging, making precise work on the joint difficult.

In Philadelphia, Ashurst addressed Blake's concerns about accessing the TMJ by using an L-shaped incision. This approach involved making a horizontal incision along the zygomatic arch for 2 cm, then turning inferiorly from the posterior end for 3 cm to reach the TMJ.

In 1918, Behan described findings related to either anterior or posterior disc detachment in the TMJ and performed repairs to reposition the disc. During the same year, Pringle hypothesized that the lateral pterygoid muscle could displace the articular disc anteriorly and medially. He treated this condition with what he believed to be the first excision of the disc. In 1921, Ashurst successfully duplicated this operation on a 16-year-old female patient.

Interestingly, both Behan and Pringle were unaware that the Swiss surgeon Ottolanz, who was a professor of surgery in Amsterdam, had previously published articles on TMJ discectomy. Ottolanz performed discectomies on two young women, aged 18 and 24, in 1906 and 1908 respectively.

During this period, Lanz, who had earlier invented the mesh skin graft, reported his surgeries in the German-language journal *Zentralbatta fur Chirurgie* a decade earlier. Meanwhile, Ashurst revived a term first used

nearly a century earlier by Cooper. He labeled the internally deranged TMJ as the "snapping jaw," a term that persisted for several decades to vaguely describe the painful popping or snapping sensations, sometimes causing the jaw to become stuck open, closed, or in between intermittently.

Earlier, there was speculation that the TMJ could displace behind the mandibular condyle, akin to knee injuries where the capsular ligament laxity allowed subluxation.

Some confusion in historical accounts may arise from the inconsistent use of terminology. The modern understanding of anterior disc displacement and reduction is relatively recent, and earlier misunderstandings are understandable when considering the diverse treatments available today for chronic subluxation and dislocation of the TMJ.

In 1918, Blake used the wiring of the coronoid process to the zygomatic arch to limit mandibular opening as a treatment approach. In Germany in 1923, Nieden developed a new procedure aimed at restricting condylar movement. His technique involved elevating an inferior-based flap of the temporalis fascia, rotating it downward, and securing the free end to the lateral joint capsule to tighten it and restrict condylar movements.

Several years later, this surgery was recognized as being based on sound surgical principles for treating joint hypermobility, with the loose lateral capsule identified as a primary contributor for decades. Ankylosis of the TMJ was among the earliest surgically treated TMJ conditions. Throughout the nineteenth century, European surgeons treated TMJ ankylosis by performing osteotomies away from the site of ankylosis.

In the United States, Murphy reported on nine patients with TMJ ankylosis whom he treated in the years leading up to 1914. His paper serves as a stark reminder of the serious complications caused by infections in the pre-antibiotic era. Murphy's treatment approach involved releasing the ankylosis by removing bone in the condyle area. He then rotated a flap of fascia and fat from the temple into the gap and kept the patient's mouth propped open for two weeks using a wooden block.

In 1930, John Morris continued the theory that condylar laxity, leading to excessive movement of the condyle, was responsible for observed pain. He disagreed with the notion of posterior disc displacement as a likely cause, considering it anatomically improbable and thus unacceptable. Drawing on Pringle's work, Morris suggested that anterior disc displacement could lead to secondary joint laxity, resulting in symptoms.

Morris summarized the available contemporary treatments for the "snapping jaw" and argued persuasively that joint surgery provided the most effective solution to address these issues. His contributions further advanced understanding and treatment options for TMJ disorders during that era.

In 1936, James Coston, an otolaryngologist from Washington University, conducted a comprehensive study involving a large group of patients who presented with a variety of symptoms such as headaches, ear pain, neuralgia, glossodynia, and other less common complaints. These symptoms were associated with abnormal jaw movements and malocclusion. Coston proposed a theory suggesting that the loss of posterior occlusion support resulted in excessive pressure on the TMJ, leading to dysfunction and nerve compression.

His theory, published in the *Journal of the Medical Association*, gained widespread acceptance, and for nearly two decades, the condition was referred to as Coston syndrome or "snapping jaw." Coston advocated against the removal of posterior molar teeth in patients experiencing head and neck neuralgia. Instead, he recommended that dentists gradually open the posterior occlusion, believing that this would decompress nerves and soft tissues within the TMJ, promoting healing. This approach was aimed at alleviating symptoms by addressing underlying mechanical issues in the TMJ complex.

Although surgery for TMJ internal derangement continued in practice, there emerged an entire school of thought that attributed joint pathology to occlusion disharmonies. In 1940 some authors questioned the anatomic basis of Coston syndrome neurological symptoms.[1] Dingman concluded a thorough review of TMJ therapy by warning against losing sight of the fact that many of the statements made regarding this subject of Coston syndrome were still within the realm of speculation and needed further scientific substantiation. By assuming a critical attitude and proceeding cautiously, the dental profession might avert the severe criticism that might arise as a result of misguided therapy. This advice remains pertinent today.

In 1948, Harry Sicher, a renowned anatomist and educator at Loyola School of Dentistry, published a seminal anatomical study that challenged the neural compression theory underlying Coston syndrome. Sicher's study provided a definitive perspective, emphasizing that the destruction of the TMJ disc and subsequent degenerative changes in the condyle and tubercle resembled a clear pattern of deforming arthritis.

He observed that local pain, referred to as a crackling sensation, and restricted joint movements were characteristic symptoms of arthritis. Sicher attributed TMJ arthritis to mandibular overclosure or displacement. He concluded by highlighting the significant role of reconstructive dentistry in managing these conditions. Sicher's work marked a pivotal moment in TMJ

[1] Fingman R. O. 1940. Diagnosis and treatment of lesions of the temporomandibular joint. *American Journal of Orthodontics and Oral Surgery*. 26: 374–90.

research, solidifying two main schools of treatment—surgical and occlusal—which, while sometimes in tension, laid the groundwork for a more robust scientific understanding of TMJ disorders.

Professor Cecil Wakely of King's College London made significant contributions to the understanding and treatment of TMJ disorders through his publications in the late 1930s and early 1940s. In 1939, he published a review on TMJ surgery in cases of mandibular dislocation, advocating for arthroplasty with a gap to treat ankylosis. He was the first to use a pedicled temporalis flap tunneled beneath the zygomatic arch as interpositional tissue.

Wakely's earlier work in 1929 focused on displaced mandibular cartilage, exploring its causation and treatment. He identified synovitis resulting from displacement as a significant contributor to pain, recognizing it as a non-infectious, intracapsular inflammatory process associated with the disorder. He also highlighted gender-related emotional issues related to chronic disc displacement, noting the psychological impact of a snapping joint, particularly in females. When conservative treatments failed, Wakely performed a discectomy with reported good results up to 15 years post-surgery.

Reed Dingman, writing in 1940 about suppurative arthritis of the TMJ, noted that, despite proper care, many cases progressed to ankylosis. In such cases, Dingman advocated arthroplasty with a pedicled interposition temporalis flap. He extensively discussed both atrophic and hypertrophic osteoarthritis of the TMJ, recommending non-surgical care unless severe symptoms of disc displacement or ankylosis developed. Dingman viewed disc displacement, condylar subluxation, and dislocation as part of a broader entity. He concluded that a discectomy appeared to be the most effective and logical procedure for internal derangement of the TMJ based on published surgical outcomes.

Caroll Silver, an orthopedic surgeon, pioneered the treatment of mandibular hypermobility by grafting a block of bone to the articular eminence. Patients underwent a rigorous recovery process, being immobilized in plaster head casts for six weeks and fed through straws. This approach reportedly prevented subsequent subluxation or dislocation after healing. Additionally, Silver conducted hundreds of discectomies and contributed significantly to the long-term outcomes documented in the literature.

In Stockholm, Karl Bowman's doctoral dissertation, entitled "Temporomandibular Joint Arthrosis and its Treatment by Extirpation of the Disc: A Clinical Study," marked a seminal contribution. Published in 1947, this work is regarded as one of the most comprehensive and well-

documented summations of knowledge on TMJ anatomy, pathophysiology, normal and impaired function, and responses to a discectomy of its time. Bowman's insights and conclusions from sixty years ago continue to hold relevance today, underscoring the enduring impact of his research in the field.[2]

The contributions of these pioneering surgeons and anatomists, characterized by their vision and dedication, have fundamentally shaped the treatment of diseases and dysfunctions of the TMJ. Their innovative medical and surgical techniques have paved the way for the future of TMJ surgery and advanced clinical practices.

Following World War II, surgical innovation across various fields accelerated significantly, and TMJ surgery benefitted from the creativity and boldness of surgeons in this era. The integration of basic science findings and the application of scientific criteria to clinical research played a crucial role in improving patient care and treatment outcomes. This period marked a transformative phase where rigorous scientific approaches were increasingly applied to enhance the effectiveness and safety of TMJ surgical interventions.

Karl Boman's summary of his work based on extensive examination of health material, spanning all ages up to 1350 cases, highlighted several key findings related to TMJ arthrosis:

1. **Symptoms**: Common symptoms included snapping, crepitations, and motion disturbances, with females being most frequently affected. Interestingly, individuals without teeth experienced TMJ symptoms less frequently compared to those using dentures.

2. **Severity and Spontaneous Resolution**: Symptoms of arthrosis were generally mild and could spontaneously disappear without leaving clinically detectable traces. These symptoms could manifest as early as 6–8 years of age but were more commonly observed in later years. In rare cases, severe symptoms requiring treatment could occur.

3. **Effect of Disc Removal**: Boman found no evidence indicating detrimental effects of disc extirpation on the unoperated joint. Therefore, bilateral disc removal was not recommended unless symptoms were severe on both sides, in which case the more severely affected joint should be operated on first. Improvement in symptoms of the other joint could often occur, and there was no disadvantage to operating on the other side subsequently.

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[2] Boman K. 1947. Temporomandibular joint arthrosis and its treatment by extirpation of the disc: A clinical study. *Acta Chirurgica Scandinavica Supplementum*. 118.

Boman's findings contributed significantly to understanding TMJ arthrosis and informed treatment approaches, emphasizing conservative management unless symptoms were severe and advocating for a strategic approach to surgical intervention when necessary.

The treatment approach advocated by Karl Boman emphasizes conservative management as the primary strategy for TMJ arthrosis. However, in cases where conservative measures fail to alleviate severe symptoms such as constriction, luxation, pain, and disturbing snapping, Boman recommends the extirpation (removal) of the disc as a viable treatment option. According to his findings, this surgical procedure can provide immediate and permanent relief from these debilitating symptoms, offering patients significant improvement in their quality of life and functional outcomes.

Ireland described condyletomy for TMJ internal derangement in 1951.[3] In 1957, Henny and Baldridge recommended a procedure that later evolved into what is known as the high condylar shave. This surgical technique involves the reshaping or reduction of the condyle of the mandible to address certain conditions affecting the TMJ. The procedure aims to alleviate symptoms such as pain, dysfunction, or malocclusion associated with the TMJ by modifying the anatomical structure of the condyle itself. Over time, the high condylar shave has been refined and adapted based on advancements in surgical techniques and understanding of TMJ disorders, contributing to its role in modern treatment protocols for specific TMJ conditions.[4] In 1961, Ward reported on a surgical procedure known as condylectomy. This procedure involved transacting (cutting across) the condylar neck through a blind approach performed externally (extraorally). The condylectomy aimed to displace the condyle anteromedially towards the subluxated meniscus of the TMJ. This surgical technique was intended to address conditions such as TMJ subluxation, where the disc (meniscus) within the joint shifts out of its normal position, causing functional impairment and pain.[5] In 1975, Banks and Mackenzie conducted a retrospective review of 211 condylotomy procedures, focusing on their outcomes in cases of TMJ disorders. Their study reported a success rate of 90% in unilateral cases, with the following outcomes:

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[3] Ireland V. E. 1951. Problems of clicking jaw. *Proceedings of the Royal Society of Medicine*. 44: 363.

[4] Henny F. A., Baldridge O. L. 1957. Condylectomy for persistently painful temporomandibular joint. *Journal of Oral Surgery*. 15: 24.

[5] Ward T. G. 1961. Surgery of the mandibular joint. *Annals of the Royal College of Surgeons of England*. 28: 139–52.

Cured: 47% of patients were completely cured of their TMJ symptoms.

Improved: 43% of patients showed improvement in their TMJ symptoms.[6]

In 1979, Mccarthy and W L Farrar described the reconstructive procedure of meniscoplasty, which relocated the meniscus from its ectopic anterior position. This was combined with a form of high condylar shave.[7]

Eriksson and Westesson reviewed 15 patients who had undergone meniscectomy 38 years earlier. They observed severe radiological changes similar to arthrosis, but the patients were generally pain-free and had an opening greater than 39 mm.[8]

A review of Ward's procedure revealed complications, including anteromedial displacement of the condyle in most cases, as observed radiologically, and facial nerve damage. It also revealed several complications, including inferior alveolar nerve damage and hemorrhage from the internal maxillary artery, attributed to the blind approach. The rationale behind the operation is to displace the condyle in relation to the meniscus to increase joint space. This newly created space liberates the condyle and prevents it from impinging on the meniscus. Over the years, the condyle remodels with the sustained increase in joint space. The review suggests that the best results were observed when there was a decrease in ramus height compared to the unoperated side, as measured on OPG. This also indicates that sustained increased intra-articular space helps eliminate pain.

In his 2005 review article, G. Dimitroulis states that the literature on TMJ surgery is predominantly observational rather than scientific. Randomized clinical trials comparing surgical treatment of the TMJ with medical treatment or no treatment do not exist, as applying scientific principles in clinical studies involving surgical intervention is often ethically unfeasible. Therefore, the true benefit of surgical intervention for TMJ disorders may never be conclusively established. Recommendations for surgery must thus rely on the best available evidence.

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[6] Banks P., Mackenzie I. 1975. Condylotomy: A clinical and experimental appraisal of a surgical technique. *Journal of Maxillofacial Surgery*. 3: 170–81.

[7] McCarty W. L., Farrar W. B. 1979. Surgery for internal derangement of the temporomandibular joint. *Journal of Prosthetic Dentistry*. 42(2): 191-196.

[8] Eriksson L., Westesson P. L. 1985. Long-term evaluation of meniscectomy of the temporomandibular joint. *Journal of Oral and Maxillofacial Surgery*. 43: 263–9; Dolwick F. M., Sanders B. 1985. Internal derangement and arthrosis. *Surgical Atlas*, pp. 202–3. St Louis Missouri: CV Mosby Co.; Marciani R. D., Ziegler R. C. 1983. Temporomandibular joint surgery: A review of 51 operations. *Oral Surgery Oral Medicine Oral Pathology*. 56(5): 472–6.

In his 2004 article, "The Role of Surgery in the Management of TMJ Disorders: A Critical Review of the Literature, Part 1,"[9] Dimitroulis provided an excellent review. He classified TMD based on clinical and radiological findings, suggesting treatment lines for the first time. His classification is self-explanatory and very useful in the clinical practice of TMD.

There has not been a universally accepted treatment line for TMD concerning TMJ internal derangement and the role of surgery. Although the role of arthroscopy is frequently suggested, it lacks comprehensive clinical analysis. Specific treatments for the causes of internal derangement still require scientific evidence.

In the small, confined joint space of the TMJ, the upper articular space is typically no more than 1–1.5 mm, making it challenging to perform desired treatments. This necessitates highly trained and experienced surgeons skilled in arthroscopy. Acquiring such skills involves a steep learning curve, and there are also limitations related to the availability of facilities. However, arthroscopy has established its role in arthrolysis and debridement for TMJ internal derangement. Advanced and improved arthroscopes are now available, and the role of surgery in TMJ internal derangement in clinical practice is undeniable. Proper case selection with an accurate diagnosis, well-supported by MRI, has shown good long-term results.

There is no universally accepted approach for treating chronically locked TMJ internal derangement. Dolwick (2007) suggested that surgical success depends on a comprehensive treatment plan that includes both non-surgical and surgical interventions. Surgery performed in isolation rarely achieves long-term success. Rene de Leeuw[10] concluded that TMJ internal derangement most often responds to non-surgical treatment. An asymptomatic click does not warrant treatment, and guidelines recommend surgical procedures only after the failure of non-surgical modalities.

Arthrocentesis is recommended for diagnosing disc derangement without reduction or disc adherence, often yielding good outcomes. It can also resolve a locked jaw caused by deranged discs. Adding sodium hyaluronate during arthrocentesis is suggested to enhance results. Surgical procedures for disc derangement typically aim to improve the relationship between the disc and condyle. These procedures include high condylotomy, discoplasty, disc repositioning, and discectomy, with or without replacement

[9] *International Journal of Oral and Maxillofacial Surgery* 2004: 33.
[10] Oral and Maxillofacial Clinics of North America 2008. *Oral and Maxillofacial Clinics of North America*. 20: 159–68.

of the removed disc. Discectomy generally results in pain relief and improved function, with success rates ranging from 43% to 93%.

Degenerative radiographic changes resembling degenerative joint disease can occur after discectomy. There have been reports of pseudo-disc formation following this procedure. Surgical options for TMJ should be considered only when there is moderate to severe persistent pain or dysfunction after conservative treatments have been exhausted. In cases of acute disc adhesion, arthrocentesis and arthroscopy are often preferred as initial treatments.

In a chapter on the diagnosis and treatment of TMJ disorders,[11] Dym and Israelin wrote that TMJ disorder is the most common musculoskeletal disorder that causes orofacial pain and that the cardinal signs patients present with are:

- A limitation of the jaw opening or function;
- pain with the jaw opening or function;
- joint sounds (occurring more in females).

They conclude that understanding the diagnosis and management of MPD and TMJ disorders is crucial for the treating doctor to provide the necessary assistance for these common ailments. Most patients will experience a significant reduction in symptoms by following the conservative treatment methods suggested in this chapter. If patients do not improve sufficiently, the least invasive procedure with the highest potential for success, such as arthrocentesis, should be considered as the surgical treatment option.

Intra-oral procedure[12]: Improvement in pain and function despite postoperative disc displacement suggests that the primary reason for success is an increase in joint space. The loss of this increased joint space over time seems to correlate with patients whose pain has not improved. Given the uncertain outcomes, repeat condylotomy cannot be recommended.

Condylar subluxation and displacement of the proximal segment are exceedingly uncommon; if they occur, immediate reoperation is required to reposition the segment. Wire fixation may be necessary to keep the proximal segment in place, or a small titanium plate and screw may be used. Malocclusion remains the most challenging complication following the removal of intermaxillary fixation (IMF), often requiring occlusal equilibration.

E. L. Schillman et al. (2014) investigated the effects of four treatment strategies for TMJ closed lock.[13] They followed the strategies recommended

[11] Dym H., Israel H. 2012. *Dental Clinics of North America*. 56: 149–61.
[12] Bouloux G. F. 2011. Modified condylotomy for temporomandibular joint dysfunction. *Atlas of Oral and Maxillofacial Surgery Clinics of North America*. 19: 169–75.
[13] *International Journal of Oral and Maxillofacial Surgery*. 43: 217–26.

by the International Association of Oral and Maxillofacial Surgeons (IAOMS). The study concludes that TMJ surgery is not necessary for managing the vast majority of patients with closed lock. When surgery is considered, arthroscopic surgery is recommended over arthroplasty, as it was found to be equally effective in reducing pain and dysfunction while being less costly. Their two-year data indicates that any treatment for closed lock, including surgery, typically results in persistent disc displacement without reduction or, in the case of discectomy, no disc remaining. Furthermore, they found that improved disc position did not result in higher success rates for the surgical group in their study.

Another study[14] reported significant improvement in pain scores and mouth opening after TMJ arthroplasty with a discectomy and temporalis myofascial flap reconstruction. Their mean following period was 6.7 months.

The viability of the temporalis flap has been studied in humans[15]. This study reported on the status of the temporalis flap in seven out of 81 patients who had undergone previous surgery. Four patients underwent TMJ magnetic resonance imaging (MRI), which revealed a soft tissue signal consistent with muscle and/or fat in the joint. Additionally, operative findings in four patients showed a well-positioned flap lining the glenoid fossa that bled upon incision. Histologic assessment of biopsy specimens from the temporalis muscle flap showed viable muscle tissue with nuclei. The researchers concluded that the temporalis flap remains biologically active and serves as a satisfactory joint lining when inferiorly based.

Feinberg and Larsen reported[16] on a technique for harvesting and insetting a pedicled temporalis muscle pericranial flap in 13 patients. They observed improved function, with an increase in the maximum interincisal opening (MIO) from 21.1 mm to 34.8 mm, resulting in a 13.7 mm increase. Only one patient did not experience any improvement in mouth opening.

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[14] De Merle M., Olubukola O., Nafius M. D., Sbaron A. D. 2017. Temporomandibular joint discectomy with abdominal fat graft versus temporalis myofascial flap: A comparative study. *Journal of Oral and Maxillofacial Surgery*. 75: 1137–43.

[15] Umeda H., Kaban L. B., Pogrel M. A., Stern M. 1993. Long-term viability of the temporalis myofascial flap used for temporomandibular joint reconstruction. *Journal of Oral and Maxillofacial Surgery*. 51: 530.

[16] Feinberg D. E., Larson P. E. 1989. The use of a pedicled temporalis muscle pericranial flap for replacement of the TMJ disc: Preliminary report. *Journal of Oral and Maxillofacial Surgery*. 47: 142–8.

Smith et al. reported[17] the use of a temporalis myofascial flap in 23 patients (28 joints) who had undergone previous surgery with alloplastic or autogenous materials. They performed an osteotomy of the zygomatic arch to access the mid-portion of the temporalis muscle. In their study, 78% of patients achieved good to excellent results in terms of diet, and 80% were satisfied or very satisfied with the outcomes. They also reported a modest reduction in pain scores. Notably, all the patients in their study had previously undergone open surgery.

Tzanidakis and Sidebottom examined[18] the success rate of open TMJ surgery in patients for whom initial TMJ arthroscopy had failed. They reported lower success rates for patients with more advanced Wilkes staging, indicating that patients with previous surgeries tend to have lower response rates to subsequent surgical interventions.

A healthy, adequately mobile disc that can be repositioned without tension should be preserved[19]. Disc preservation surgery has been reported as successful; however, there is considerable variability in the techniques used by different surgeons, which include:

- an additional eminectomy
- a partial disc reduction
- the use of Mitek anchors
- concurrent orthognathic surgery
- the application of articular cartilage grafts, which may show fibrous changes and fragmentation.

Recent studies comparing a discectomy alone with a discectomy combined with an abdominal dermis fat graft have shown no significant differences in symptom improvement.

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[17] Smith J. A., Sandler N. A., Ozaki W. H., Braun T. W. J. 1999. Subjective and objective assessment of temporalis myofascial flap in previously operated temporomandibular joint. *Journal of Oral and Maxillofacial Surgery*. 57: 1058.

[18] Tzanidakis K., Sidebottom A. J. 2013. Outcome of open temporomandibular joint surgery following failure to improve after arthroscopy: Is there an algorithm for success? *British Journal of Oral and Maxillofacial Surgery*. 51: 818.

[19] Renapurkar S. K. 2018. Discectomy versus disc preservation in internal TMJ derangement. *Oral and Maxillofacial Surgery Clinics of North Americ*a.

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CHAPTER 2

SURGICAL ANATOMY OF THE TEMPOROMANDIBULAR JOINT

DR J N KHANNA

Introduction

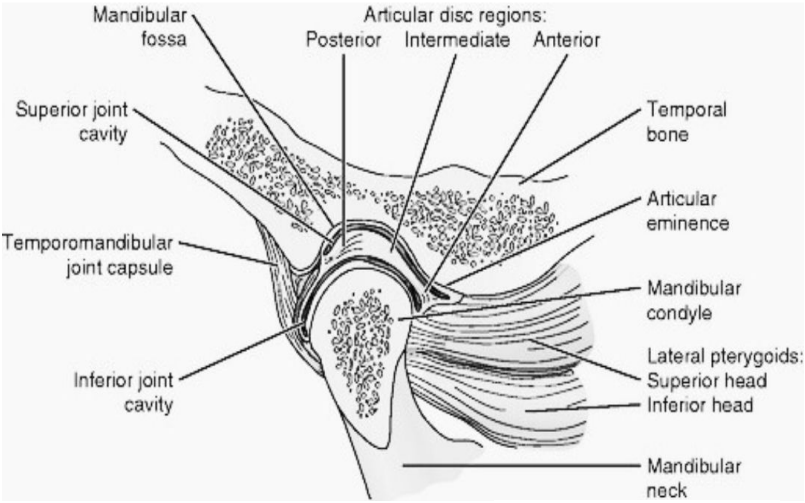
The temporomandibular joint (TMJ) is a ginglymoarthrodial synovial joint, which is anterior to the external auditory meatus below the skull base formed by the glenoid fossa and eminentia at the cranial base and mandibular condyle below it. The function of the TMJ is the most complex in the human body, yet having smooth, co-ordinated movements.

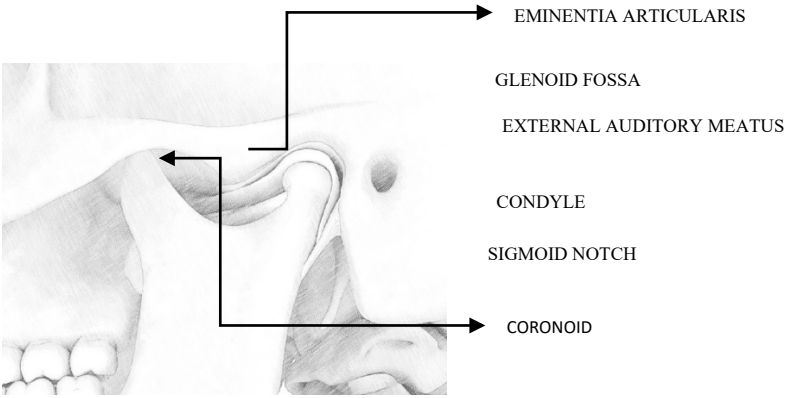
Up to two years of age, the condyle is bulbous and highly vascular with vessel perforators that disappear after two years of age, yet the condyle remains rich in vascularity until the completion of growth.

The glenoid fossa at the cranial base is shallow but raconteurs in the growth phase. This small complex joint suffers from multiple dysfunctions, deformities and pathologies of an inflammatory nature, tumors both benign and malignant. This complex craniomandibular articulation has two separate joints, the right TMJ and the left TMJ. These two separate joints work in unison. TMJ movements are smooth, well-co-ordinated and pain-free.

Embryology

The TMJ develops later than most other human joints. The TMJ develops between seven and 11 weeks of gestation. The mandibular condyle and squamous temporal bone are formed by intramembranous ossification and the articular disc is formed by condensation of the mesenchyme in the region of the TMJ. TMJ is considerably underdeveloped at birth in comparison to other diarthrodial joints, making it susceptible to perinatal and postnatal insults. The development of the joint continues through early childhood years as the joint is utilized for sucking motions and, eventually, chewing.



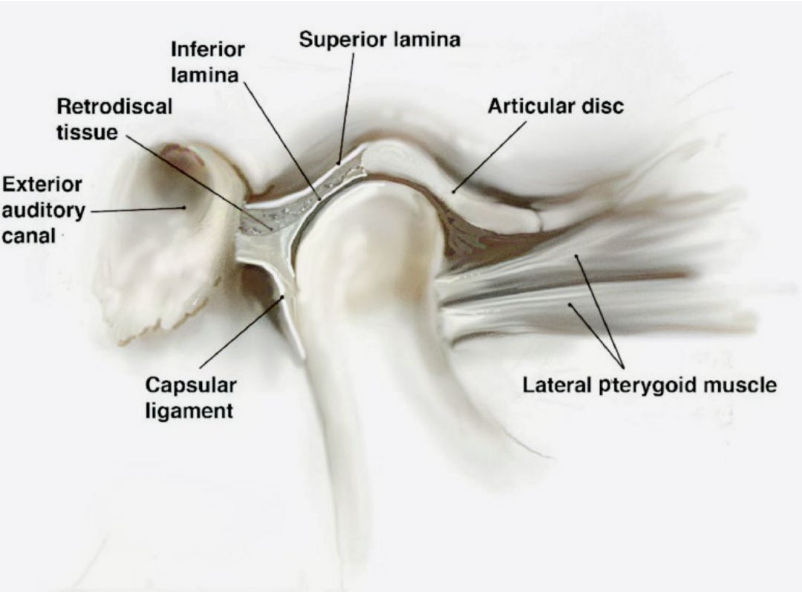


TMJ is a ginglymoarthrodial synovial joint having a cranial part and mandibular condyle. The cranial part consists of the glenoid fossa and eminentia articularis. They form the upper part of the TMJ articulation at the cranial base. The cranial part is fixed. The lower part, the condylar part of the mandible, forms the movable complex of the TMJ. The articular surface of the condyle and articular portion of the temporal bone, the fossa and eminence are made of dense cortical bone. The mandibular component consists of an ovoid condylar process seated atop a narrow mandibular neck. The condyle is perpendicular to the ascending ramus of the mandible and is oriented with a long axis of 10 to 30 degrees posterior to the frontal plane. The TMJ is enclosed by a capsule composed of loose connective tissue, it

extends from the posterior portion of the temporal bone glenoid fossa and articular eminence superiorly to the neck of the mandibular condyle and inferiorly in the shape of an inverted pyramid. Within the joint capsule are articular surfaces of fibrocartilage.

The glenoid fossa is just anterior to the external auditory meatus and is a concave portion of the articular surface of the undersurface of the squamous portion of the temporal bone.

The articular eminence is the anterior convex portion of the articular surface of the glenoid fossa. The medial and lateral borders of the joint follow the squamotympanic and petrosquamous fissures.

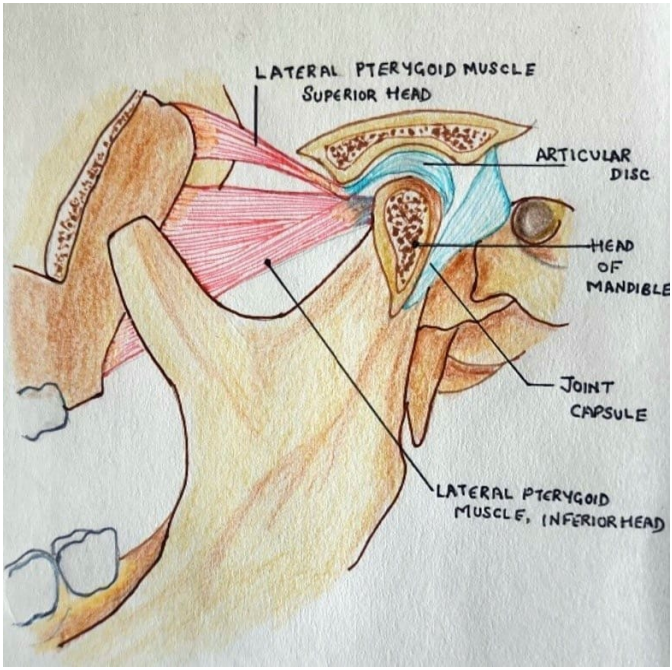


The TMJ fossa is more of a depression in the base of the skull within which the mandibular condyle functions. The mandibular condyle is a spheroidal or oval structure that is capable of a wide range of movements. It is above the narrow mandibular neck. It measures from 15 to 20 mm mediolaterally and 10 mm anterioposterally.

The joint capsule covers the TMJ. The TMJ has an intracapsular meniscus, a disc dividing the synovial cavity into two non-communicating joint spaces, a superior and inferior synovial compartment.

The meniscus is an oval plate of fibrous tissue that assumes a biconcave configuration in the sagittal plane and has three distinct

segments: an anterior band, an intermediate zone and a posterior band. Both the anterior and posterior bands are triangular and are connected by the intermediate zone. This consists of dense collagenous connective tissue that is avascular and devoid of nerve tissue in the central area. However, the disc has vessels and nerves in the peripheral area. The disc is thinnest in the center, about 1 mm on average and becomes thicker peripherally, about 2 to 3 mm. The posterior band is thicker than the anterior band. The anterior and posterior bands are longer mediolaterally than the anteroposterior dimension. The anterior band is attached to the joint capsule condylar head and superior belly of the lateral pterygoid muscle. The posterior margin of the posterior band is attached to the bilaminar zone, which is a rich neurovascular tissue composed of superior and inferior lamina. These retrodiscal laminae serve as posterior attachments, blending with the joint capsule and temporal bone to provide stability to the disc. Lateral attachment of the disc is also present and blends with the capsule and inserts it condylar; neck collateral ligaments connect the medial and lateral borders of the disc to the corresponding poles of the condyle and further stabilize the disc.



These attachments allow the disc movement anteriorly and posteriorly on the articular surface of the condyle. The circumference of the disc blends with the capsule surrounding the joint, dividing the TMJ into an upper compartment and a lower compartment. The superior joint compartment is 2 to 3 mm in width. The lower, inferior joint compartment is about 1 mm in width or less. The meniscus is a fibro cartilaginous structure designed to adapt the condyle firmly, being firmly attached to the medial and lateral poles of the condyle. The thin intermediate zone of the disc maintains its position between the articulating surface of the mandibular condyle and the articular eminence, the configuration resembling a bowtie.
The upper joint compartment is bounded superiorly by the glenoid fossa and eminentia articularis of the cranial base and inferiorly by the upper surface of the meniscus.

The lower compartment is below the meniscus, formed between the meniscus and the condyle. The meniscus is very closely adapted to the condyle component, resulting in hardly any space between them. The meniscus, being firmly attached to the condyle, accompanies the condyle in translator movements. The meniscus (disc) allows smooth functional movements between the cranial part and the mandibular condyle synovial membrane compartment. The synovial membrane encloses the joint compartment giving synovial fluid to the joint essential for functional needs. TMJ acts as a hinge for opening and as a pivot about which the mandible hangs in the rest position and as a guide or support in other movements such as speech and swallowing. The correct position of the meniscus and the condyle is in part maintained by the shape of the meniscus and their anterior and posterior thick bands which help to position it on the condylar head. It is held down by the attachment to the condylar neck inferior to the articular surface medially and laterally, but in an anterioposterior direction, the bands tend to position it as the condyle translates and rotates. The lateral pterygoid muscle has a stabilizing role in controlling the meniscal and condylar position. However, in powerful masticatory movements, the temporalis muscle acts to limit the loading on the TMJ. A significant factor in decreasing the joint forces has been the enlargement of the coronoid process.

The limited development of the eminentia articularis and the presence of the meniscus is associated with the development of a lateral mandibular movement. The lateral pterygoid muscle enables such movements and further assists in the grinding action. The horizontal fibers of the temporalis muscle acting through the coronoid process and the ascending ramus control the joint loading. These fibers act with the lever arm of the ramus like a fulcrum of the mandibular provided by the pterygoid

masseteric sling. The protective action of these fibers prevents TMJ overloading, which may be compromised during surgical procedures such as a coronoidectomy. The TMJ is not a load-bearing joint. The occlusion of the teeth supports and guides the joint function.

Histological growth changes in the articular fossa of the immature joint layer of cartilage are present as proliferative cartilage cells, and deep inside, this is a zone of hypertrophic cartilage cells. This layer gradually diminishes and eventually disappears, leaving only the fibrocartilage layer. The cartilage, which forms the junction between bone and the articular tissue, is apparently responsible for the remodeling or recontouring of articular fossa in immature joints. In mature joints, there is fibrous tissue only in the fossa; fibro cartilaginous tissue is on the anterior slope of the condylar head and on the posterior slope of the articular eminence, where it is thickened. The fibrous surface represents an adaptive mechanism for joints subjected to friction. With maturation, the cartilaginous layer immediately below the surface decreases in thickness and leaves fibro cartilaginous tissue by the time the bone end plate is complete. The mature joints' biomechanical forces, if within physiological limits, result in the adaptation and remodeling of the joint and assist in maintaining acceptable function. Under adverse conditions, the remodeling may become extensive, resulting in a deviation from the joint components, which can interfere with the joint function. Functional stimulus probably induces this differentiation for the proliferative response of their articular tissue and the underlying bone.

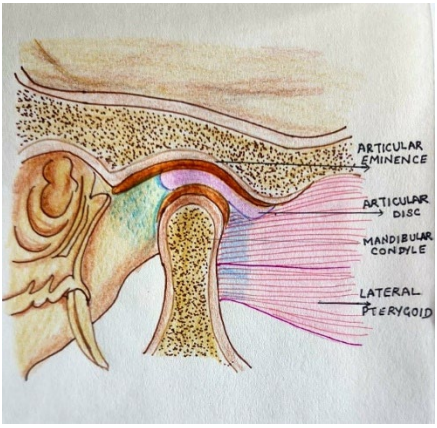


Fig: showing surgical anatomy of the TMJ

Research indicates that an increase in the biomechanical load of the joint stimulates cellular and cartilage formation from undifferentiated connective tissue. This often leads to the thickening of soft tissue covering the condyle

and temporal components and changes in the form of these components and the meniscus. If the demands on the remodeling of the TMJ exceed the capacity of these tissues to respond to the stimulus, an osteoarthritic lesion may develop. The articular meniscus is primarily collagenous, and the presence of cartilage in the meniscus is a response to the excessive loading of the joint. The following tissue layers can be recognized in both condylar and temporal articular surfaces.

(1) The surface layer adjacent to the articular cavity is composed of fibrous connective tissue.

(2) The intermediate layer is of undifferentiated connective tissue.

(3) The deeper layer is of fibro-cartilage tissue, which varies in thickness.

The fibrous surface layer represents an adaptive mechanism for the joint. The functional wear and tear within the physiological limit are taken care of by the adaptive ability of the condyle throughout life. It is important to understand that the mandibular condyle is not a growth center as it only plays the role of an adaptive-reactive center that responds to the stimulus provided by the function supported by functional matrix theory. The relative potential manifests itself in the elongation of the ramus during the growth phase. The glenoid fossa constantly changes to maintain the functional relation with the condyle.

The meniscus is a fibrocartilaginous structure designed to adapt condyle firmly and is attached to the medial and lateral poles of the condyle.