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Review Article

Surgical innovations in temporomandibular joint disorders: A comprehensive review

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ABSTRACT:

Temporomandibular joint (TMJ) disorders pose a significant clinical challenge due to their multifactorial origin and profound impact on mandibular function and overall quality of life.While conservative therapies remain the first line of management, surgical intervention is often necessary in advanced or refractory cases. This review explores the latest advances in surgical techniques for TMJ disorders, encompassing minimally invasive procedures like arthroscopy and arthrocentesis, as well as open joint surgeries such as discectomy, eminectomy, and condylectomy. The resurgence of alloplastic joint replacement and emerging regenerative therapies utilizing mesenchymal stem cells (MSCs) are also highlighted. Additionally, the role of robotic-assisted and minimally invasive surgeries in improving patient outcomes is discussed. These advancements have not only expanded the therapeutic options for clinicians but have also significantly enhanced functional recovery and patient comfort. A comprehensive understanding of these evolving techniques is essential for optimal management of TMJ pathologies.

Keywords: Arthroscopy, arthrocentesis, alloplastic TMJ replacement regenerative technique, discectomy, eminectomy, condylectomy, robotic surgery

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INTRODUCTION

One of the most peculiar joints in the human body, the temporomandibular joint (TMJ) coordinates complex movements across several orthogonal planes and rotational axes.(1)TMJ disorders can greatly affect a person's jaw function. These disorders may cause pain which makes it hard for patients to open their mouths fully or chew food easily. As a result, individuals with TMJ issues often experience locking sensations in the joint adding to their discomfort. This can lead to irritation and affect daily activities such as eating and speaking. In a general dental practice patients often report discomfort in their jaw muscles which can feel like cramping. They may also experience painful clicking sounds in their temporomandibular joints (TMJ). These issues can become worse after long dental procedures which may strain the muscles and joints. It is important for dental professionals to recognize these symptoms and address them appropriately. Providing relief and support can help improve the overall experience for patients during their dental visits.Proper diagnosis and treatment are essential for improving jaw function and relieving pain associated with TMJ disorders.Many patients with jaw problems can improve by following simple steps like resting their jaw and eating soft foods. However, some individuals need more help from professionals. This help may include treatments like occlusal splint therapy which uses a special device to support the jaw. Physiotherapy can also be beneficial as it helps strengthen the jaw muscles and improve movement. In certain cases, medications might be necessary to reduce pain and inflammation ensuring a better recovery. This article aims to give a simple overview of the current surgical procedures to treat them. (2)

ADVANCES IN SURGICAL TECHNIQUES

- **ARTHROSCOPY**

Direct visual evaluation of internal joint structures, including biopsies and other surgical procedures carried out under visual supervision with the aid of an arthroscope, is possible with TMJ arthroscopy.(3)Area to be injected is shaved and disinfected. A puncture of TMJ is performed after infiltration of anesthesia. After aspiration of intracavity fluid, the surface is irrigated with saline solution. Within a distance of 5mm forward a punctum of incision is done in which insertion of arthroscope sheath is done into joint cavity. If there is outflow of fluid then the insertion is successful. Through the sheath sterile saline solution is injected about 33^0C at pressure of 70cm H_2O to expand the joint cavity and when the material obscures the wall the liquid is removed followed by pumping of nitrogen. The removed liquid is used for cytological examination.(4)For a range of TMJ disorders, arthroscopy has emerged as a popular therapeutic option. Individuals for whom temporomandibular disorders (TMDs) cannot be effectively treated with conservative approaches It has been demonstrated that arthroscopy, a minimally invasive surgical technique, produces adequate results without the need for open joint surgery. TMDs are conditions affecting the TMJ and the masticatory muscles that are connected to it. TMDs can cause a number of symptoms, such as headaches, jaw clicking, restricted mouth opening, and pain in the joint and surrounding muscles. The most prevalent painful, non-infectious diseases affecting the orofacial region are TMDs. It is anticipated that arthroscopy will be less successful if severe degenerative joint disease is clearly present.(3)

- **ARHTROCENTESIS**

D. W. Nitzan first proposed arthrocentesis of the temporomandibular joint in 1991 as the most convenient surgical procedure. Its goals were to remove inflammatory mediators, release the articular disc, and break down adhesions between the disc's surface and the joint fossa using hydraulic pressure from the lavage solution.The basic idea is to insert two needles into the upper joint space, followed by lavage with Ringer's solution or physiological saline mixture. The solution is injected into the joint using one needle, and the liquid is drained using the other. A skin puncture, situated approximately 10 mm ventrally from the tragus on an imaginary line that connects the tragus with the outside corner of the eye (the Holmlund line), is the most effective way to access the upper joint area. Once the tip of the needle has made contact with the posterior wall of the articular eminence, it is inserted up, towards the front, and inward to a depth of roughly 2 cm while the patient's mouth is open. The application is carried out with light pressure following the insertion of the first needle with a syringe that contains two milliliters of physiological saline or Ringer's solution. The needle is positioned correctly in the upper joint space if roughly the same volume of fluid is later aspirated back. It is occasionally possible to observe contralateral movement of the lower jaw's chin part during application.

The second needle is placed 2 mm behind the line that connects the tragus with the outer corner of the eye, 10 mm in front of the first. This procedure is done in anesthesia with auriculotemporal nerve. However, studies have proved that procedure can be done in general anesthesia also. Ringers' solution has better tolerance to fibrous tissue as compared to isotonic saline solution. There are fewer possible risks and the process is softer and shorter in case of single needle technique. The facial nerve branches, which are situated where the second needle is inserted, are not at danger of injury. By injecting fluid into the joint space at a specific pressure, the single-needle technique enables the joint space to enlarge and any adhesions inside the joint to be severed.The mouth is left open when the needle is inserted. The patient is then instructed to shut their mouth. In this manner, the same needle is used to drain the fluid from the joint space. 50 mL of fluid is used overall, and the process is done at least ten times. The phenomena of disc adherence to the fossa or eminence are explained by adhesions that take place inside the temporomandibular joint. Most of the time, their lysis results in better mouth opening. As a result, the single-needle approach is recommended for joints with substantial adhesions and hypomobility or for joints with advanced degenerative changes that could make inserting the second needle extremely difficult.(5)

- **ALLOPLASTIC TMJ REPLACEMENT**

Due to certain challenges faced which resulted in several foreign body reactions to the proplast and Teflon used in the production of the prosthesis's glenoid fossa component, the use of alloplastic materials for TMJ restoration was discontinued in the 1970s. In order to remove the action of the temporalis muscle and allow for greater mandibular opening, the surgery was performed in a standard manner using a preauricular approach to the glenoid fossa and a submandibular approach to the mandibular ramus. Following a bone incision was created beneath the ankylosis's primary body; the stealth navigation system was used to determine the depth of the incision. Once the removal of the desired bone is done and the creation of the preoperatively identified space, titanium screws were used to secure the prosthesis's glenoid fossa component to the base of the zygomatic arch. Following the submandibular incision, the ramus and condyle component were positioned, with the condyle seated in the glenoid fossa and secured to the mandibular ramus with many titanium screws. Before this, arch bars were wired to the teeth in the early phases of the procedure, and intermaxillary fixation was used to preserve the occlusion. Because the ramus

and glenoid fossa components of the TMJ Concepts prosthesis were custom-made, they fit nicely and required little sculpting. At the time of surgery, however, the Biomet Lorenz prosthesis had to be chosen. At the time of surgery, three sizes of glenoid fossa and ramus condyle components were offered for trial. After the size was chosen, the prosthesis was placed, typically including bone resection. Titanium screws were used to fasten the various components to the glenoid fossa and ramus. Layers of sutures were applied to the wounds, using nylon for the skin and resorbable sutures for the deeper layers. Every wound was drained, and the next day, the drains were taken out.(6)Due to defective material selection and associated investigations, the early prostheses failed, bringing total joint replacement into disfavor.The problems center on the prosthesis's fit and the artificial joints' inability to adequately replicate the TMJ's natural anatomical function. Although some of the fit issues have been resolved by the TMJ Concepts joint's individual design, the function still need improvement.(6)

- **REGENERATIVE TECHNIQUE**

Recent research has clarified the several functional roles of stem cells, especially MSCs, in TMJ regeneration and repair, including replacement cell and support cell functions through trophic factor secretion. These special qualities of stem cells have not yet been completely utilized for TMJ regeneration and repair.(7)The use of MSCs for TMJ regeneration and repair has gained a lot of attention in recent years. Interestingly, authors showed how effective synovial MSCs produced from the TMJ are at repairing the TMJ disc. TMJ-derived synovial MSCs were cultivated under chondrogenic conditions with TGF-β3 supplementation after being seeded on a fibrin-chitosan composite scaffold. The immunodeficient mice's dorsum was subsequently transplanted with these constructions after they had been implanted in the punched TMJ disc explants. After four weeks of in vivo implantation, distinct fibrocartilage production was seen, along with the typical deposition of type I and type II collagens.(7)

OPEN TMJ SURGICAL TECHNIQUES

- **DISCECTOMY**

For over a century, temporomandibular joint (TMJ) discectomy without disc replacement, or discectomy, has been used to treat TMJ discomfort and dysfunction that is not responsive to non-surgical therapies with positive clinical results. According to certain accounts, discectomy may result in osteoarthritis (OA) and, in rare cases, significant alterations that may necessitate total joint replacement. However, it is challenging to determine whether discectomy is the cause of OA from the literature because studies lack one or more of the following: control groups, outcome measures stratified to the preoperative joint disorder or disease, pre- and postoperative radiological assessment, analysis of the potential impact of prior less invasive treatments such as arthrocentesis or arthroscopic lysis and lavage, and short-term follow-ups that distinguish OA from ongoing remodeling processes.(8)

- **EMINECTOMY**

Myrhaug was the first to describe eminectomy, which is the removal of articular prominence by ostectomy using rotation instruments that may or may not be attached to scalpels in 1951. Since then, it has been carried out with positive outcomes and efficacy validated in the literature. (9)The primary benefit of using a miniplate in articular eminence, a more contemporary technique, over eminectomy is that it is reversible and less demanding technique. Its reduction of the maximal mouth opening is its primary issue. Yet there aren't many studies evaluating its application in the literature, and none that contrast it with eminectomy.(9)

- **CONDYLECTOMY**

To rectify the jaw abnormality, orthognathic surgery can be performed concurrently with the high condylectomy and disc repositioning technique.34 This treatment may be carried out in one or two stages by the surgeon. Orthognathic surgery can be done after the disc relocation is completed in stage 1 surgery. We advise using the sagittal split ramus osteotomy for the mandible as the preferred procedure when orthognathic and TMJ surgeries are done in a single operation because it allows for positional control of the condyle and preserves the proximal segment's maximum soft tissue attachments and vascularity. Other techniques, such as the inverted L or vertical ramus osteotomies, require increased stripping of the periosteum and may lead to vascular compromise of the proximal segment, as well as causing difficulties with positional control of the condyle.(10)

EMERGING TECHNOLOGIES

Over the past few decades, there has been a significant increase in the use of minimally invasive surgery (MIS). More than 90% of procedures, including appendectomy, tubal ligation, cholecystectomy, gastric bypass, myomectomy, and prostatectomy, are being carried out using MIS techniques. The primary driver of this paradigm shift is the substantial decrease in patient body trauma brought about by fewer or even no surgical incisions. Many other advantages for the patient follow from this decrease in physical trauma, including a decreased risk of complications, less pain, a faster recovery, a shorter hospital stay, less cosmetic deformity, less psychological effects, and an overall improvement in quality of life.(11)

➢ ROBOTIC SURGERY

In addition to the well-liked laproscopic procedures, recent advancements in minimal invasion include robotic surgery and laser microsurgery. Surgery using robots is becoming more and more common in head and neck oncology for the treatment of various tumors affecting various sites, including the oral cavity, pharynx (hypopharynx, oropharynx, and nasopharynx), parapharyngeal space, larynx, and base of skull, in addition to abdominal surgery, urology, orthopedics, radiosurgery, interventional radiotherapy, cardiac surgery, and neurosurgery. (12)

Over the past few decades, there has been a significant increase in the use of minimally invasive surgery (MIS). The primary cause of this is the considerable decrease in surgical trauma brought about by fewer or even no incisions. The pathophysiology of the temporomandibular joint is still poorly understood, and its therapy is debatable. For this Because of this, even though TMJ-MIS is controversial in and of itself, it may be a viable alternative for patients who have not responded to conservative care and in whom open treatment may be viewed as aggressive. (11)

SIMPLIFYING SURGICAL TECHNIQUE

In the majority of contemporary configurations, a live video stream is sent to a flat screen via high-resolution CCD cameras. The loss of stereopsis, or the sense of depth and 3-D, is one of the primary issues with video-assisted MIS. This is frequently the result of deficient hand-eye coordination and incorrect tool movements and happens when a three-dimensional (3D) image is projected onto a two-dimensional screen. Since the benefits of 3D technology are more obvious in larger joints, it would not be beneficial to employ it in a small joint like the TMJ at this time.(11)

CONCLUSION

Due to recent developments, TMJ surgeons can now treat the surrounding structures in addition to the temporomandibular joint itself.Surgical techniques have greatly improved not only the way we treat patients with TMJ issues and orofacial discomfort, but also the methods used to carry out procedures that are most beneficial to the patient.(13)

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