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Arthroscopy Combined with Platelet-Rich Plasma Injections in Temporomandibular Joint Disorders: A Review

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Abstract

Temporomandibular joint disorders are associated with pain, dysfunction, and reduced quality of life. Emerging treatments, such as arthroscopy combined with platelet-rich plasma (PRP) injections, offer promise in managing these conditions. This review provides a comprehensive description of the combined approach involving PRP injection and TMJ arthroscopy. The review outlines a detailed surgical procedure for level II arthroscopy, as well as the specialized method for preparing PRP, step by step. Contrary to traditional approaches advocating for the exhaustive use of conservative treatments, minimally invasive procedures should be considered as an effective initial treatment option or implemented early, especially when patients do not demonstrate clear benefits from initial conservative treatments. Performing TMJ arthroscopy requires extensive training. Surgeons must master critical steps through practice to ensure optimal patient outcomes, emphasizing the importance of high surgical skills for patient benefit. Arthroscopy combined with PRP injections represents a promising therapeutic approach for TMJ disorders compared to other injectable materials.

Highlights

1 - Minimally invasive procedures should be considered as an effective initial treatment option or implemented early, especially when patients do not demonstrate clear benefits from initial conservative treatments. 2 - Injections of biologically active substances, such as Platelet-rich plasma, embody the future of TMJ treatment. 3 - A comprehensive surgical protocol for level II arthroscopy is outlined, incorporating a novel method for injecting retrodiscal tissue. 4 - Performing TMJ arthroscopy requires extensive training. Surgeons must master critical steps through practice to ensure optimal patient outcomes, emphasizing the importance of high surgical skill for patient benefit.

1. Introduction

Temporomandibular joint (TMJ) disorders present a significant challenge in clinical practice, often causing pain, dysfunction, and diminished quality of life for affected individuals. While traditional treatment modalities have shown varying levels of success, emerging techniques combining arthroscopy with PRP injections hold promise as a potential therapeutic approach. [1, 2]

Platelet-rich plasma (PRP) therapy has gained significant attention in the field of regenerative medicine due to its potential for tissue repair and rejuvenation. [3, 4] In recent years, there has been a growing interest in exploring the use of PRP injections as a viable treatment option for joint-related conditions. [5]

Arthroscopy, a minimally invasive surgical technique, offers direct visualization and access to the internal structures of the TMJ, allowing for precise diagnosis and targeted treatment. It has been widely employed for various TMJ pathologies, including, osteoarthritis, and autoimmune conditions such as Rheumatoid Arthritis, Psoriatic Arthritis, etc. [6–8] On the other hand, PRP, a concentrated solution derived from the patient's own blood, enriched with a high concentration of platelets, growth factors, cytokines, and other bioactive molecules, has gained attention for its regenerative properties and potential to enhance tissue healing and repair.

These components play a crucial role in tissue healing, inflammation modulation, and regeneration. When injected into the affected joint, PRP aims to harness these regenerative properties to stimulate tissue repair, reduce pain, improve joint function, and potentially halt disease progression. [9–11]

Combining arthroscopy with PRP injections presents a synergistic approach, leveraging the benefits of both techniques. Arthroscopy provides a comprehensive assessment of the joint's condition, allowing for the identification of specific structural abnormalities, while PRP injections aim to promote tissue regeneration, reduce inflammation, and alleviate symptoms. The growth factors present in PRP have been shown to stimulate cellular proliferation, angiogenesis, and extracellular matrix production, all of which are crucial for tissue healing and repair. [12, 13]

Several studies have investigated the use of arthroscopy combined with PRP injections in TMJ disorders, with encouraging results. These studies have demonstrated improved pain relief, enhanced joint function, and positive changes in imaging findings following the intervention. [14, 15] Furthermore, the minimally invasive nature of the procedure and the potential for reduced recovery time make this approach an attractive alternative to more invasive surgical options. After evaluating many other injectable materials, PRP emerged as the most recommended option when combined with arthroscopy. [9] Postoperatively, Parameters such as pain relief, improvement in jaw function, eating ability, social interactions, and overall satisfaction are essential considerations for assessing patients' well-being and treatment success.

This review aims to provide a comprehensive overview of TMJ surgical anatomy, diagnosis, and treatment protocols for TMD patients, with a specific focus on PRP injection compared to other alternatives from the past, present, and future. The review emphasizes the use of PRP injection under arthroscopy and outlines a detailed surgical procedure for level II arthroscopy, as well as the specialized method for preparing PRP, step-by-step.

2. Anatomy and orientation of the surgical site

The TMJ is divided into two main compartments: the upper compartment and the lower compartment. The upper compartment, often referred to as the superior joint space, comprises the articulation between the disc and the articular eminence of the temporal bone. This section of the joint facilitates translational movements during mouth opening and closing. Conversely, the lower compartment, also known as the inferior joint space, involves the articulation between the mandibular condyle and the articular disc, allowing hinge movements. [16] This disc serves as a cushion, absorbing forces and enabling smoother movements. It has a biconcave structure composed of fibrocartilage tissue, comprising three distinct functional segments: the posterior band, intermediate zone, and anterior band. The slender intermediate zone imparts flexibility, facilitates seamless articulation, and safeguards the superior and inferior articulating surfaces. The intermediate zone is relatively avascular and can be demonstrated as such arthroscopically. A distinct demarcating vascular zone separates the retrodiscal and posterior bands from the fibrocartilaginous intermediate zone. The bilaminar posterior bands manifest as retrodiscal tissue with sufficient thickness to facilitate injection with therapeutic agents. Perforations, resulting from advanced arthritis, are observed to rupture in the bilaminar zone and the lateral part of the disc. However, depending on the type of disc displacement, perforations may occur in different locations. Meanwhile, the robust anterior and posterior bands occupy the space formed by the convex surface of the mandibular condyle, contributing to both the structural integrity and overall stability of the disc. The lower compartment is crucial for rotational or sliding motions that occur during various jaw activities, such as chewing and speaking. The coordination between these two compartments allows the TMJ to accommodate a wide range of functional movements, contributing to its complex and intricate nature. [17, 18] Understanding the specific dynamics of each compartment is essential for a comprehensive assessment and management of TMJ disorders. Arthroscopy begins with the placement of the first port within the superior compartment. Once the first port is introduced, a thorough diagnostic sweep of the joint ensues. Throughout this process, seven specific points of interest are meticulously visualized and assessed to achieve a comprehensive understanding of the joint's condition. [19–21] These points include the medial synovial drape, pterygoid shadow, retrodiscal synovium, posterior slope of the articular eminence, articular disc, intermediate zone, and anterior recess.

In the TMJ region, the key arteries are the superficial temporal artery and vein, originating from the external carotid artery. The superficial temporal artery courses over the zygomatic process of the temporal bone, passing behind the neck of the condyle, and divides into frontal and parietal branches. The internal maxillary artery and the pterygoid plexus of veins are susceptible to vascular injury if the depth of instrumentation is not properly restricted. [22, 23]

In terms of nerves, the facial nerve's extracranial branches include the temporal, zygomatic, buccal, marginal mandibular, and cervical branches. Notably, the temporal and zygomatic branches may be at risk during TMJ procedures. The trigeminal nerve is crucial for facial sensory and mastication muscle innervation. Additionally, the auriculotemporal nerve, a branch of the mandibular nerve, runs with the superficial temporal artery and vein near the fossa puncture site. [24]

Moreover, it is essential to recognize the overlapping structures and close proximity between the joint and the middle and internal ear structures. While ear canal perforation, hearing loss, and vestibular loss are exceedingly rare, their potential significance should not be underestimated. [25]

3. Diagnosis and classification - Wilkes Criteria under arthroscopic view

The diagnosis of Temporomandibular Disorder (TMD) has considerably advanced over time, particularly with the recent adoption of the Diagnostic Criteria for TMD (DC/TMD) in 2016. [26] These criteria are deemed reliable and valid for the majority of prevalent diagnoses, providing an effective means of communication in multidisciplinary settings. The classification encompasses the most frequent TMDs, classified under the two main entities of joint origin versus muscle origin, encompassing both pain-associated conditions (such as myalgia, arthralgia, and headaches attributed to TMD) and non-pain-associated conditions (including disc displacements, degenerative joint disease, and subluxation). This classification is useful for diagnosis and patient evaluation but does not pertain to surgical planning. In 2023, Dimitroulis introduced a new surgical classification that offers simplicity, dividing it into five categories based on clinical presentation, radiological assessment, and suggested surgical treatments. This classification aligns with modern treatment protocols, contrasting with the widely used Wilkes Criteria, which remains one of the most utilized surgical classifications that recently became more outdated. [27]

Individuals experiencing TMD are typically referred to the Oral and Maxillofacial department by their dentist or general practitioner. They should undergo an initial evaluation that includes a comprehensive history, clinical examination, and radiological assessment. Our team employs a digital form that encapsulates all the data for pre-surgical and post-surgical evaluations.

3.1. Clinical examination

Objective parameters include measurements of maximal inter-incisal opening (MIO) and lateral excursion (measured in mm). The measurement is conducted twice, both with and without the surgeon's assistance, to ensure a comprehensive assessment of the full range of movement. Additionally, the assessment includes tenderness under palpation of the muscles of mastication, evaluation for hypertrophy, inspection for joint tenderness, noises such as clicks or crepitations, "End Feel" test to distinguish between muscle-to-joint origin dysfunction, Mahan test which can evaluate joint and muscle under overloading, and other intraoral assessment such as Angle's classification of malocclusion, open-bite, over-jet, over-bite, and dentition support of occlusion. [28, 29]

It is essential to record subjective parameters during each patient examination, both pre-and post-procedure. Pain assessment is efficiently carried out using the visual analog scale (VAS), where scores range from 0 (signifying no pain) to 10 (indicating severe pain). Furthermore, the diet score indicates alterations in diet consistency, ranging from 0 (reflecting a liquid diet) to 10 (representing a normal diet with no restrictions).

3.2. Radiological evaluation

Imaging the TMJ is essential for both hard and soft tissue. Radiographs such as lateral cephalometry or posterior-anterior (PA) view and orthopantomogram (OPG) radiographies are utilized as primary screening tools mainly for evaluating the bony structure of the joint and facial asymmetry. Approximately 75% of CT-assessed osteoarthritis goes undetected with panoramic radiography, and the interobserver reliability is poor. [30] According to a position paper by the American Academy of Oral and Maxillofacial Radiology, orthopantomogram radiography is useful for detecting gross TMJ pathology. [31] MRI has long been the preferred method for assessing temporomandibular joint (TMJ) disorders, offering comprehensive visualization of both soft tissue and bone. However, for bone surface abnormalities, CT is generally considered superior, detecting about 40% more cases of osteoarthritis compared to MRI. [30] Cone-beam computed tomography (CBCT) shows acceptable accuracy in diagnosing osseous abnormalities, although image quality may vary across different CBCT machines. While CT excels in revealing cortical bone issues associated with TMJ osteoarthritis, such as erosion and osteophytes, MRI remains exclusive for evaluating bone marrow. MRI provides a high-quality view of pathologies involving the disc, offers a dynamic assessment of the disc's function, and allows for the most intricate observations, including the detection of perforations. [32, 33] MRI should be considered the reference test to establish the baseline before any arthroscopy, from our point of view. (See Figure 1. A-C)

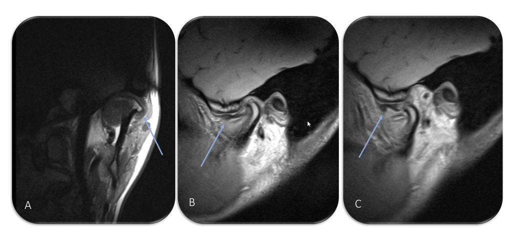

Figure 1. MRI images of anterior and lateral disc displacement without reduction (see arrows). A: Coronal T1-weighted MRI (TSE) of the left TMJ in open mouth position reveals lateral displacement beyond the lateral pole; B: Sagittal proton density weighted MRI in closed mouth position displays anterior disc displacement related to the articular eminence and anterior to the mandibular condyle; C: Sagittal proton density weighted MRI in open mouth position indicates no reduction of the disc between the articular eminence and the mandibular condyle.

3.3. Final diagnosis

Upon collecting all clinical and radiological data, patients should be diagnosed using the Diagnostic Criteria for TMD (DC/TMD). [26] Although it was now considered as outdated, Wilkes criteria serves as a valuable tool for practitioners, offering widely accepted terminology for defining internal derangement (ID) disorders (see Table 1). The Wilkes criteria is initially applied to the patient following clinical evaluation, then again after imaging, mainly classification on MRI, and for the third time during arthroscopy. We have developed an arthroscopic criteria that aligns with the Wilkes criteria, incorporating findings that are observable exclusively under arthroscopic view for the final diagnosis of the patient. Wilkes based his research and publication on tomographic, arthrographic, and, later, on MRI. Additionally, his surgical diagnoses were grounded in open joint procedures, which were more common in those days. [34]

4. The stepwise treatment protocol - Surgical technique & Armamentarium

Patients are referred to the TMJ clinic by their dentist or ENT surgeon, where they undergo evaluation by the team. Each patient is assessed using a standardized form, and treatment is provided in a stepwise manner based on the diagnosis and the stage of the disease. Those experiencing internal derangement typically receive conservative treatment initially, with further imaging pursued if necessary.

4.1. Conservative treatment as a preliminary step

The National Institute for Health and Care Excellence (NICE) guidelines recommend adopting a comprehensive biopsychosocial approach to management. It's important to reassure individuals that TMD is typically slowly progressive, and symptoms can improve. Educate them on the nature of the disorder and available management options. Encourage self-management practices, such as adhering to a soft diet during acute pain and avoiding activities that exacerbate symptoms. Consider short-term analgesia or, if necessary, low-dose benzodiazepines for acute symptoms, along with medications like amitriptyline or gabapentin for chronic pain. Manage comorbidities by addressing stress, providing relaxation techniques, and setting realistic goals. Offer advice on sleep hygiene and provide information sources, such as the NHS leaflet on TMD, for a comprehensive understanding.

Patients are initially advised to consult their dentist for hard acrylic stabilizing or anterior repositioning splint therapy. It is important to note that these splints can be costly, and some patients may encounter challenges in obtaining this appliance. Additionally, physiotherapy, preferably conducted by head and neck specialist physiotherapists, is recommended pre- and postoperatively.

4.2. Surgical technique

At our Department patients undergo a standardized surgical procedure with general anesthesia and nasotracheal intubation, performed by the same surgeon (DK). Before draping, the surgical site is prepared with Betadine solution. The external auditory canal is packed with a cotton pellet soaked in Betadine, while Tegaderm is used to cover the nasal tube and the patient's nose. A transparent drape is then used to cover the mouth, allowing for jaw manipulation while preventing any oral fluids from contaminating the surgical site.

During the procedure, the assistant manipulates the patient's jaw forward and backward while the surgeon marks the portal entry points with a marking pen. (see Figure 2)

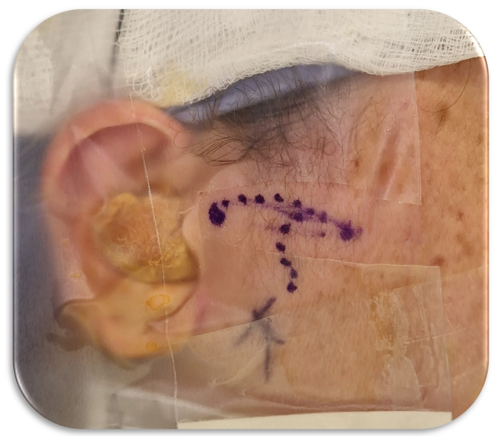

Figure 2. Throughout the procedure, the assistant guided the patient's jaw in forward and backward movements, while the surgeon identified the portal entry points using a marking pen. In level I arthroscopy, the mark was positioned at the uppermost posterior border of the glenoid fossa, and for level II arthroscopy, a second mark was made at the foremost position of the condyle during forward jaw movement.

For level I arthroscopy, the mark is placed at the most superior posterior border of the glenoid fossa, and for level II arthroscopy, a second mark is placed at the most anterior position of the condyle when the jaw is pulled forward. Next, the joint space is insufflated with 5ml lidocaine 2% with no adrenaline using a 23G needle to expand the space. The surgeon then performs a "sharp-to-blunt" TMJ arthroscopic puncture technique using a 1.9 mm operative system (Nexus CMF McCain, Salt Lake City, Utah, USA) to enter the patient's superior joint space. Irrigation of the joint is performed using saline solution, with the pressure of irrigation controlled by another assistant and a pressure infuser bag. A 16G needle is placed into the superior compartment as an outflow of irrigation fluid, 5 mm anterior to and slightly below the entry of the first portal entry. The first portal is introduced, followed by a thorough diagnostic sweep of the joint. During this process, seven specific points of interest are

Table 1. Table 1. Wilkes Criteria of TMJ Internal derangements. [34]

Stage	Clinical	Radiological	Surgical
I. Early stage	No significant mechanical symptoms other than early opening, reciprocal clicking; no pain or limitation of motion	Slight forward displacement; good anatomic contour of the disc; negative tomograms	Excellent anatomic form; slight anterior displacement; passive incoordination demonstrable
II. Early/ intermediate stage	One or more episodes of pain; beginning major mechanical problems, loud clicking, transient catching, and locking	Slight forward displacement; early signs of disc deformity with a slight thickening of posterior edge; negative CT	Anterior disc displacement; early anatomic disc deformity; good central articulating area
III. Intermediate stage	Multiple episodes of pain; major mechanical symptoms including locking (intermittent or fully closed), restricted motion, and functional difficulty	Anterior disc displacement with significant disc deformity/prolapse (increased thickening of posterior edge); negative CT	Marked anatomic disc deformity with anterior displacement; no hard tissue changes
IV. Intermediate/ late stage	Slight increase in severity as compared to intermediate stage	Positive CT showing early-to-moderate degenerative changes—flattening of eminence; deformed condylar head; sclerosis	Hard tissue degenerative remodeling of both bearing surfaces; multiple adhesions in anterior and posterior recesses; no perforation of disc or attachments

carefully visualized and assessed to gain a comprehensive understanding of the joint's condition. If the joint space is hyperemic at the retrodiscal area and presents with chondromalacia, a second portal is introduced for level II arthroscopy. The "triangulation" technique [35] is used for the second portal, which is placed anteriorly as marked under jaw manipulation.(see Figure 3)

While viewing the second portal with the scope, an arthroscopic coblation (ReFlex Ultra ™45, ArthroCare ENT, Austin, Texas) is used to coagulate the hyperemic retrodiscal tissue.(see Figure 4) In addition, if needed, a biopsy is taken with a grasper (Nexus CMF McCain, Salt Lake City, Utah, USA), and a blunt straight probe evaluates the disc reduction.(see Figure 5)

At the end of the procedure, through the second portal cannula, PRP is injected into the retrodiscal tissue with a spinal needle.(see Figure 6) Sutures are utilized to close the wounds at the portal entry points using Vicryl Rapide™ 5/0.

Figure 3. McCain triangulation and transillumination technique involve the second puncture with the condyle seated in the fossa. The puncture site is determined based on triangulation principles, where the vectors of instrument orientation form an equilateral triangle. This facilitates a consistent and secure pattern for the placement of the second punctures.

Figure 4. A and B: The presentation of hyperemia in the retrodiscal tissue, with the ReFlex Ultra™45 (ArthroCare™ ENT, Austin, Texas, USA) Coblator introduced through a second working cannula before activation. C and D display retrodiscal tissue that has been cleared and treated after coblation. E: Clinical presentation of the coblator placed straight within the second port.

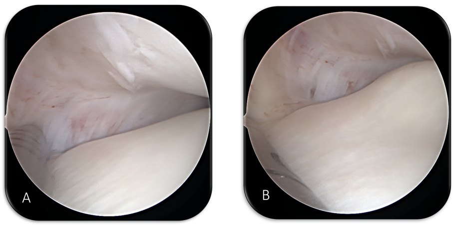

Figure 5. A and B: Disc reduction evaluation by a blunt straight probe introduced through the second working cannula. Anatomical structures can be seen clearly such as the Medial synovial drape, the pterygoid shadow and the posterior slope of the articular eminence.

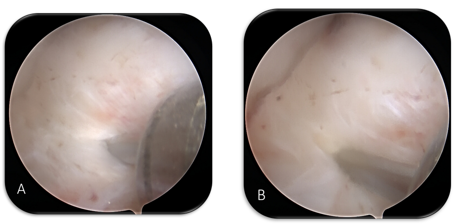

Figure 6. A and B: A spinal needle is inserted through the second working cannula into the retrodiscal tissue for the final injection of PRP.

4.3. Armamentarium

Arthroscopy of the TMJ involves a steep learning curve that necessitates regular practice on a weekly basis. The initial step of performing level I arthroscopy is challenging but, with time, it enables the practitioner to progress to level II and eventually, with meticulous practice, to level III. In contemporary times, arthroscopy has the potential to establish a new standard of care that was previously unavailable. In the past, straightforward cases were addressed through open joint surgery.

4.3.1. Arthroscope

An arthroscopic system should possess a viewing angle of at least 30° and strive for a minimal focal distance. The resolution of images is a critical parameter, setting the limits for visualizing intricate details. "White balance" is also crucial for achieving optimal performance and visualizing. Our team obtained all arthroscopies with a Nexus operating system (Nexus CMF McCain, Salt Lake City, Utah, USA). (see Figure 7) The joint was examined with a 1.9-mm, Nexus Scope, the scope has a total length of 115 mm, with a working length of 63.1 mm. It provides a field of view spanning 65 degrees, and its direction of view is set at 30 degrees. The arthroscope is connected to an ultra-high-definition camera system (Synergy UHD4, Arthrex, Munich, Germany). The UHD4 4K monitor is offered in 32" to maximize the quality of the image. (see Figure 8)

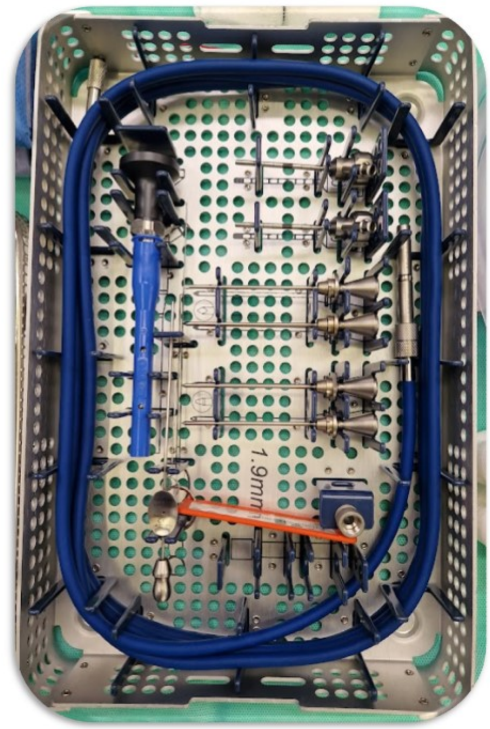

Figure 7. McCain 1.9mm Arthroscope System (Nexus CMF McCain, Salt Lake City, Utah, USA).

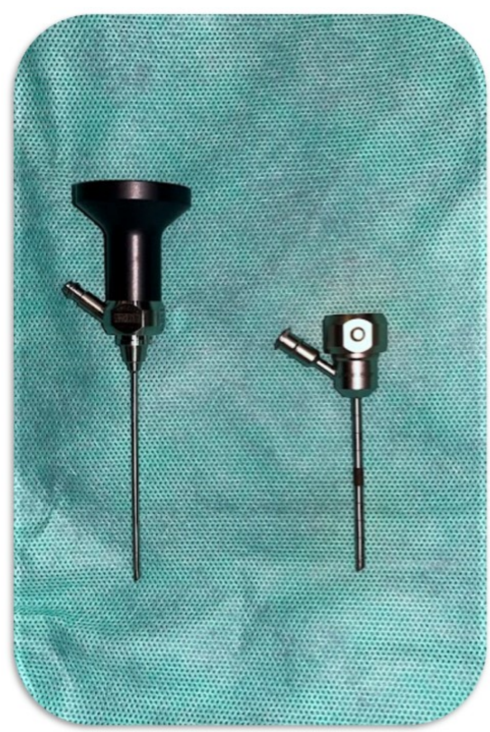

Figure 8. The 1.9-mm Nexus Scope is 115 mm long with a 63.1 mm working length, a 65-degree field of view, and a 30-degree direction of view. The accompanying 1.9 mm Warburton Collar-lock Scope Cannula is 50 mm long, marked for a 25 mm working length for scope or portal use.

4.3.2. Cannulas, trocars, and obturator

For level II or III arthroscopy the Nexus operating system (Nexus CMF McCain, Salt Lake City, Utah, USA) provides 1.9 mm Warburton Collar-lock Scope Cannula of 50mm long. The cannula is marked to allow control of a 25 mm working length used for the scope or as a working portal. A set of two 1.9 mm sharp trocars and 1.9 mm blunt obturators are needed to be introduced to the superior joint space to enable scope placement. (see Figure 9)

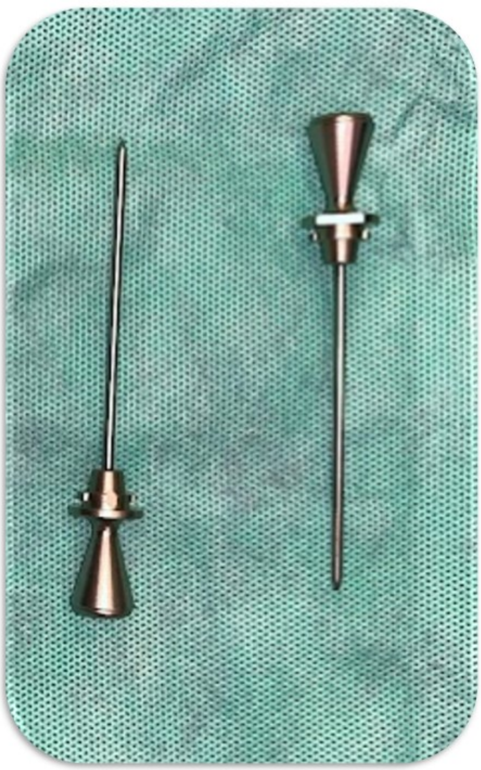

Figure 9. A set of two 1.9 mm sharp trocars and 1.9 mm blunt obturators are needed to be introduced to the superior joint space to enable scope placement.

4.3.3. Probes, graspers and biopsy forceps

As components of the 1.8 mm Nexus set, probes are crafted in various shapes, including straight or curved options, with blunt designs for manipulating and mobilizing the disc and detaching adhesions. Tissue grasping forceps and serrated biopsy forceps come into play when gathering small biopsy samples and for debriding pathological tissue.

4.3.4. Coablation

"Coblation" is a controlled ablation technique involving the application of high voltages to a conductive irrigate (sodium) between an electrode and tissue. This process transforms sodium ions into ionized vapor (plasma), which contains excited particles that break tissue's molecular bonds, leading to its removal. Unlike traditional methods, Coblation breaks down tissue into simpler compounds rather than exploding it into smaller pieces. The process is carried out at low temperatures between 60°C and 70°C, contrasting with the higher temperatures in electrosurgery (about 400°C to 600°C). The authors mainly use coblation for posterior retrodiscal tissue cauterization, pterygoid anterior release, synovectomy, and hemostasis. The ReFlex Ultra ™45 (ArthroCare™ ENT, Austin, Texas Austin, Texas,USA) Coblator, used by our team, utilizes radio frequency energy to create plasma and effectively ablate tissue. In the past, normal 0.9% saline was utilized for irrigation, but currently, the recommended choice is Ringer's lactate solution. [36] (see Figure 10)

Figure 10. The ReFlex Ultra ™45 (ArthroCare™ ENT, Austin, Texas Austin, Texas,USA) Coblator, used by our team, utilizes radio frequency energy to create plasma and effectively ablate tissue. The flexible probe easily passes straight through the 1.9 working cannula.

4.3.5. Spinal needle

The ACP® (Autologous Conditioned Plasma) double syringe system (Arthrex, Naples, Florida, USA) was initially used by out team to inject PRP at the conclusion of the arthroscopic procedure into the superior joint compartment, with 2.5 ml administered to each side (commonly bilateral, totaling a 5 ml injection). The PRP was injected through the arthroscopic cannula after removing the second port. Subsequently, the author (DK) developed a technique, by which PRP is injected into the retrodiscal tissue using a spinal needle (22G*3.50", 0.7mm*90mm). This novel technique is currently undergoing prospective research through a randomized controlled trial (see Figure 11).

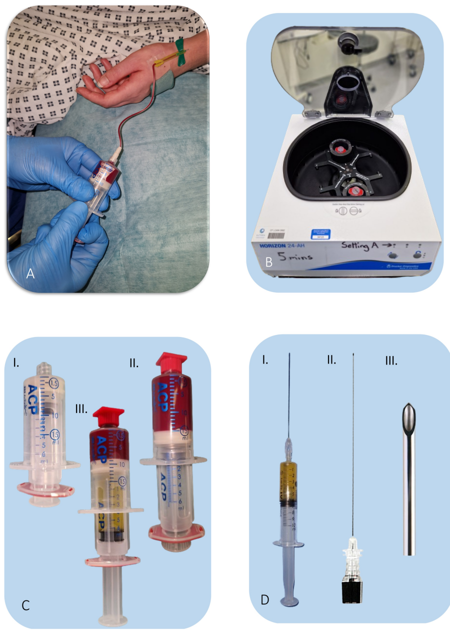

Figure 11. PRP preparation and application. Preparation steps for the Arthrex ACP® (Autologous Conditioned Plasma) double syringe, PRP extraction system (Arthrex, Naples, Florida, USA). A: Showing the extraction of autologous blood intraoperatively. B: The separation of PRP and erythrocyte layers by 5 minutes centrifugation. C: The harvested PRP via the double syringe system (I. empty double syringe, II. After blood harvesting and III. separated PRP after centrifugation). D. PRP ready for injection (I. PRP in a 5 ml syringe and 22G spinal needle, II. 22G*3.50", 0.7mm*90mm spinal needle, III. tip of the spinal needle used).

Arthrex ACP is a blood plasma concentrate that is used in orthopedic treatments to promote healing and tissue regeneration. [37, 38] The PRP product was obtained and prepared according to the manufacturer's instructions. After extraction of patient's blood during surgery via puncture of a peripheral vein, usually a small amount of blood (about 30-60 mL) is drawn from the patient's arm using a sterile technique. The blood is placed in a specialized centrifuge and spun at a high speed (1500 RPM for 5 mins) to separate the plasma from the other blood components. Centrifugation, a process that separates its components based on density. During centrifugation, the heavier elements, notably red blood cells, settle at the bottom, while the lighter components, including platelets and plasma, remain suspended in the upper layer. The layer containing PRP, rich in platelets and growth factors, is carefully extracted from the top of the tube post-centrifugation. The Arthrex ACP system uses a double centrifugation technique to obtain a high concentration of platelets and growth factors. After centrifugation, the plasma is collected using a sterile syringe and transferred to a sterile container. This PRP preparation, once collected, can be further activated, if desired, to enhance its therapeutic potential. ACP® does not involve an activation step after centrifugation, and the PRP is used in its natural form. This step is performed immediately before injection to ensure maximum potency. Injection of PRP was applied intra-articular through the cannula under sterile conditions. (see Figure 11)

5. Injectable materials: Platelet-rich plasma, steroids, hyaluronic acid, and new alternatives

In the realm of TMJ interventions, various injectable materials have been explored to address the complex challenges associated with this anatomical region.

5.1. Hyaluronic acid (HA)

HA is a polysaccharide, specifically a non-sulfated glycosaminoglycan. It is composed of recurring units of D-glucuronic acid and N-acetylglucosamine, featuring alternating beta (1–3) glucuronide and beta (1–4) glucosamine bonds. Physiologically HA, naturally present in both articular cartilage and synovial fluid, has been investigated for its viscoelastic properties, aiming to improve lubrication and reduce friction within the TMJ. [39] This injectable substance holds promise in alleviating pain and enhancing joint function in cases of TMD. There are different formulations of hyaluronic acid available for intra-articular injection. These formulations may vary in terms of molecular weight, concentration, and other factors. [40]

5.2. Steroids

Corticosteroids have been employed as injectable agents in the TMJ to mitigate inflammation and manage symptoms of TMD. These anti-inflammatory medications aim to suppress the immune response, thereby reducing pain and swelling in the joint. While corticosteroid injections may provide effective short-term relief, their long-term use requires careful consideration due to potential side effects. Intra-articular corticosteroid injections have demonstrated positive outcomes in the management of various TMJ disorders such as juvenile idiopathic arthritis and rheumatoid arthritis. [41] Nevertheless, reported side effects include the potential exacerbation of pre-existing joint conditions. Additionally, an animal study revealed condylar resorption following a single TMJ injection with dexamethasone, emphasizing the importance of considering such adverse effects. [42]

5.3. Platelet-rich plasma (PRP)

PRP is another emerging injectable material in the TMJ literature. PRP is derived from the patient's own blood and contains concentrated platelets, growth factors, and other bioactive substances. Advocates of PRP suggest its potential to promote tissue healing and regeneration, making it a subject of interest for TMJ disorders. [43–45] PRP has gained attention in the field of orthopedics for its multifaceted biological activities within joints, viewed through the lens of biochemistry. The intricate biochemical composition of PRP plays a pivotal role in modulating various cellular processes critical for joint health and healing.

At a fundamental level, platelets within PRP release growth factors such as platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), and insulin-like growth factor (IGF-1). These growth factors are potent stimulators of cell proliferation, angiogenesis, and extracellular matrix synthesis. PDGF, for instance, promotes the migration and proliferation of cells involved in tissue repair. TGF-β contributes to the formation of new blood vessels and the regulation of inflammation. IGF-1 is instrumental in promoting cell growth and differentiation. By harnessing these bioactive components, PRP aims to create an optimal biochemical environment within joints, fostering tissue regeneration, reducing inflammation, and potentially improving overall joint function. [46, 47] The intricate interplay of these biochemical factors underscores the promising role of PRP in TMJ applications, offering a nuanced perspective from the realm of biochemistry on its therapeutic potential within joints.

5.4. Mesenchymal Stromal Cells (MSCs)

The future of TMJ treatment draws inspiration from recent orthopedic breakthroughs, especially in the realm of ortho-biologics. Among the progressive alternatives, mesenchymal stromal cells (MSCs) stand out, offering promise in osteoarthrosis (OA) therapy. [48] Apart from their structural role in tissue repair, MSCs exhibit immunomodulatory and anti-inflammatory actions through direct cell-to-cell interactions or the secretion of bioactive factors. [49] These versatile MSCs are easily obtained from various tissues, including bone marrow, adipose tissue, synovial membrane, peripheral blood, and skin. [50] Bone marrow, particularly bone marrow MSCs (BMSCs), serves as a commonly used source due to its ease of collection. BMSCs have been explored in both cultured forms, expanded through culture, and as a simple bone marrow concentrate (BMC) due to their relative abundance. The minimal cell manipulation approach, enabling the direct on-site production of bone marrow aspirate concentrate (BMAC) in a single treatment step, has found widespread application in clinical practice, particularly in treating cartilage lesions. Recently, it has been hailed as a promising injective approach for degenerative orthopedic conditions. [51] Recently, the on-site production approach is gaining prominence in the field of TMJ treatment. [52, 53] This method, with its focus on immediacy and precision, marks a notable shift in the landscape of therapeutic interventions. As advancements in technology continue to shape the trajectory of TMJ care, it opens up exciting avenues for future research. The exploration of novel techniques, further refinement of existing methodologies, and a deeper understanding of the molecular and cellular mechanisms involved in TMJ disorders are essential directions for future investigations. By leveraging cutting-edge technologies and insights, researchers aim to enhance the efficacy and precision of on-site treatments, ultimately paving the way for more effective and tailored approaches to TMJ care.

6. Pre- and postoperative management

In our centre all patients undergo day case admission and are discharged on the same day. Intraoperatively, they all receive co-amoxiclav (1 g intravenously) and dexamethasone (6.6 mg IV), with no postoperative antibiotic prescription. Pain is managed using analgesics or anti-inflammatory drugs such as Ibuprofen or Naproxen. Patients are advised to maintain an elevated head position during recovery and to sleep with 2-3 pillows, keeping the head at a 30-degree elevation. The primary follow-up visit is scheduled for 6 weeks after surgery. Patients are instructed to commence jaw-stretching exercises soon after surgery. Beyond the initial 48 hours, they are encouraged to apply warm heat (e.g., heating pads or a microwave-warmed cloth) to the jaw muscles and temples as needed, and to continue their physiotherapy sessions. Splint therapy is recommended on the same day as the operation.

7. Conclusions

TMJ Disorder presents a multifaceted challenge requiring a holistic approach for precise diagnosis and effective management. Meta-analyses indicate that patients with advanced arthritis derive significant benefits from early arthroscopic intervention combined with Platelet-Rich Plasma (PRP) injections. [9, 54, 55] While established classification criteria serve as a solid foundation for diagnosis, there remains a lack of consensus on a universally adopted surgical classification, with the Wilkes criteria being the predominant choice in surgical clinical research. Advanced imaging modalities such as MRI and CT scans play a pivotal role in providing comprehensive data for evidence-based decision-making, highlighting the potential utility of a novel radiological classification system. [26, 31, 56, 57] Therapeutic TMJ arthroscopy serves a dual role in both diagnosis and treatment, offering real-time visualization of joint pathology. [58] Integration of arthroscopy into comprehensive management strategies is supported by research, underscoring its immediate therapeutic benefits. [59] PRP, obtained from the patient's blood, contains platelets and growth factors capable of promoting tissue healing and regeneration in TMJ disorders. By releasing key factors like PDGF, TGF-β, and IGF-1, PRP aims to foster an optimal biochemical milieu, mitigating inflammation and enhancing overall joint function. [37, 38] In summary, the combination of arthroscopy with PRP injections presents a promising therapeutic avenue for addressing TMJ disorders.

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