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Clinical Evaluation of Autologous Conditioned Serum Prolotherapy in Temporomandibular Joint Disorders

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Abstract

Purpose

Temporomandibular disorder is a prevalent cause of non-dental, non-infectious facial pain, leading to significant discomfort and impaired function of the temporomandibular joint. Conventional treatments often offer temporary relief. Autologous Conditioned Serum prolotherapy has shown promise in other musculoskeletal disorders, but its efficacy in TMD management remains underexplored. This study aims to evaluate the potential ability of ACS in managing TMD.

Methods

A non-randomized trial was conducted among 25 patients aged 20–50 years diagnosed with TMD. Participants received ACS injections over four weeks. Primary outcomes included pain relief (Visual Analog Scale) and secondary outcomes such as joint functionality (mouth opening and range of motion) and joint clicking. Statistical analysis was performed using repeated measures ANOVA, Chi-square tests, and bonferroni post hoc comparisons.

Results

Significant reductions in pain scores were observed from preoperative (7.08 ± 1.41) to the 6-month follow-up (2.32 ± 1.14) ($F = 89.71$, $p = 0.0001$). Improvements in mouth opening were observed, with a mean increase from 27.32 ± 4.24 mm preoperatively to 36.76 ± 3.47 mm at 6 months ($F = 111.28$, $p = 0.0001$). Range of motion showed significant improvement, with 84% of participants demonstrating a ROM > 5–7 mm at 6 months. Joint click decreased from 32% to 12%, though without statistical significance ($p = 0.30$).

Conclusion

ACS prolotherapy significantly improved key symptoms of TMD, including pain relief, mouth opening, and joint function, suggesting that ACS may be a promising non-invasive, first-line treatment for TMD, offering long-term symptom relief and functional improvement.

Introduction

Temporomandibular disorder (TMD) is a collective term for a heterogeneous group of disorders of the Temporomandibular Joint (TMJ) and related muscles. In the orofacial region, TMD is the most common cause of non-dental and non-infectious pain. Non-odontogenic chronic facial pain often stems from TMD, a broad classification encompassing diverse conditions that lead to discomfort and impaired function of the TMJ. Symptoms commonly linked with TMDs comprise joint pain, orofacial discomfort,

persistent headaches, and earaches(1). These may manifest alongside variations in jaw movement such as hyper- or hypo-mobility, jaw locking, dysfunction, difficulty with speech or clenching, and audible clicking during mouth movements. At times, TMD can also manifest without accompanying pain. The TMJ is prone to experiencing similar degenerative changes and pathologies observed in other synovial joints due to the frequent and repetitive stresses it endures. Aetiology for temporomandibular disorder remain to be multifactorial (2).

An international agreement on the clinical management of TMDs recommends employing non-surgical therapeutic approaches. Alongside education and lifestyle modifications, suggestions include the use of basic analgesics, occlusion splints, physiotherapy and acupuncture. As surgery is typically viewed as a final resort for TMD, patients often seek alternative treatments and prolotherapy, also referred to as Regenerative Injection Therapy (RIT) is one of the alternative modalities for treatment of TMD. Medical practitioners widely employ various injection therapies to treat musculoskeletal conditions. Typically, a common injection consists of a blend of corticosteroid and anaesthetic administered into joints and peritendinous areas. However, alternative techniques and agents such as dextrose, platelet rich plasma, Autologous whole blood is also currently utilised (3).

Traditional treatment methods like physiotherapy, home exercises, dietary restrictions provide temporary relief but seldom offer a cure. Persistent muscle spasm and myofascial pain, often linked to TMJ dysfunction are typically attributed to underlying laxity. Prolotherapy acts by stimulating ligament and capsular repair thus providing a more permanent and long-lasting relief.

Prolotherapy is defined as “the rehabilitation of an incompetent structure, such as a ligament or tendon, by inducing the proliferation of cells”. The word “Proles” means growth. Prolotherapy injections induce the stimulation or growth of new, healthy ligament and tendon tissues (4). It is a natural, minimally invasive technique that encourages the body to repair the painful area by supporting its natural healing process. Prolotherapy technique is a natural, minimally invasive procedure that encourages the body to heal the affected area by facilitating the natural healing process.(5) An agent is administered into the ligament to prompt a proliferative reaction within it. These injections aim to reinforce the ligaments and alleviate pain. Various substances have been employed as proliferants, including psyllium seed oil, dextrose with glycerine and phenol, lignocaine. The prolotherapy injections with dextrose and platelet rich plasma have shown satisfactory results in inflammatory and non-inflammatory conditions associated with TMJ disorders (6).

Prolotherapy has been found to be superior to splints in reducing pain and in improving mouth opening and clicking. It provides long term relief of symptoms; it should be considered in patients with internal derangement of TMJ before the surgical intervention is initiated (7).

Autologous Conditioned Serum (ACS) which has been used in the field of orthopaedics yet to be explored in TMJ disorders as proliferants. It has anti-inflammatory properties because of its ability to inhibit the cytokine 1L -1 beta through the production of its natural receptor antagonist. The use of ACS is recommended in knee osteoarthritis (KNOA) and other inflammatory conditions related to joints. ACS

has shown satisfying results with increased efficacy in other joints of the body and have shown potential benefits in the treatment of KNOA and tendinopathies, muscle injuries (8).

The purpose of the study is to evaluate ACS Prolotherapy as a novel minimally invasive approach for patient's refractory to conservative management. Given the limited availability of literature on the application of ACS in TMD management, investigators have hypothesized that there is no effect or improvement in TMJ disorders on using ACS as a treatment modality. Thus, the aim of the study is to investigate the potential ability of ACS in managing TMD by assessing the efficacy of clinical parameters, including pain relief, joint functionality, joint clicking, and the stability of the treatment outcome over time.

Methodology

This non-randomized prospective study included 25 patients aged 20–50 years diagnosed with TMD based on clinical and radiological examination. The study included patients with Wilkes Class I or II TMD, refractory to conservative treatment, and with degenerative TMJ disorders or Degenerative Joint Disease (DJD). Patients with severe debilitating diseases, pregnant or lactating women, previous TMJ surgery, or those unwilling to participate or follow up were excluded. The primary predictor variable was the use of ACS for treating TMD. The primary outcome variable was pain relief, measured using the Visual Analog Scale (VAS). Secondary outcome variables included joint functionality (maximum mouth opening and range of motion), joint click (present or absent), and treatment outcome stability.

Before the intervention, all patients underwent a thorough preoperative evaluation. This began with a detailed case history, where key aspects such as the onset, duration, and nature of symptoms, pain characteristics (including intensity, frequency, and location), and the impact on daily activities were carefully documented. Pain characteristics were categorized by type (sharp, dull, throbbing) and intensity (mild, moderate, severe). The clinical examination involved assessing pain intensity using the Visual Analog Scale (VAS), examining mandibular mobility, and palpating for any muscle tenderness or dysfunction. Radiological imaging, including an Orthopantomogram (OPG) and Magnetic Resonance Imaging (MRI) of the TMJ, was conducted to evaluate both bony and soft tissue changes. (Fig. 1) Additionally, basic medical examinations were performed to ensure the patients were fit for the procedure and had no contraindications. These steps were crucial in establishing a baseline for each patient before proceeding with the ACS treatment.

The preparation of ACS began with the drawing of whole blood from each patient. Using a 10 ml syringe with a 26-gauge needle, the blood was collected into a vacutainer containing Chromium Sulphate ($CrSO_4$) treated glass beads, which help in the accumulation of anti-inflammatory mediators. The vacutainer was then incubated for 24 hours at 37°C, allowing the serum to develop the necessary biological components. Following this, the serum was centrifuged at 4000 rpm for 5 minutes to separate the supernatant, which was then filtered, collected, and stored until its use in the patient. This ACS

preparation was kept at the Department of Lab Sciences, Army Hospital, until it was ready for injection. (Fig. 2A)

ACS injection was performed under aseptic conditions with local anaesthesia (2% lignocaine with 1:80,000 adrenaline). Anatomical landmarks were marked using the Holmlund-Hellsing line to locate the superior joint space and pericapsular region for injection. (Fig. 2B) A 26-gauge needle was inserted into the superior joint space at a depth of 20–25 mm, with 2 ml of ACS injected into the joint. (Fig. 2C) The procedure was done unilaterally and repeated for four consecutive weeks at one-week intervals. After each injection, patients were observed for 1 hour in the recovery room before being discharged with follow-up instructions.

After the ACS injection, patients were moved to the postoperative observation room for a minimum of 1 hour to ensure that there were no immediate adverse reactions. Postoperatively, patients were instructed to take NSAID analgesics (Ibuprofen 400 mg and Paracetamol 325 mg) as needed for pain relief. An external pressure dressing was applied to the preauricular region where the injection was administered to reduce swelling and discomfort. Follow-up assessments were scheduled for the 7th day, 14th day, 1 month, and 6 months to monitor the patient's recovery and evaluate the effectiveness of the ACS treatment. During each follow-up visit, standardized clinical parameters were assessed to monitor recovery and the effectiveness of ACS treatment. Pain, maximum mouth opening, range of motion, and joint click were re-assessed during each visit to track improvements or any complications. Pain was evaluated using the Visual Analog Scale (VAS), where patients rated their pain from 0 (no pain) to 10 (worst pain imaginable), allowing for consistent monitoring of pain relief over time. Maximum Mouth Opening (MMO) was measured in millimetres using a Vernier calliper, from incisal edge to incisal edge, to assess improvements in jaw function. (Fig. 2D) Range of Motion (ROM) was measured in millimetres by instructing the patient to perform lateral (right and left), protrusive, and retrusive mandibular movements, with normal movement defined as 5–7 mm. Any deviations from this range were noted. Joint Click was evaluated by palpating and auscultating the preauricular region during mandibular movement to detect the presence or absence of clicking, which was recorded as a binary outcome (Yes/No). Data were systematically recorded by the same observer at each stage of follow-up, ensuring consistency in the evaluation process.

Data were analysed using IBM SPSS Statistics for Windows, Version 21.0. Repeated measures ANOVA was used for intragroup comparison of pain, mouth opening, and range of motion followed by Bonferroni post hoc analysis. A Chi-square test was employed for joint click analysis. Statistical significance was set at $p < 0.05$.

Results

Among the 25 participants, 40% (n = 10) were males, and 60% (n = 15) were females, with a mean age of 35.4 ± 4.77 years. Table 1 presents the distribution of pain scores and mouth opening at various time points. The mean pain scores decreased significantly from pre-op (7.08 ± 1.41) to Day 7 (4.36 ± 1.19) and

6 months (2.32 ± 1.14), with a statistically significant overall change (F = 89.71, p = 0.0001). Similarly, mouth opening showed a significant improvement, increasing from a mean of 27.32 ± 4.24 mm at pre-op to 36.76 ± 3.47 mm at 6 months (F = 111.28, p = 0.0001).

Table 2 summarizes the pairwise comparisons of pain and mouth opening between the time points using the post hoc test. Pain scores showed significant differences in all comparisons between pre-op and post-treatment time points (p < 0.0001), with the greatest improvement observed between pre-op and Day 14 (mean difference 4.72, p = 0.0001). Mouth opening also demonstrated significant improvement at all post-treatment intervals, with the largest change between pre-op and 6 months (mean difference − 9.44, p = 0.0001).

Table 3 presents the distribution of ROM and joint click at various time points. The number of participants with ROM < 5–7 mm decreased significantly from 19 (76%) pre-op to 4 (16%) at 6 months (p = 0.001). In contrast, the number of participants with ROM > 5–7 mm increased significantly from 6 (24%) pre-op to 21 (84%) at 6 months. Joint click did not show significant changes across the time points (p = 0.30), with a slight reduction in the number of participants experiencing joint clicks, from 8 (32%) pre-op to 3 (12%) at 6 months.

Table 1
Distribution of pain scores and mouth opening at various time points

Parameter	Pre-op	Day 7	Day 14	1 month	6 months	F	p value
Pain	7.08 ± 1.41	4.36 ± 1.19	2.36 ± 0.81	2.24 ± 1.05	2.32 ± 1.14	89.71	0.0001*
Mouth opening	27.32 ± 4.24	31.52 ± 4.01	34.72 ± 3.87	36.12 ± 3.55	36.76 ± 3.47	111.28	0.0001*

Table 2
Pair wise comparison of pain and mouth opening between time points using post hoc test

Parameter	Timeline	Mean difference	95% CI for difference		p value
			Lower	Upper	
Pain	Pre-op – Day 7	270	2.199	3.241	0.0001*
	Pre-op – Day 14	4.720	3.932	5.508	0.0001*
	Pre-op – 1 month	4.840	3.9118	5.762	0.0001*
	Pre-op – 6 months	4.760	3.956	5.564	0.0001*
	Day 7 - Day 14	2.000	1.382	2.618	0.0001*
	Day 7–1 month	2.120	1.296	2.944	0.0001*
	Day 7–6 months	2.040	1.361	2.719	1.000
	Day 14–1 month	0.120	-0.3229	0.569	1.000
	Day 14–6 months	0.040	-0.480	0.560	1.000
	1 month – 6 months	0.080	-0.582	0.422	1.000
Mouth opening	Pre-op – Day 7	-4.200	-4.843	-3.557	0.0001*
	Pre-op – Day 14	-7.400	-8.570	-6.230	0.0001*
	Pre-op – 1 month	-8.800	-10.074	-7.526	0.0001*
	Pre-op – 6 months	-9.440	-10.846	-8.034	0.0001*
	Day 7 - Day 14	-3.200	-3.936	-2.464	0.0001*
	Day 7–1 month	-4.600	-5.492	-3.708	0.0001*
	Day 7–6 months	-5.240	-6.315	-4.165	0.0001*
	Day 14–1 month	-1.400	-1.935	-0.865	0.0001*
	Day 14–6 months	-2.040	-2.742	-1.338	0.0001*
	1 month – 6 months	-0.640	-0.991	-0.289	0.0001*

Table 3
Distribution of Range of motion and joint click at various time points

Parameter	Pre-op	Day 7	Day 14	1 month	6 months	p value
Range of motion, n (%)						
< 5-7mm	19 (76)	9 (36)	6 (24)	3 (12)	4 (16)	0.001**
> 5-7mm	6 (24)	16 (64)	19 (76)	22 (88)	21 (84)	
Joint click, n (%)						
No	17 (68)	17 (68)	20 (80)	21 (84)	22 (88)	0.30
Yes	8 (32)	8 (32)	5 (20)	4 (16)	3 (12)	

Discussion

ACS, an innovative agent for prolotherapy in TMD, has demonstrated notable efficacy in orthopaedic applications, particularly in the management of knee osteoarthritis (OA). As a source of IL-1 receptor antagonist (IL-1Ra), ACS facilitates the repair of cartilage and subchondral bone, positioning it as a viable alternative therapy for degenerative joint diseases (9, 10). Its therapeutic benefits in OA are well established, with evidence showing improvements in clinical signs and symptoms through enhanced tissue regeneration and the mitigation of degenerative processes (11, 12). However, despite its documented success in knee OA, the application of ACS in TMJ disorders remains underexplored and lacks empirical evidence. Considering the critical role of IL-1β in the pathogenesis and progression of TMJ osteoarthritis, the aim of the present study is to clinically evaluate the patients with TMD managed by use of Autologous Conditioned Serum prolotherapy.

Pain is often the most debilitating symptom in TMD, and the primary reason patients seek treatment. In the present study, the pain scale assessment revealed a marked reduction in pain levels, with pre-operative scores averaging 7.08, decreasing to 2.32 at the six-month follow-up. This reduction in pain signifies not only the effectiveness of ACS in providing symptomatic relief but also its potential role in improving patients' quality of life. This is consistent with the pain reduction reported by Ravikumar C et al (13). in TMJ, who demonstrated that Dextrose prolotherapy group showed better pain relief at 2 weeks, the ACS group demonstrated superior outcomes at 2 months, suggesting overall ACS group. In their study, the median pain score in the control group decreased from 6.5 pre-operatively to 0 by 2 months, demonstrating pain reduction like the significant decrease observed in the current study. Although their results showed a quicker resolution of pain at 2 weeks and 1 month, the significant pain reduction by 6 months aligns with the current findings, indicating better pain reduction in terms of long-term pain management.

In the study by Baltzer et al (12). on patients with knee OA, the clinical effects of ACS were compared with hyaluronan (HA) and saline (placebo). For the ACS group, mean pain scores decreased notably from a baseline of 69.6 to 33.8 at week 7, 29.6 at week 13, and 29.5 at week 26. While all treatment groups

experienced symptom reduction and quality of life improvements following intra-articular injections, ACS demonstrated significantly superior effects. No significant differences were observed between the effects of HA and saline. Thus, supporting our findings that ACS not only alleviates pain but also enhances joint function. The anti-inflammatory action of ACS, by increasing IL-1ra levels, likely plays a central role in these pain-relieving effects.

Tassara M et al (14). on patients with knee and hip OA treated with ACS reported a significant decrease in pain over the course of the study. Furthermore, during the follow-up, 25% of cases showed increased pain, while 68% remained stable, and 2 cases improved further. No significant differences in VAS reduction were found based on gender, but younger patients tended to have slightly better outcomes, although not statistically significant. Our results showed a pronounced improvement, possibly attributable to differences in the patient population or the specific condition being treated (TMD versus osteoarthritis).

Kilinc BE and Oc Y (15) reported that intraarticular ACS for knee osteoarthritis (KNOA) resulted in a large reduction in pain and improved range of motion (ROM) for up to one year. This long-term efficacy in KNOA is comparable to the TMJ results, where pain reduction was maintained at the 6-month follow-up, although the current study only tracks outcomes up to this point.

Furthermore, the study by Baselga García-Escudero et al (16). on patients with highly symptomatic knee OA treated with ACS alongside physiotherapy reported a significant reduction in pain, with mean pain scores decreasing from 8.10 at baseline to 2.76 at the 6-month follow-up. This was followed by a slight increase in pain at 12 months (mean score of 2.81) and 24 months (mean score of 3.03). This trend closely aligns with the findings of our current study.

Similarly, in the study by Pishgahi et al (17). patients treated with either ACS or PRP experienced significant improvements in pain intensity and knee function at both the 1-month and 6-month follow-ups, with more pronounced benefits observed in the ACS group. ACS demonstrated a more pain reduction, with scores improving from 61.25 at baseline to 46.88 at 1 month, and further to 35 at 6 months. Dextrose prolotherapy, however, did not result in any significant changes in pain or function in the treated knee. Thus, ACS provides significant pain relief and functional improvement, similar to its documented benefits in other joints suggesting its potential effectiveness as a treatment for TMD.

One of the major functional impairments in TMD is limited mouth opening, which can affect chewing, speaking, and overall quality of life. In this study, the assessment of mouth opening demonstrated substantial improvement. The mean mouth opening increased from 27.32 mm pre-operatively to 36.76 mm by the six-month follow-up. The rapid improvement was observed as early as day 7, with further progressive increase throughout the follow-up period, emphasises the early and sustained benefits of ACS in improving joint function. This progressive enhancement reflects a statistically significant change ($F = 111.28$, $P = 0.0001$), indicating that ACS may effectively promote the recovery of mandibular mobility.

This outcome aligns with Ravikumar C et al (13). who reported that ACS showed significantly better improvement in mouth opening at 2 months post-operation compared to the control group (DP). Although there were no significant differences at earlier time points, the results suggest that ACS treatment leads to better functional outcomes over time, particularly in the long term. Furthermore, this aligns with findings by Wehling et al (8). who highlighted the role of ACS in increasing anti-inflammatory cytokines, particularly IL-1ra, which contributes to reducing inflammation and promoting tissue healing. The improvements in mouth opening observed in our study are likely due to the anti-inflammatory effects of ACS, which could help alleviate intra-articular inflammation and enhance joint mobility.

Improving the ROM is a key indicator of successful TMD management. Dysfunction in the TMJ often results in stiffness or reduced mobility. ACS may aid in repairing damaged tissues within the joint, leading to better flexibility and a wider range of motion. The current study showed a significant improvement in ROM, with 76% of patients having a ROM less than 5–7 mm before treatment, dropping to 16% by 6 month. On the other hand, patients with a ROM greater than 5–7 mm increased to 84% by 6 months. Despite these fluctuations, the overall changes in ROM were statistically significant ($p < 0.001$), indicating that ACS therapy provides short-term improvements in TMJ mobility, though longer-term effects may require additional attention. Hence the study documented improvements in the range of mandibular motion, with significant increase observed by the six-month follow-up. This enhancement suggests that ACS not only alleviates pain but also restores functional mobility in patients suffering from TMD. The enhanced functional outcomes associated with ACS, which may be attributed to its ability to promote tissue healing and reduce inflammation more effectively than hyaluronic acid in a study by Frizziero in cases of KNOA and musculoskeletal diseases (11).

These findings align with Tassara et al.'s (14) study on knee OA, who observed that ROM consistently improved with significant early gains observed after two injections and sustained improvements ($p < 0.01$). Similarly, Damjanov N et al (18). found that ACS therapy improved joint function after 4 weeks of treatment, with benefits lasting up to 24 weeks. This is consistent with the early improvements noted in the current TMJ study, though both studies indicate some variability in long-term results. Meta-analysis by Raeissadat SA et al (19). also supports the use of ACS in knee OA, demonstrating that ACS can enhance joint function. Moreover, Simon MJK et al (20). reported that ACS injections in the shoulder joint could reduce disability and delay the need for surgical intervention, further validating ACS as a viable treatment option across different joints.

Clicking, popping, or grinding sounds in the TMJ are common symptoms of TMD, often indicative of internal joint derangements, such as disc displacement or joint inflammation. Reducing or eliminating these sounds can be a sign of improved joint stability and alignment. Through ACS treatment, the study monitors changes in these joint sounds as a measure of enhanced intra-articular health. The attenuation of joint click serves as a pivotal marker for enhanced TMJ functionality. In the present study, the prevalence of patients exhibiting joint click declined progressively from 32% at baseline to 12% at the 6-month assessment, indicating a consistent amelioration. Although there is statistically no significant difference ($p = 0.30$), the trend suggests that ACS therapy may facilitate the mitigation of joint click over

time. This marked decrease in the prevalence and severity of clicking and crepitus suggests that ACS plays a pivotal role in restoring normal joint function, as patients reported complete resolution of joint sounds by the six-month follow-up.

When compared to Ravikumar et al (13). who observed TMJ sounds, the trends are quite similar. In their study, 66.7% of the patients in the ACS group had clicking sounds pre-operatively, which reduced to 8.3% at the 2-month follow-up, showing a comparable trend of sound reduction over time. The dextrose prolotherapy group in their study, however, did not show a similar improvement, as joint sounds persisted in the majority of these group patients. By 2 months, 91.7% of patients in the ACS group were free of joint sounds, which indicates a more pronounced and expeditious resolution of joint sounds compared to the current findings. Thus, the current study's findings reinforce the notion that ACS may address not only the symptoms of TMD but also the underlying mechanical dysfunctions contributing to joint sounds.

The absence of serious adverse effects (bleeding or intra articular hematoma, synovitis, increase in blood pressure, numbness) in the present study study further supports the safety profile of ACS, as previously highlighted by Frizziero et al.(11), Raeissadat et al.(19), Tassara M et al.(14) and Smith PA (21). This favourable safety profile, coupled with the significant clinical improvements observed, positions ACS as a promising treatment for TMD. Similarly, Baltzer et al (12). reported comparable frequencies of adverse events between the ACS and saline groups, with a higher incidence in the hyaluronic acid (HA) group, further underscoring the relative safety of ACS in therapeutic applications.

While the study demonstrates significant clinical improvements, they are not without limitations. The sample size was relatively small, and further studies with larger populations are necessary to validate these findings. Additionally, the absence of a comparator group limits the ability to assess the relative efficacy of ACS compared to other treatment modalities. Furthermore, the long-term efficacy of ACS in treating TMD has not been fully evaluated. Future research should also focus on understanding the precise mechanisms through which ACS exerts its therapeutic effects in TMD, as these remain unclear, especially in comparison to its established efficacy in orthopaedic conditions. Also, additional research is needed to fully understand the long-term efficacy of ACS in treating TMD.

Thus, the study concluded that ACS prolotherapy effectively alleviates key symptoms of TMD, such as pain, limited mouth opening, and joint sounds. Significant improvements in pain levels and mouth opening were observed, indicating ACS's potential to restore joint function and stability. Despite some fluctuations in range of motion, ACS can be considered as a first-line, non-invasive treatment for TMD.

Declarations

Competing interests:

The authors have no relevant financial or non-financial interests to disclose.

Ethical approval:

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of institute .The number is EC/NEW/INST//2024/4843

Consent to participate:

Informed consent was obtained from all individual participants included in the study and document for same uploaded

Consent to publish:

The authors affirm that human research participants provided informed consent for publication of images

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Author Contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [Utkarsha Kaushal], [Vivek Saxena] [Vishal Gupta [Rangarajan H], Nikhil Choraria. The first draft of the manuscript was written by Utkarsha Kaushal and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data Availability

The data that support the findings of this study are available from the authors upon reasonable request .

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Figures

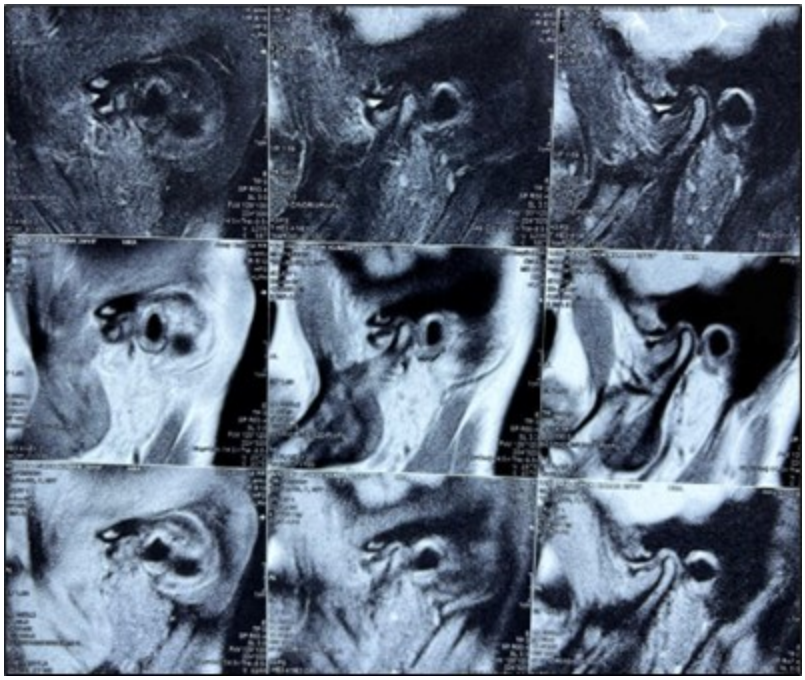


Figure 1

MRI suggestive of Internal derangement of right TMJ

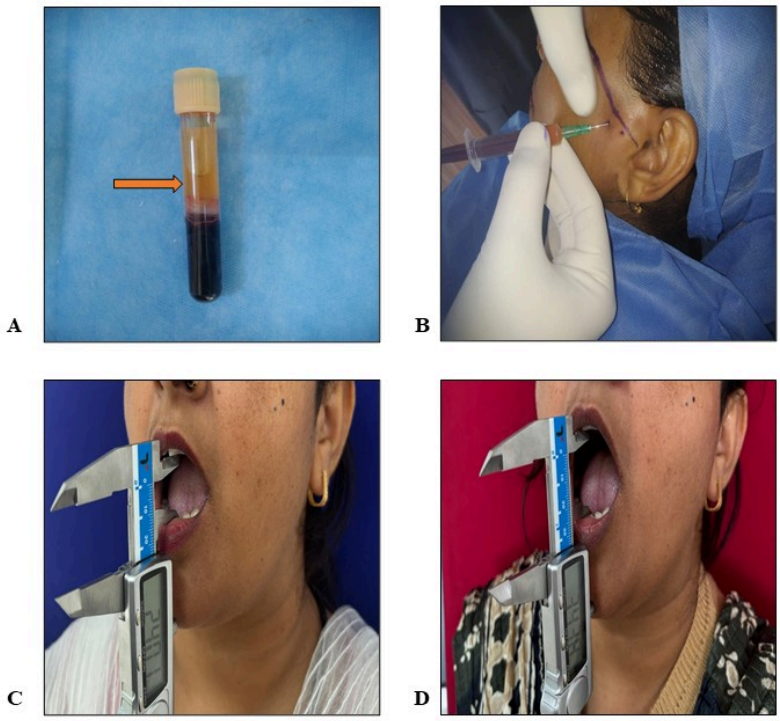


Figure 2

2A ACS in the supernatant part; **2B** Marking of Holmlund Hellsing line from tragus to lateral canthus and injecting ACS in superior joint space; **2C** Pre-operative mouth opening; **2D** Post-operative mouth opening at 1 month