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Computed Guided Prolotherapy Versus Conventional Prolotherapy in The Treatment of TMJ Internal Derangement

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ABSTRACT

Aim: This study was conducted to compare Computed guided arthrocentesis with conventional arthrocentesis followed by I-PRF prolotherapy in the treatment of TMJ internal derangement. **Subjects and methods:** the study was carried out on 20 patients divided into two groups: Group I, patients underwent arthrocentesis followed by I-PRF injection using conventional TMJ injection technique with the aid of facial anatomical landmarks. Group II, patients underwent arthrocentesis followed by I-PRF injection using a CT-guided 3D printed surgical guide. Pain scores measured and MIO, preoperatively, immediately after the procedures, 1 week, 1 month, and 3 months. MRI was made 1 week and 3 months after the procedures. The number of attempts of needle insertions of 1st & 2nd needle (Right -Left) were assessed and the Time of operation and pain during the operation were assessed. **Results:** a significant decrease in pain during procedures, immediately post-operative, 1 week and 1 month post-operative, number of insertions and relocation of the needles in each joint, and time of the procedures in the guided arthrocentesis group compared to the conventional arthrocentesis group. On the other hand, there was no significant difference between both groups in MIO, preoperative pain after 3 months. **Conclusion:** Digital arthrocentesis and prolotherapy of TMJ showed superiority and could replace the current conventional and prolotherapy types. Intra-articular PRF injection after arthrocentesis is an effective treatment method for the pain relief of TMJ internal derangements.

KEYWORDS

Computed guided prolotherapy, I-PRF, TMJ internal derangement, minimally invasive TMJ surgery

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INTRODUCTION

The articular disc can move out of its normal position on the condylar head, causing internal derangements of the temporomandibular joint. This can lead to two common types of disc displacement: disc displacement with reduction (which may or may not cause intermittent locking) and disc displacement without reduction (which may or may not limit opening) [(1)]. Before 1975, the only surgical treatments for the internal problem of the temporomandibular joint (TMJ) were either removing the articular disc or relocating it. However, after arthroscopic lavage was introduced to dissolve adhesions and remove inflammatory

mediators, patients experienced more mouth opening and less discomfort. Even though lavage did not restore the anatomic relationship between the articular disc and the mandibular condyle, it was a breakthrough as a much less invasive procedure with positive clinical outcomes [2].

Nitzan et al.[3] decided to switch from arthroscopy to arthrocentesis, which had been used for treating large joints since 1960, because of the high percentage of success of arthroscopic lavage. By establishing arthrocentesis as a conservative method for TMJ lavage that has fewer problems and is less expensive, they did away with the necessity for high-priced instruments (2,4). To reach the superior joint space of the TMJ, they selected surface landmarks and demarcation sites for needle insertions[3,5].

However, it takes a lot of knowledge to employ this method, which uses surface facial cues as a guide for accessing the deeply situated superior joint region inside the TMJ. It poses the danger of extra-articular injection, may require several punctures, and increases the likelihood of facial nerve damage and hematoma development. It may also cause post-operative pain[5,6]. But, using different surgical splints and devices, the computer-assisted surgical simulation offered the opportunity to carry out a virtual plan in the operating room [7,8]. The superior space of the TMJ may be more accurately reached with a needle by using 3D surgical guides created using computed tomography, and they also lessen the possibility of damaging or traumatizing other structures.

PATIENTS AND METHODS

In this study, 20 patients with bilateral TMJ internal derangement (disc displacement with and without reduction) who also had restricted mouth opening, clicking, discomfort, or deviation or deflection of the mandible with opening were included. Clinical and magnetic resonance imaging (MRI) examinations both supported the internal abnormality of the joint. Each patient received a permission document. The study was conducted in the College of dental medicine's oral and maxillofacial department at Al-Azhar University's Assiut branch. This study was authorized by the dental medical faculty's ethics council at Al-Azhar University's Assiut branch.

Inclusion criteria:

Patients with bilateral or unilateral TMJ internal derangement who did not respond to conservative treatment as soft diet, occlusal splint, muscle relaxant, non-steroidal anti-inflammatory drugs or movement restriction. Patients who are not contraindicated to perform MRI or CT scan.

Exclusion criteria:

All patients with any systemic diseases contraindicated the procedures (poly arthritis or rheumatoid diseases), neurologic disorders, condylar fracture or previous TMJ injection, head and neck cancer, completely edentulous patients, patients with implanted metal or medical devices, developmental and congenital disorders of TMJ.

Sample size calculation

We used G power version 3.1 statistical software, Franz Faul, Universität Kiel Germany to perform a power analysis based on the time of previously treated trial cases (9). We calculated the sample size needed for comparing two independent means (two groups) with a given α, power, and effect size. We set the α error probability at 0.05, the effect size (f) at 1.71, the power at 0.95 and the number of groups at 2. The results showed that we needed at least n = 18 samples, (9 samples for each group). To account for a possible dropout rate of about 10 % of patients, we used 20 samples, (10 samples for each group).

t tests - Means: Difference between two independent means (two groups)

Analysis: A priori: Compute required sample size

Input:	Tail(s)	=	One
	Effect size d	=	1.7100257
	α err prob	=	0.05
	Power (1-β err prob)	=	0.95
	Allocation ratio N2/N1	=	1
Output:	Noncentrality parameter δ	=	3.6275123
	Critical t	=	1.7458837
	Df	=	16
	Sample size group 1	=	9
	Sample size group 2	=	9
	Total sample size	=	18
	Actual power	=	0.9658699

Grouping and intervention:

Patients were divided randomly into two groups: **Group I**: patients underwent arthrocentesis followed by I-PRF injection using conventional TMJ injection technique with the aid of facial anatomical landmarks. **Group II**: patients underwent arthrocentesis followed by I-PRF injection using a CT-guided 3D printed surgical guide. Stabilizing specific occlusal splint was made for each patient in each group 2 weeks before TMJ arthrocentesis.

Preoperative preparation:

1. Fabrication of the patient-specific surgical guide [10]:

- A CT scan of the patient is scheduled. A dedicated DICOM (Digital imaging and communication in medicine) reader was used to import CT scans. The program carried out the planning for the patient-specific guidance (MIMICS medical 19.0 Materialise. Leuven, Belgium). Fabrication was carried out.
- Rubber base impressions of the maxillary teeth were taken, and poured with hard stone, then the cast was scanned with a dental scanner to produce files in a standard tessellation language (STL) form which were imported to the 3D printing machine along with the CT data to produce the wafer remaining part of the guide
- The guide was made up of two distinct parts: (1) a maxillary component that fits over the maxillary teeth, and (2) a unilateral or bilateral body that rests on the cheek's outside contour and fits over the external ear for fixation and stability. Both components were joined by an arm. The precise surgical guide was then 3D printed from PLA (polylactic acid) and fitted to the patient's cheekbones, ear, and maxillary teeth. Finally, the guide was disinfected in a glutaraldehyde solution for 24 hours before surgery.

Operative procedures:

1- Auriculotemporal nerve was blocked with 1ml (5mg) of mebacaine 0.5% without vasoconstrictor on each side or one side, depending on whether the TMJ problem was bilateral or unilateral. The patient was in an upright posture and opened and closed their jaw as the TMJ condyle was felt with the index finger. They were then instructed to open their mouth wide, and the condyle's contour was traced inferiorly with the finger until the condyle's neck was reached. The needle was inserted posteriorly, superiorly, and forward to the neck of the mandible at a depth of approximately 13 mm, where the solution was injected. A 13-mm long needle (diameter 3 mm) and a 3-ml syringe were used for the injections and negative aspiration was performed before injection.

2- Arthrocentesis [11]:

Group I: We injected Group I conventionally with the aid of the facial landmarks. We positioned a patient comfortably at a 45° angle in the dental chair, with their head turned to the unaffected side. We set up, cleaned, and enclosed the target location with sterile drapes. We drew a canthotragal line from the center of the tragus to the outer canthus of

the eye and marked the entry points along it on the patient's skin with a washable felt tip pen. The first point (posterior entry point), which corresponds to the glenoid fossa, was 10 mm from the midtragus and 2 mm below the line. The second point (anterior entry point), which corresponds to the articular eminence, was 20 mm from the midtragus and 10 mm below the line. We used a biting block to keep the patient's mouth open during the operations and instructed them to open their lips wide. We inserted an 18-gauge needle at the first location and injected 2-3 ml of ringer lactate to enlarge the joint space. We placed a second 18-gauge needle at the second location to provide a free flow of the solution through the joint area. We lavaged the superior joint region with an 80–90 ml solution of ringer lactate in total using a 20-ml syringe attached to the first needle. We injected 1 ml of prepared I-PRF into the upper joint space after we finished the arthrocentesis procedure. We gently manipulated a patient's lower jaw in the vertical, protrusive, and lateral directions to facilitate the lysis of adhesions and to further free up the disc after we removed the needles.

Group II: We performed arthrocentesis with ringer lactate on the patients and then injected I-PRF into the superior space of TMJ with the aid of a specific CT-planned 3D-printed surgical guide, which guided the needle insertion. We assessed the accuracy of the needle insertion into the superior space of TMJ. We positioned the patients comfortably at a 45° angle on the dental chair and swabbed their intraoral and extraoral areas with betadine. We fitted the maxillary part of the patient-specific guide over the maxillary teeth and applied and customized the body part, either unilaterally or bilaterally, to fit the patient's face and external ear. We put together and fixed the connecting arms in the desired position. We used a biting block to keep the patient's mouth open throughout the operations. We inserted an 18-gauge needle at the first sleeve and administered 2-3 ml of ringer lactate through it to widen the joint space. We placed a second 18-gauge needle at the second sleeve to allow the solution to flow freely through the joint space. We used a 20-ml syringe to inject ringer lactate into the superior joint space through the first sleeve, and ringer lactate came out through the second needle. We used 80–90 ml of solution for the lavage of the superior joint space. We injected 1 ml of ready-to-use I-PRF into the upper joint space after we finished the arthrocentesis. We removed the needles and the patient-specific 3D printed guide and gently moved a patient's lower jaw in the vertical, protrusive, and lateral directions to help with the lysis of adhesions and to further free up the disc.

Follow-up phase:

Clinical follow-up: Patients were asked to return for follow-up after one week, one month, and three months. Primary study variables were the number of relocations of the first and second needles and the time and pain measured on the visual analog score (VAS) during the procedures. Comparison of the pain score measured on a visual analog scale (VAS) and MIO, lateral and protrusive movement preoperatively, immediately after the procedures, 1 week, 1month and 3 months through digital calipers were the secondary study variables .

Radiographic follow-up: MRI was made 1 week and 3 months after the procedures . T1 assessed any change in disc position and T2 assessed the presence of edema or inflammation.

Statistical analysis

Using the computer application SPSS (Statistical package for social science) version 26.0, data were tabulated, coded, and then analysed. Pairwise Student's t-test: -Used to compare the means of two sets of similar numerical data (parametric). A comparison between two related sets of numerical (non-parametric) data is made using the Wilcoxon signed rank test. Repeated actions Analysis of Variance (ANOVA): - Used to compare numerical (parametric) data between more than two related groups, followed by post-hoc Bonferroni Fisher exact is used to compare categorical data in a table across groups (2x2). Statistical significance was defined as a P value 0.05.

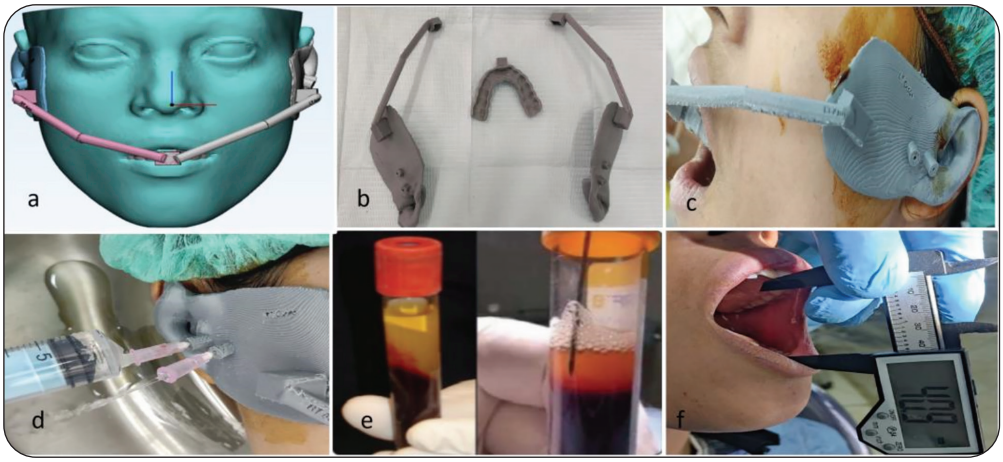

Fig. (1) ***a,*** The virtual patient soft tissue profile with positioning of arthrocentesis guide with a connecting arm extending from the guide to the wafer part, ***b,*** different separated parts of surgical arthrocentesis guide, ***c,*** surgical arthrocentesis guide in position, d, in and out flow of arthrocentesis fluid by the aid of the surgical guide, ***e,*** obtained injectable PRF after centrifugation, and ***f,*** postoperative maximum interincisal opening (MIO).

RESULTS

Pain on visual analogue scale (VAS):

As shown in table (1), a comparison of the guided arthrocentesis group within preoperative, immediately post-operative, 1 week, and 1 month post-operative showed a significant decrease compared to that in the conventional arthrocentesis group (p=0.003,0.03&0.046 respectively) while the comparison of Guided arthrocentesis group within 3 months post-operative showed non-significance compared to that in conventional arthrocentesis group (p=0.07 &0.4 respectively). Regard comparison of the guided arthrocentesis group within the first, second & third intervals showed non-significance compared to that in the conventional arthrocentesis group (p=0.66,0.26 & 0.27 respectively) while the comparison of the guided arthrocentesis group within the fourth interval showed significance increase compared to that in conventional arthrocentesis group (p=0.02).

Table (1) *Comparison of Pain on the visual analog scale between conventional arthrocentesis & guided arthrocentesis groups within preoperative, immediately post-operative, 1 weak , 1 month & 3 months post-operative and first, second, third & fourth intervals.*

	group I (n=10)	**group II (n=10)**	**P**
Pre operative	6.5±.6	4.8±.7	0.003*
Immediately post operative	5.20±1.75	3.10±.42	0.03*
1 weak	4.00±1.62	2.40±.55	0.03*
1 month	2.20±.84	1.20±.45	0.046*
3 months	1.46±.05	1.80±.84	0.4
p2	**<0.001***	**0.004***	
First interval	-2.00(-2.00- 0)	-2.00(-2.00--1.00)	0.66
2nd interval	-1.50(-1.50- -1.00)	-.50(-1.50- 0)	0.26
3rd interval	-1.50(-2.00- -1.50)	-1.00(-1.00--1.00)	0.27
4th interval	-.50(-1.00- 0)	1.00 (0- 1.00)	0.02*

Data expressed as mean±SD (standard deviation) or median (IQR) P: Probability
**:significance <0.05*

Test used: Student's t-test(Paired) for data expressed as mean±SD & Wilcoxon signed rank test for data expressed as median (IQR)

Maximal incisal opening (MIO) :

As shown in table (2), a comparison of the guided arthrocentesis group within preoperative, immediate postoperative, 1 weak, 1 month & 3 months post-operative showed non significance compared to that in conventional arthrocentesis group (p=1.0,0.77, 0.54, 0.39&0.47 respectively). Regard comparison of the guided arthrocentesis group within the first, second, third & fourth intervals showed non significance compared to that in the conventional arthrocentesis group (p=0.7,1.0, 1.0& 0.09 respectively).

Table (2) *Comparison of Maximal incisal opening between conventional arthrocentesis & guided arthrocentesis groups within preoperative, immediate post operative, 1 week, 1 month & 3 months post-operative, and first, second, third & fourth intervals.*

	group I (n=10)	group II (n=10)	P
Preoperative	38.1±4.4	38.1±5.2	**1.0**
Immediately post-operative	41.4±3.3	42.1±3.8	**0.77**
1 weak	41.7±3.0	42.9±3.0	**0.54**
1 month	41.9±2.5	43.5±3.1	**0.39**
3 months	42.2±2.3	43.5±3.2	**0.47**
p2	**0.002***	**0.007***	
First interval	3.0(2.5-3.5)	4.0(2.4-5.0)	**0.7**
2nd interval	0.5(-0.5-1.0)	0.1(-0.5-1.1)	**1.00**
3rd interval	0(0-1.0)	0.5(-1.5-2.0)	**1.00**
4th interval	0(0-0.5)	-0.5(-2.5-0)	**0.09**

Data expressed as mean±SD or median (IQR)
SD: standard deviation IQR:interquartile range
*P:Probability *:significance <0.05*
Test used: Student's t-test(Paired) for data expressed as mean±SD & Wilcoxon signed rank test for data expressed as median (IQR)

No of location of 1st & 2nd needle (Right -Left)

As shown in Table (3), a comparison of a number of locations of 1st needle (rt & lt) of the guided arthrocentesis group (1.00±0, 1.00±0 respectively) showed a significant decrease compared to that in the conventional arthrocentesis group (2.60±1.52, 4.00±2.55) (p=0.046, 0.03 respectively). Comparison of No of location of 2nd needle (rt & lt) of guided arthrocentesis group (1.00±0, 1.00±0 respectively) showed a significant decrease compared to that in conventional arthrocentesis group (3.40±1.67, 4.00±1.58) (p= 0.01,0.003 respectively).

Table (3) *Comparison of the number of locations of 1st & 2nd needle (rt & lt) between conventional arthrocentesis & Guided arthrocentesis groups.*

	Group I (n=10)	Group II (n=10)	P
No of location of 1st needle(rt)	**2.60±1.52**	**1.00±0**	**0.046***
No of location of 1st needle(lt)	**4.00±2.55**	**1.00±0**	**0.03***
No of location of 2nd needle(rt)	**3.40±1.67**	**1.00±0**	**0.01***
No of location of 2nd needle(lt)	**4.00±1.58**	**1.00±0**	**0.003***

Data expressed as mean±SD
SD: standard deviation
*P: Probability *: significance <0.05*
The test used: Student's t-test (Paired)

Time of operation and pain during operation:

As shown in Table (4) and Figure (40-41), a comparison of the time of operation of the guided arthrocentesis group (6.70±.27) showed a significant decrease compared to that in the conventional arthrocentesis group (14.00±.79) (p=<0.001). Comparison of Pain during operation on VAS of the guided arthrocentesis group (2.20±.84) showed a significant decrease compared to that in the conventional arthrocentesis group (6.80±1.15) (p=<0.001).

Table (4) *Comparison of Time of operation & Pain during operation on VAS between conventional arthrocentesis & guided arthrocentesis groups.*

	group I (n=10)	group II (n=10)	P
Time of operation	14.00±.79	6.70±.27	<0.001*
Pain during operation on VAS	6.80±1.15	2.20±.84	<0.001*

Data expressed as mean±SD P:Probability
**:significance <0.05*
SD: standard deviation The test used:
Student's t-test(Paired)

Radiographic results:

Postoperative MRIs of all patients (taken with the open mouth position) 3 months showed that early reduction of the articular disc to its almost normal position during open mouth position. There was thickening of retrodiscal tissues which is attributed to the anti-inflammatory and chondrogenesis effect of I-PRF. Postoperative MRI evaluation at 1 week of edema revealed that the size of edema after arthrocentesis and I-PRF injection was more apparent and more noticeable in group I than in group II which may be attributed to the traumatic arthrocentesis and multiple needle insertion.

Postoperative complications:

In this study, a postoperative complication was noted. Three female patients in group I reported having minor preauricular edema in the immediate postoperative period. One female patient in group I complained that closing her eyelid was difficult.

DISCUSSION

To compare computed guided arthrocentesis with traditional arthrocentesis followed by I-PRF prolotherapy for treating TMJ internal derangement, this study was done. Based on the findings of this study, the computer-guided arthrocentesis technique would be more effective than the conventional technique with more precise and comfortable procedures. It would also decrease potential complications, provide easier access to the joint space, cause less trauma and pain, and increase the effect of arthrocentesis. This research is comparable to the one used by Hyder et al. [12].

In the present study, we discovered that there was a substantial difference between the two groups in terms of process duration, the number of needle relocations, and patient comfort, demonstrating the superiority of the computer-guided injection approach over the traditional one. The length of the procedure as a whole and attempts to move the needle have an impact on the recovery. Similar to the study used by Siviri et al. [9], postoperative discomfort and edema are reduced by shorter operating periods and fewer puncture attempts. The danger of complications and discomfort increases with the frequency of needle insertions. As a result, difficulties are less likely the more precisely the needle is put. Clinicians can execute injection operations with a decreased risk of problems by using a needle guide. Without a guide, operators would need years to develop the kind of expertise that would reduce difficulties[8,13]

According to this study, prolotherapy and digital arthrocentesis reduce postoperative pain temporarily. Shorter operations and fewer puncture attempts result in less postoperative discomfort and edema. The total procedure duration and efforts to reposition the needle also had an impact on the postoperative results. According to Wiler et al. (14), a typical technique for knee arthrocentesis did not cause any more discomfort or take any longer than a US-guided approach.

According to this study, there was no discernible difference in postoperative MMO between the two groups. Except for 3 instances in group I and 2 cases in group II, both groups in the current research showed a substantial reduction in TMJ discomfort, MMO, and clicking 1 month following therapy, which was sustained going forward. It is possible that the removal of inflammatory mediators and

breakdown of adhesions, which reduce discomfort and enhance range of motion, is to blame for the outstanding patient response to arthrocentesis[3,15]. On the other hand, as shown by the findings of Lippross et al, [16] in their experimental work using a pig model of rheumatoid arthritis of the knee joint, injectable PRF may be effective due to its anti-inflammatory action.

CONCLUSION

Digital arthrocentesis and prolotherapy of TMJ showed superiority and could replace the current conventional and prolotherapy types. Intra-articular PRF injection after arthrocentesis is an effective treatment method for the pain relief of TMJ internal derangements.

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العلاج التجددي الموجه حاسوبياً مقارنة بالعلاج التجددي التقليدي في علاج الاضطرابات الداخلية لمفصل الفك

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الملخص :

الهدف: أجريت هذه الدراسة لمقارنة بزل المفصل الموجه المحوسب مع بزل المفصل التقليدي متبوعًا بحقن الصفائح الدموية الغنية بالفيبرين القابلة للحقن في العلاج التجددي في علاج الخلل الداخلي في المفصل الفكي الصدغي. المفصل متبوعاً بحقن الصفائح الدموية الغنية بالفيبرين القابلة للحقن باستخدام تقنية حقن المفصل الفكي الصدغي التقليدي المرضى.

المواد والأساليب: أجريت الدراسة على عشرين مريضاً مقسمين إلى مجموعتين: المجموعة الأولى، خضع المرضى لبزل بمساعدة المعالم التشريحية للوجه. المجموعة الثانية، خضع المرضى لبزل المفصل متبوعًا بحقن الصفائح الدموية الغنية بالفيبرين القابلة للحقن باستخدام دليل جراحي مطبوع ثلاثي الأبعاد موجه بالأشعة المقطعية. يتم قياس درجات الألم والفتح الأقصى ما بين القواطع/قبل الجراحة، مباشرة بعد الإجراءات، أسبوع واحد، شهر واحد، وثلاثة أشهر. تم إجراء التصوير بالرنين المغناطيسي بعد أسبوع وثلاثة أشهر من الإجراءات. تم تقييم عدد محاولات إدخال الإبرة الأولى والثانية (اليمين - اليسار) وتم تقييم وقت العملية والألم أثناء العملية.

النتائج: انخفاض كبير في الألم أثناء العمليات، مباشرة بعد العملية الجراحية، بعد أسبوع وشهر واحد من العملية الجراحية، وعدد عمليات الإدخال ونقل الإبر في كل مفصل، ووقت الإجراءات في مجموعة بزل المفصل الموجه مقارنة مع المجموعة التقليدية مجموعة بزل المفصل. من ناحية أخرى، لم يكن هناك فرق كبير بين المجموعتين في الفتح الاقصي بين القواطع او الألم قبل الجراحة بعد ثلاثة أشهر.

الخلاصة: أظهر بزل المفصل الرقمي والعلاج المفصلي للمفصل الفكي الصدغي التفوق ويمكن أن يحل محل النوع التقليدي والعلاج المفصلي الحالي. يعد حقن الصفائح الدموية الغنية بالفيبرين القابلة للحقن داخل المفصل بعد بزل المفصل طريقة علاجية فعالة لتخفيف آلام اضطرابات المفصل الفكي الصدغي الداخلية.

الكلمات المفتاحية: العلاج التحفيزي الموجه المحوسب، الصفائح الدموية الغنية بالفيبرين القابلة للحقن، الخلل الداخلي في المفصل الفكي الصدغي، جراحة مفصل الفك ذات التدخل الجراحي البسيط.