The Short-Term Results of the Modified Concentric-Needle Technique for Single-Puncture Arthrocentesis: A Preliminary Study

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ABSTRACT

Objective: To determine the clinical applicability of the modified concentric cannula technique (CCT), focusing on the duration of the arthrocentesis, the number of reposition of cannula, and the occurrence of complications.

Study Design: Descriptive study.

Place and Duration of the Study: Department of Oral and Maxillofacial Surgery, Ankara Yildirim Beyazit University, Ankara, Turkiye, between September 2021 and May 2022.

Methodology: Forty patients with Wilkes III temporomandibular joints (TMJ) internal derangement were identified and 13 patients who met the inclusion criteria were reviewed. The main outcomes regarding the clinical applicability of modified CCT included the duration of arthrocentesis, the number of reposition of cannula, and the occurrence of complications.

Results: The values of maximum mouth opening (MMO) without pain and MMO without assistance measured in the immediate postoperative period and at the 4th and 8th postoperative weeks were found to be significantly higher than the pre-arthrocentesis values. The values of MMO with assistance measured in the immediate postoperative period and at the 8th postoperative week were also significantly higher than the baseline values. Compared with preoperative values, notable decreases in pain scores were observed at the 4th ($p = 0.003$) and 8th ($p = 0.002$) postoperative weeks. The assessment of the jaw dysfunction also revealed significantly lower scores at the 4th ($p = 0.024$) and 8th ($p < 0.001$) postoperative weeks.

Conclusion: Modified CCT of arthrocentesis substantially decreased pain and improved mandibular functions in patients with internal derangement of TMJ. Additionally, this technique could be performed with a reduced number of cannula relocations and required a shorter operative time even with the use of a higher irrigation volume during the lavage procedure.

Key Words: *Arthrocentesis, Temporomandibular joint disorder, Temporomandibular joint.*

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INTRODUCTION

Arthrocentesis of temporomandibular joint (TMJ) is the first-line of invasive treatment for patients with internal derangements and inflammatory disorders of TMJ who do not respond to conservative methods. The lavage of TMJ is suggested to reduce pain and increase jaw function by removing adherents, inflammatory mediators, and eliminating the negative pressure within the joint.[1-3] The classical double puncture technique (DPT) involves the insertion of two cannulas into the upper joint compartment following local anaesthesia. In this technique, one cannula is used for the injection of the Ringer's lactate or physiological saline, and other is used for the outflow of the fluid.

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Immediately after the lavage, hyaluronic acid (HA) can also be injected into the joint space to decrease the friction and increase the lubrication of the joint.[1,4,5] However, difficulties in accurate positioning of cannulas and increased number of cannula relocations during DPT might prolong the procedure time.[2,6] Besides, since the insertion point of the second cannula is situated very close to facial nerve, which lies anteromedial to the glenoid fossa, the risk for postoperative facial nerve paraesthesia is also increased in DPT.[5,7] Therefore, different single puncture techniques (SPT) have been proposed to either ease the procedure, shorten the procedure time, and decrease the risk of complications.[8] Senturk *et al.* categorised SPT into single puncture Type 1 (SPT-1) and Type 2 (SPT-2).[9] In SPT-1 of arthrocentesis, one cannula is used for both injection and ejection of the fluid;[5] whereas, SPT-2 of arthrocentesis adopts the use of a Shepard cannula, soldering of two needles in Y-shape, intravenous catheters, or concentric cannulas that involve different lumens or ports within the same cannula for the inflow and outflow of the irrigant.[6,9]

The use of concentric cannulas was first described by Oreroglu *et al.* as an inexpensive and practical method for arthrocentesis of

TMJ.[10] In this method, joint lavage is performed through an inner cannula with a 27-gauge which is inserted into a 21-gauge cannula, and the fluid flows out through the space between these two cannulas. Although the CCT may facilitate the lavage procedure, it has been recommended only for certain cases in which limited irrigation of joint compartment would be sufficient. The prolonged time required for lavage procedure is another drawback of this technique.[10] Besides all these, the efficiency of CCT of arthrocentesis has not been confirmed by any clinical study with follow-up.

To eliminate the above-mentioned disadvantages of the CCT, the technique was modified with the use of different diameters of cannulas. The main aim of the present study was to determine the clinical applicability of the modified CCT, focusing on the duration of the arthrocentesis, the number of the reposition of cannula, and the occurrence of complications. The secondary objective of the study was to evaluate the short-term efficiency of this technique in terms of the pain severity, jaw dysfunction, and the range of mandibular movements.

METHODOLOGY

The data of patients who were treated with modified CCT of arthrocentesis between September 2021 and May 2022, at the Department of Oral and Maxillofacial Surgery, Ankara Yildirim Beyazit University, were evaluated in this retrospective descriptive study. Inclusion criteria were as follows: Patients with minimum age of 18 years, diagnosed with Stage 3 disorders based on Wilkes classification[11] with TMJ pain, restriction of mandibular movement and/or locking of mouth opening, patients whose diagnosis was also confirmed by magnetic resonance imaging (MRI) of the TMJ and no relief with at least six months of conservative treatment (i.e., medical treatment and/or splint therapy). The patients who had a history of previous arthrocentesis or TMJ surgery, hypomobility due to muscular or bone pathology, malignant diseases in the head and neck region or any systemic diseases affecting TMJ, and the patients with incomplete clinical record, as well as those treated with other arthrocentesis techniques, were excluded.

All procedures were conducted under local anaesthesia. Following the disinfection of the periauricular region with povidone-iodine solution, the auriculotemporal nerve block was performed using 1-2 ml of 2% lidocaine hydrochloride without epinephrine (Jetokain Simplex®, Adeka, Istanbul, Turkiye). The puncture point was marked 10 mm anterior to the tragus and 2mm below the Holmund line. For modified CCT of arthrocentesis, a 19-gauge, 38-mm long cannula was first inserted into the entry point (Figure 1).

The 21-gauge, 40-mm long cannula was then inserted into the 19-gauge cannula which was already in the superior joint space (Figure 2).

The irrigation solution was delivered from the inner cannula whose diameter was smaller than the outer one, and the irrigation solution flowed out through the space between these two cannulas (http://www.youtube.com/shorts/qvBDwznPagE) (Figure 3).

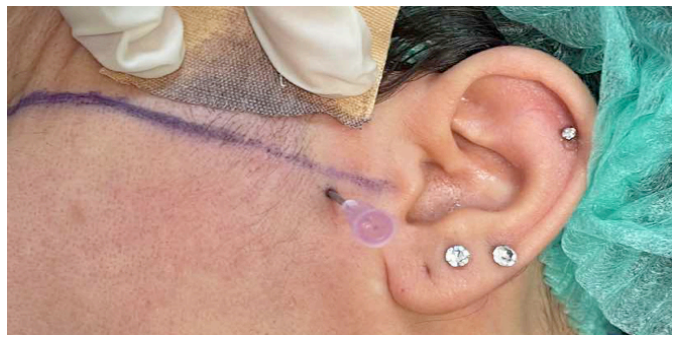

Figure 1: Insertion of a 19-gauge cannula into the entry point for modified concentric cannula technique of arthrocentesis.

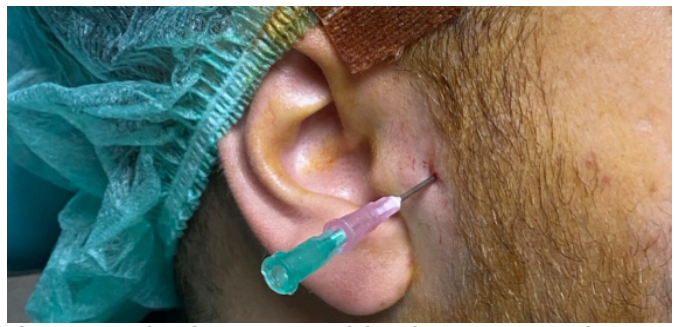

Figure 2: Insertion of 21-gauge cannula into the 19-gauge cannula.

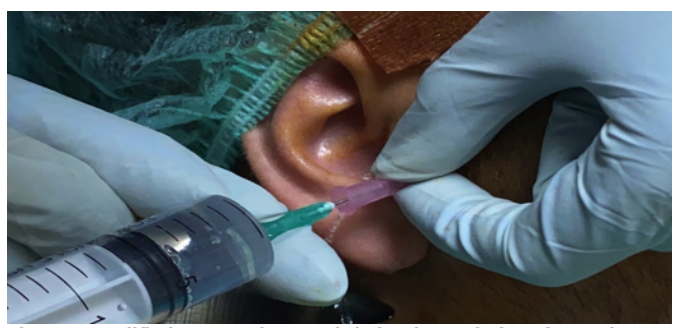

Figure 3: Modified concentric cannula irrigation technique for TMJ lavage is in use.

The lavage of TMJ was performed using a 100 ml sterile isotonic sodium chloride solution. Since the larger diameter of cannulas used compared to the conventional CCT, the joints could be irrigated under high pressure. One ml of hyaluronic acid (Orthovisc®, Anika Therapeutics, Inc., Bedford, MA, USA) was administered to the superior joint cavity at the end of the procedure. Anti-inflammatory drugs were prescribed, and the postoperative recommendations including a soft diet and mouth-opening exercises (10 times per day) were given for seven days.

The main outcomes regarding the clinical applicability of modified CCT included the duration of arthrocentesis, the number of repositions of cannula and the occurrence of complications. The total procedure time was measured from the insertion of the first cannula to the complete removal of both cannulas. The reposition of the cannula which was required following the sudden cease of the irrigant outflow due to the movement of the cannula out of the joint cavity, and the complications (i.e., bleeding and preauricular swelling) that occurred during the arthrocentesis were recorded.

Table I: Comparison of mandibular movements at the baseline, immediately following the procedure, and at the 4th and 8th postoperative weeks.

	Pre-op	IAtP	4th week	8th week	p-value
Pain-free mouth-opening	28.5 ± 11.6[a,b,c]	36.5 ± 7.7[a]	38.7 ± 9.5[b]	40.1 ± 9.4[c]	0.009†
Maximum unassisted mouth-opening	37.3 ± 10.8[a,b,c]	43.2 ± 6.8[a]	42.9 ± 10.2[b]	44.3 ± 9.0[c]	0.017†
Maximum assisted mouth-opening	41.1 ± 9.4[a,c]	44.8 ± 6.5[a]	44.6 ± 8.6[d]	46.5 ± 8.3[c,d]	0.003†
Mandibular lateral movement to right side	7.0 [3.9-8.9][b,c]	7.0 [5.0-9.1]	9.0 [8.0-10.0][b]	9.0 [8.0-10.5][c]	<0.001‡
Mandibular lateral movement to left side	6.0 [3.7-8.0][b,c]	7.0 [5.0-9.0]	9.5 [7.1-10.0][b]	10.0 [7.5-10.5][c]	<0.001‡
Protrusive movement	2.3 ± 1.7[a,b,c]	3.5 ± 1.8[a]	3.6 ± 1.7[b]	4.5 ± 2.1[c]	0.010†

IAtP: Immediately after the procedure. Repeated measurements of †ANOVA via Wilks' Lambda test, ‡ Friedman test. [a] Pre-op vs. IAtP (p <0.05), [b] Pre-op vs. 4th week (p <0.05), [c] Pre-op vs. 8th week (p <0.05), [d] 4th week vs. 8th week (p = 0.005).

Table II: Comparison of pain severity and jaw dysfunction scores at the baseline and at the 4th and 8th postoperative weeks.

	Pain severity score	Jaw dysfunction score
Pre-op	5.0 [4.0-8.0][a,b]	8.0 [4.5-8.5][a,b]
4th week	1.0 [0.5-2.5][a]	3.0 [1.5-5.5][a]
8th week	1.0 [0.5-2.5][b]	3.0 [1.5-4.0][b]
p-value ‡	<0.001	<0.001

IAtP: Immediately after the procedure. Data were shown as median [25th-75th] percentiles. ‡ Friedman test. [a] Pre-op vs. 4th week (p <0.05), [b] Pre-op vs. 8th week (p <0.01).

The researcher (Erbasar GNH) performed all the arthrocentesis and the researcher (Sancak K) recorded data (duration of arthrocentesis, the number of repositions of cannula, and the occurrence of complications) on the form.

The pain severity and jaw dysfunction were evaluated preoperatively and at the 4th and 8th postoperative weeks. The pain severity was assessed on a 10cm visual analogue scale (VAS), where 0 indicated no pain and 10 indicated the worst pain imaginable. The difficulty during jaw function was also measured on a 10cm VAS, wherein 0 indicated no limitation and 10 indicated severe limitation. The range of mandibular movements, including maximum mouth-opening (MMO) without pain, MMO with and without assistance, and protrusion and lateral movements were also recorded preoperatively, immediately following the procedure, and at the 4th and 8th postoperative weeks.

Data analysis was performed using IBM SPSS statistics version 25.0 software (IBM Corporation, Armonk, NY, US). Shapiro-Wilk and Levene tests were used to investigate whether the normal distribution and variance homogeneity assumptions were met. Categorical data were expressed as numbers (n) and percentages (%) while quantitative data were given as mean ± SD, median (min-max) or median (25th-75th) percentiles, where applicable. The differences among follow-up times were evaluated by repeated measurements of ANOVA *via* Wilks' Lambda test. However, the Friedman test was used for the analysis of the longitudinal data if the parametric assumptions were not met. When the p-values were statistically significant, the Bonferroni adjustment or Dunn-Bonferroni tests were applied to identify which follow-up periods were significantly different from others. A p <0.05 was considered statistically significant.

RESULTS

Forty patients with Wilkes III TMJ internal derangement were identified. Three patients with history of a previous arthrocentesis, four patients with incomplete clinical data, and twenty patients treated by different arthrocentesis techniques other than modified CCT were excluded from the study. Therefore, 13 patients who met the eligibility criteria were reviewed. Of those patients, 10 were females, and 3 were males, with a mean age of 33.8 ± 11.4 years. Regarding intraoperative variables, only one cannula relocation was required in one of the patients. Also, soft tissue swelling due to the fluid extravasation was observed in the same case. The duration of the procedure took between 3 and 5 minutes to perform, with a mean duration of 4.11 minutes.

All variables regarding the range of mandibular movements showed notable improvements in the follow-up period. The values of MMO without pain and MMO without assistance measured in the immediate postoperative period and at the 4th and 8th postoperative weeks were found to be significantly higher than the baseline values. The values of MMO with assistance measured in the immediate postoperative period and at the 8th postoperative week were also significantly higher than the baseline values. The maximum right and left lateral movements were significantly increased at the 4th and 8th postoperative weeks compared to the pre-arthrocentesis values. The values of protrusion measured in the immediate postoperative period and at the 4th and 8th postoperative weeks were found to be significantly higher than the baseline values (Table I).

As compared with preoperative values, notable decreases in pain scores were observed at the 4th (p = 0.003) and 8th (p = 0.002) postoperative weeks. The assessment of the jaw dysfunction also revealed significantly lower scores at the 4th (p = 0.024) and 8th (p <0.001) postoperative weeks (Table II).

DISCUSSION

Arthrocentesis is a minimally invasive technique for the treatment of internal derangements and inflammatory degenerative disorders of the TMJ with successful clinical results. Different techniques and modifications of this procedure have been described to reduce the extent of tissue trauma, simplify the technique, and improve the efficiency of the treatment.[1,2,12,13] This preliminary study aimed to evaluate the

clinical applicability and the short-term efficiency of arthrocentesis using modified CCT in managing TMJ internal derangement in patients with Wilkes stage III. This modified technique remarkably shortened the duration of the procedure and significantly enhanced the range of the mandibular movements, decreased the pain, and improved the jaw function.

Guarda-Nardini *et al.* described SPT of arthrocentesis in an attempt to ease the procedure and reduce the complications related to conventional DPT of arthrocentesis. Although the technique offers some important advantages including stable access to the upper joint cavity, limitation of trauma due to the elimination of the second needle, and reduction in patients' postoperative pain and morbidity, it was recommended to constrain the injection-ejection process up to 10 repetitions with 40ml of irrigation solution.[5] Some other modifications of SPT of arthrocentesis, which are also classified into SPT-2 involving different lumens within the same cannula for lavage, were described in the literature. To date, several clinical trials have compared the clinical efficacy of SPT of arthrocentesis with the classical arthrocentesis method. The comparative clinical studies reported no significant differences in pain reduction, chewing efficiency, limitation of jaw function, range of mandibular movements, and postoperative analgesic use between the SPT-1 and the classical DPT of arthrocentesis in the treatment of different internal derangement of TMDs.[1,3,14-17] Additionally, the perceived subjective efficacy as well as the tolerability of the treatment were found to be similar for both arthrocentesis techniques.[1,14,15] Similarly, the clinical studies revealed no significant differences between SPT-2 and classical DPT of arthrocentesis for the pain intensity and the range of mandibular movements relative to the baseline values.[18,19] Furthermore, although a limited number of studies could be included to pooled- or meta-analysis due to the variations across the studies, some similar conclusions were reached by recent systematic reviews.[7,20,21] These studies concluded no differences between SPT and DPT of arthrocentesis in relation to maximum mouth-opening over the follow-up intervals. On the other hand, Monteiro *et al.* reported a statistically significant difference in pain levels between the two techniques, favouring the use of DPT.[7,20] According to the findings of the related literature, there were no notable differences between either a variant of SPT or DPT in terms of patient-related variables. All arthrocentesis techniques were found equally efficacious in the treatment of internal derangement of TMDs. Therefore, the choice of arthro-centesis should primarily depend on the procedure-related factors including easiness, availability and cost-effectiveness of the technique, and short operative time.

Oreroglu *et al.* first described the CCT of arthrocentesis as a clinically feasible method in 2012; since then no clinical study has been performed to assess the effects of this technique in the treatment of internal derangement of TMDs.[10] In the current preliminary study, the authors modified the CCT of arthrocentesis both to increase the applicability of the technique within a wider patient group and to shorten the procedure time. The short-term findings of the present study revealed a substantial increase in MMO, maximum lateral, and protrusive movements immediately after the procedure and throughout the follow-up period.

The systemic reviews reported no significant reduction in the procedure duration between SPT-1 and DPT of arthrocentesis. On the other hand, data from these studies demonstrated that SPT was easier to perform and required significantly less needle relocations as compared to DPT.[7,20] In the study of Bayramoglu *et al.,* significantly longer procedure duration was reported with the use of SPT-1 of arthrocentesis.[15] The longer duration of the procedure was expected with the use of SPT-1, because the outflow of irrigant can only occur when the injector was removed from the cannula and patients were asked to close their mouth.[20] Besides, this injection-ejection process was recommended to perform up to 10 repetitions with the use of approximately 40ml of solution. However, the lavage procedure should be ideally carried out using 100mL of physiological saline.[5] Hence, the inflammatory catabolytes may not be completely flushed out with the use of SPT-1 as the lavage method. On the other hand, the results of clinical studies which evaluated the procedure-related parameters including duration of procedure and ease of procedure, significantly favoured the use of SPT-2 of arthrocentesis.[2,6,18] The shortened procedure duration in SPT-2 might be related with the use of larger diameter cannula systems, which ease the outflow of irrigating solution. Nevertheless, larger-sized cannulas might also increase tissue trauma. Compared to other studies in which procedure duration of different arthrocentesis techniques was reported in the literature,[2,18,22,23] the modified CCT of arthrocentesis seems to have the shortest procedure time. According to the results of the present study, the modified CCT could be performed within approximately 4 minutes. Additionally, the use of smaller-sized cannulas in this technique might also decrease the risk of complications. Neither vascular injuries during the procedure nor postoperative haematoma or ecchymosis occurred in any of the patients in the current study. Only soft tissue swelling due to the fluid extravasation was observed in one of the patients, also one cannula relocation was required in the same case. Hence, it can be asserted that modified CCT also presents proposed benefits of SPT-2 in terms of practicality of arthrocentesis, including duration of the procedure and relocation of the cannula. Since the diameters of cannula exceed 1.5mm with SPT-2 of arthrocentesis, the modified CCT offers an easier access to hypomobile joints with adherences or degenerative joints with osteophytic changes by using a single 19-gauge (1-mm) cannula.[10] Generally, SPT-1 is recommended in those cases since the insertion of the second needle can be complicated in a narrower joint cavity.[5] However, the modified CCT also ensures the technical possibility for lavage with a higher volume of irrigation solution than that with SPT-1.

Intra-articular injection of HA into the joint space provides pain reduction and functional enhancement.[24] Nonetheless, the use of modified CCT might ensure a more efficient HA injection without any leakage from joint cavity, since there is no second outflow needle or the second point of injection.[5,10]

There were some limitations of this investigation. First, and most importantly, the current study was designed as a preliminary study in which intra-operative and clinical variables were analysed retrospectively. Secondly, only a limited number of patients who were treated with a modified technique of CCT were included in the study. The difference between this modified technique and conventional CCT was not presented. Nevertheless, this is the first study that has evaluated intra-operative variables and clinical outcomes of CCT of arthrocentesis with a follow-up period. The modified CCT is an easy, safe, and rapid lavage procedure which incorporates the advantages of SPT Type 1 and Type 2 of arthrocentesis. Despite the promising results obtained from the present study, future comparative clinical studies with larger sample sizes should be undertaken to confirm the superiority of modified CCT over the other arthrocentesis techniques.

CONCLUSION

The current study indicates that modified CCT of arthrocentesis substantially decreases pain and improves mandibular functions in patients with internal derangement of the TMJ. Additionally, this technique could be performed with a reduced number of cannula relocations and requires a shorter operative time, even with the use of higher irrigation volume during the lavage procedure.

ETHICAL APPROVAL:
The study was approved by the Ethics Committee of the University of Oral and Health Training and Research Hospital (Approval no: E-2022-14, Dated: 27-04-2022).

PATIENTS' CONSENT:
Informed written consent was obtained from the patients.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
GNHE: Design, acquisition and analysis of data, and writing of the manuscript.
MFS: Design of the study and editing of the manuscript.
KS: Acquisition and analysis of data and writing of the manuscript.
All authors approved the final version of the manuscript to be published.

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