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ORIGINAL ARTICLE

Efficacy of Sodium Hyaluronate for Temporomandibular Joint Disorder by Single-Puncture Arthrocentesis

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Abstract
Background The term temporomandibular joint internal derangement has characteristic clinical findings such as restricted mouth opening, pain, irregular deviated jaw function and clicking sounds. The technique of TMJ arthrocentesis has gained widespread acceptance as a simple and effective technique for the treatment of acute persistent closed lock of the TMJ. Arthrocentesis is known as the lavage and lysis of upper joint compartment.
Purpose To evaluate the efficacy of sodium hyaluronate followed by single-puncture arthrocentesis. Sodium hyaluronate is the sodium salt of hyaluronic acid which is a polysaccharide of the glycosaminoglycans family, found in many extracellular tissues, including synovial fluid and cartilage. Exogenous hyaluronate can stimulate the synthesis of endogenous hyaluronic acid.
Methods In our study, a sample of 10 patients (7 females and 3 males) with TMJ disorder was selected. Arthrocentesis was done followed by sodium hyaluronate injection for all the patients.
Results On follow-up ranging from 1 to 3 months, pain at rest and pain on mastication had substantially decreased in all patients and mandibular function and mouth opening had significantly improved.
Conclusion Our study shows that single-puncture Ringer's lactate arthrocentesis followed by sodium hyaluronate injection is effective in the management of the internal derangement of the temporomandibular joint.

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Keywords Temporomandibular joint disorder · Arthrocentesis · Sodium hyaluronate · Internal derangement · Single-needle arthrocentesis

Introduction

The temporomandibular joint is the most complex joint in the body. The disc separates the head of the condyle from the temporal bone and divides the TMJ cavity into upper and lower compartments. Internally, the synovial membranes create the articular supradiscal and infradiscal spaces. The synovial fluid irrigates both the joint compartments and is responsible for lubrication of the joint cavity and alleviating friction [1]. The temporomandibular disorders may have intra-capsular, extra-capsular or combined origins.

The term temporomandibular joint internal derangement has characteristic clinical findings such as restricted mouth opening, pain, irregular deviated jaw function, clicking sounds, chronic headache, masticatory muscle tenderness and impaired joint movements [2, 3]. This disorder results in abnormal positioning of the articular disc, resulting in mechanical interference and restriction of the normal range of mandibular activity [4].

Different conservative treatments are suggested such as medical therapy, bite appliance, physiotherapy, occlusal splint therapy, soft diet and behavioural therapy. These different conservative treatments continue to be the most effective way of managing most of the TMD patients [3, 4]. However, surgery should be considered only when the facial pain or dysfunction is not corrected to a level of patient satisfaction by nonsurgical modalities. The surgical modalities include arthroscopy, condylectomy, discectomy, disc repair and repositioning [2].

Murakami et al. [1] first described the technique of TMJ arthrocentesis. The technique of TMJ arthrocentesis has gained widespread acceptance as a simple and effective technique for the treatment of acute persistent closed lock of the TMJ [5]. Irrigation also washes away inflammatory mediators that are released after manipulation of the joint.

Materials and Methods

Study Design

In our study a sample of 10 patients (7 females and 3 males) with temporomandibular joint disorders were selected. The age range was from 25 to 62 years (mean age 38.40 years).

All these patients had undergone conservative treatment before this procedure, but did not respond to the same. All the patients gave their informed consent for the treatment. Patients' complaints were pain in the joint, reduced mouth opening and overall decreased masticatory efficiency. Thorough examination of the joints was performed, and panoramic radiograph was advised.

Before the procedure various parameters were assessed, such as mouth opening. Pain at rest and pain on mastication were assessed using a visual analogue scale (VAS) from 0 to 10 with the extremes being 'no pain' to 'severe pain'. Functional limitation during jaw movement was determined as 0—absent; 1—slight; 2—moderate; 3—intense; and 4—severe.

Sodium Hyaluronate

Sodium hyaluronate is the sodium salt of hyaluronic acid, a glycosaminoglycan found in various connective, epithelial and neural tissues. Sodium hyaluronate, a long-chain polymer containing repeating disaccharide units of Na-glucuronate-N-acetylglucosamine, occurs naturally on the corneal endothelium bound to specific receptors for which it has a high affinity.

The first commercially sold sodium hyaluronate was developed by Endre Alexander Balazs in 1980. Prior to 1980 this material was used in clinical trials for both humans and animals (race horses) to treat osteoarthritis in the late 1970s and early 1980s under the brand names of Hylartin and Hylartin Vet [6]. It is similar to the lubricating fluid that occurs naturally in the articular capsule of the knee joint. Once injected into the joint capsule, it acts as both a shock absorber and a lubricant for the joint [7, 8]. Thus, sodium hyaluronate is used as a viscosupplement, administered through a series of injections into the knee increasing the viscosity of the synovial fluid, which helps lubricate, cushion and reduce pain in the joint [9].

Device

Two 18-gauge needles of 38 mm length were taken, and a bend of 30°–35° was given towards the bevel. Then the two bended needles were joined in Y design with the bevel facing outwards and silver soldering was done on both the sides, followed by trimming the extra metal on the appliance and polishing. This appliance was sterilized by using autoclave (Fig. 1).

Injection Technique/Procedure

The patient was seated in a semi-supine position, and a cotton plug was placed in the patient's ear to prevent the entry of fluid. Disinfection of the pre-auricular area was done with Betadine. Local anaesthesia (2 ml; lignocaine 2% with 1:80,000 adrenaline) was injected slowly into the upper joint cavity.

The puncture site was located by drawing a line from the midpoint of the tragus of the ear to the outer canthus of the eye (Holmlund line); a point was located 1 cm anterior to tragus of the ear and 2 mm inferior to this line. An 18-gauge needle appliance was inserted at this point and directed to the upper joint compartment by asking the patient to open the mouth (Fig. 2). After the needle appliance was inserted inside the upper joint cavity, Ringer's lactate solution (300 ml) was flushed in through one needle of the needle appliance under pressure and from the other needle it is flushed out. During the procedure the mandible was mobilized and the joint was passively manipulated to release the adhesion. After this 1 ml of sodium hyaluronate (hyorth) was injected into the space through one needle while closing the other with the finger (Fig. 3). Then the needle appliance was withdrawn. The

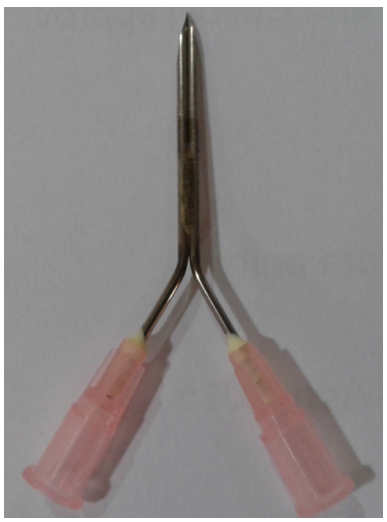

Fig. 1 Fabricated needle appliance

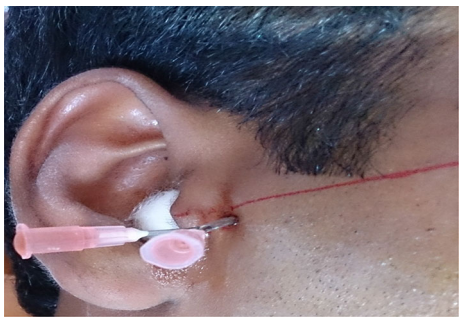

Fig. 2 Needle appliance insertion

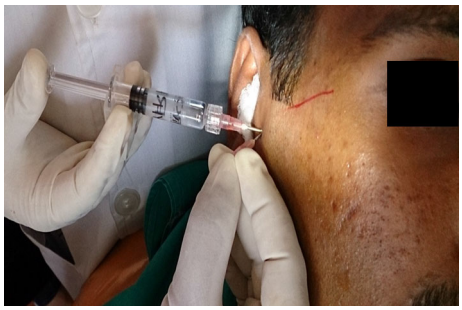

Fig. 3 Sodium hyaluronate injected

patient was sent home after 30 min of the procedure without any post-operative medication and was advised post-operative mouth opening exercise.

Statistical Analysis

Statistical analysis was performed using SPSS, version 22, and Microsoft Excel. Categorical data were expressed in terms of frequencies and percentages. For parametric test data were expressed in terms of mean and standard deviation. For nonparametric test data were expressed in terms of median and IQR (interquartile range).

To compare pre and post parametric test-paired *t* test was used for mouth opening and corresponding nonparametric test Wilcoxon signed-rank test was used for pain at rest, pain on mastication, subjective efficacy of the treatment and functional limitation.

Patients were followed up after 1 week, 1 and 3 months after the procedure for the assessment of mouth opening. Pain at rest and pain on mastication were assessed using VAS. Functional limitation during jaw movement was assessed as per study design. Subjective efficacy of the treatment was assessed as 0—poor; 1—slight; 2—moderate; 3—good; and 4—excellent. All the five clinical parameters were assessed by the same operator at the time of diagnosis and at each appointment during follow-up, after the treatment.

Results

Mouth Opening

The mouth opening was assessed pre-operatively and at 1 week, 1 and 3 months post-operatively, as shown in Fig. 4. From paired t test, there was a statistically significant difference between pre- and post-operatively at 1 week, 1 and 3 months, respectively, as shown in Table 1.

Pain at Rest

Visual analogue scale from 1 to 10 was used to evaluate the pain at rest. Pain score pre- and post-operatively at 1 week, 1 and 3 months decreased, respectively, and from Wilcoxon signed-rank test, there was a statistically significant difference between pre- and post-operatively at 1 week, 1 and 3 months, respectively, as shown in Table 2.

Pain on Mastication

Visual analogue scale from 1 to 10 was used to evaluate the pain on mastication. Pain score pre- and post-operatively at 1 week, 1 and 3 months decreased, respectively, and from Wilcoxon signed-rank test, there was a statistically significant difference between pre- and post-operatively at 1 week, 1 month and 3 months, respectively, as shown in Table 3.

Functional Limitation During Jaw Movement

Functional limitation during jaw movement was measured as per study design, and the result showed overall improvement. The functional limitation score pre- and post-operatively at 1 week, 1 and at 3 months decreased, respectively, and from Wilcoxon signed-rank test, there was a statistically significant difference between pre- and post-operatively at 1 week, 1 and 3 months, respectively, as shown in Table 4.

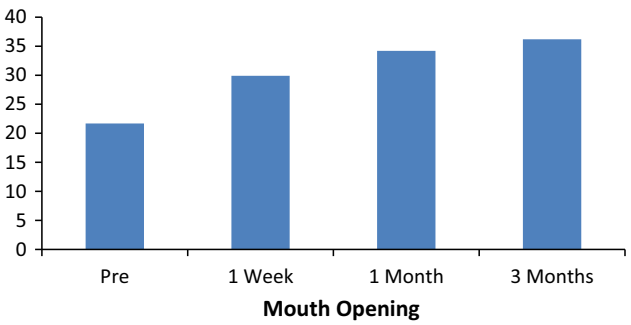

Fig. 4 Mouth opening

Table 1 Mouth opening analysis of the samples

	N	Mean	SD	Pair	Paired *t* test statistic	*P* value
Pre	10	21.70	6.056			
1 week	10	29.90	5.195	Pre-1 week	− 7.795	< .001
1 month	10	34.20	5.432	Pre-1 month	− 8.213	< .001
3 months	10	36.20	4.367	Pre-3 months	− 8.426	< .001

Table 2 Pain-at-rest analysis of the samples

	N	Median	IQR (interquartile range)	Pair	*Z* (Wilcoxon statistic)	*P* value
Pre	10	2.5	1–4			
1 week	10	1	0–2	Pre-1 week	− 2.716[b]	.007
1 month	10	0	0–0	Pre-1 month	− 2.677[b]	.007
3 months	10	0	0–0	Pre-3 months	− 2.677[b]	.007

Table 3 Pain-on-mastication analysis of the samples

	N	Median	IQR (interquartile range)	Pair	*Z* (Wilcoxon statistic)	*P* value
Pre	10	8	7–9			
1 week	10	3.5	3–4	Pre-1 week	− 2.816	.005
1 month	10	2	1–3	Pre-1 month	− 2.820	.005
3 months	10	1	0–1	Pre-3 months	− 2.829	.005

Table 4 Analysis of functional limitation during jaw movement

	N	Median	IQR (interquartile range)	Pair	*Z* (Wilcoxon statistic)	*P* value
Pre	10	3	3–4			
1 week	10	2	1–2	Pre-1 week	− 2.879[b]	.004
1 month	10	1	0–1	Pre-1 month	− 2.889[b]	.004
3 months	10	0	0–1	Pre-3 months	− 2.913[b]	.004

Subjective Efficacy of the Treatment

Subjective efficacy of the treatment was measured as per study design and was assessed from the first follow-up. Subjective efficacy of the treatment score at 1 week, 1 and 3 months increased, respectively, and from Wilcoxon signed-rank test, there was a statistically significant difference between pre- and post-operatively at 1 week, 1 and 3 months, respectively, as shown in Table 5.

Discussion

The use of single-puncture arthrocentesis was proposed by Guarda-Nardini et al. [10], and they concluded it to be more advantageous than the traditional arthrocentesis technique. Shepard cannula that holds the two needles together was used by Rehman and Hall for arthrocentesis which was relatively thick [11]. Due to the larger needle size, the risk of damage to the adjacent vital structures was relatively high. Rahal et al. used the single-puncture arthrocentesis technique using a new device where two 18-gauge needles, 1.5 inch long, were bent at 30° and welded together in a Y fashion with bevel facing outwards (Fig. 1). Multiple punctures through the TMJ capsule are often necessary and may lead to extra-articular leak of the lavage solution and thus decrease the intra-articular pressure required for lysis of the adhesions [12]. So single-puncture arthrocentesis has been advocated, which allows both irrigation and washout through the same device and makes the procedure much easier and convenient for the patient as well as the operator and thus improves success

Table 5 Analysis of subjective efficacy of the treatment

	N	Median	IQR (interquartile range)	Pair	*Z* (Wilcoxon statistic)	*P* value
Pre	10	3	2–3			
1 week	10	3	3–3	Pre-1 week	− 2.236	.025
1 month	10	3	3–4	Pre-1 month	− 2.460	.014
3 months	10	3	2–3	Pre-3 months	− 2	.046

rate [13]. In our study we fabricated the needle appliance using two 18-gauge needles. Then we joined two bended needles in Y design and soldered. Thus, we agree that single-puncture arthrocentesis makes the procedure much easier and convenient for the patient as well as the operator and thus gives better success rate.

Kaneyama et al. undertook a study to investigate the ideal volume of perfusate for arthrocentesis of the TMJ disorders wherein they evaluated 17 joints in 17 patients with TMD. They concluded that although the concentrations of bradykinin, interleukin 6 and protein during arthrocentesis were effectively reduced by more than 200 ml of lavage ($P < .05$), with a perfusate volume of 300–400 ml, the protein and bradykinin were no longer detectable; hence, they set the ideal lavage volume of perfusate for arthrocentesis between 300 and 400 ml [14]. In the current study we used around 300 ml of Ringer's lactate for arthrocentesis of the joint. Our results showed that the arthrocentesis was effective as all the clinical symptoms were significantly improved during the follow-up period.

After arthrocentesis various medications such as sodium hyaluronate, hyaluronic acid, corticosteroids can be injected in the upper joint space. Arthrocentesis followed by intra-articular injection of sodium hyaluronate has shown good outcomes in the treatment of TMJ disorders [15, 16].

Nitzan had reported pre-auricular infection swelling after arthrocentesis, and Carol reported an extra-dural haematoma. Certain transient complications such as temporary facial paralysis due to the use of local anaesthesia and local swelling of the surrounding tissue may arise. However, these complications disappear after few hours of the procedure [17]. However, in our study we did not come across any such complications as swelling and allergy. All the 10 patients were comfortable post-operatively and completely symptom-free.

Conclusion

We conclude that the single-puncture Ringer's lactate arthrocentesis followed by sodium hyaluronate injection is effective in the management of the internal derangement of the temporomandibular joint. It is a more simplified, safe, less time-consuming outpatient procedure with a low rate of complications and no post-operative discomfort according to our study. However, further studies with large sample size and long follow-up are required to support the current study.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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