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Effect of Articular Cavity Injection Combined with Bite Splint Treatment on Anterior Disc Displacement Without Reduction

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Abstract: *Objective:* To observe the clinical effect of articular cavity injection combined with bite splint therapy for the treatment of anterior disc displacement without reduction (ADDWoR). *Methods:* The research subjects for this study were 30 patients with ADDWoR treated in the temporomandibular joint specialist outpatient clinic from November 2018 to November 2019, with a disease duration of 1 to 6 months. The treatment group was treated with an articular cavity injection of sodium hyaluronate + bite splint. The control group was treated with a simple articular cavity injection of sodium hyaluronate. The two groups were followed up once every 2 weeks to evaluate the treatment effect and observe the clinical efficacy of the two groups. Statistical analysis was carried out using SPSS 24.0. *t*-test and general linear regression analysis were carried out to compare the data of both groups, and χ^2-test and binary logistic regression analysis were performed for pain index comparison. *Results:* There was no significant difference in terms of the efficacy of the treatment received by both groups. The mouth opening and joint pain of patients in both groups were significantly improved after treatment ($P < 0.001$). *Conclusion:* Articular cavity injection of sodium hyaluronate and occlusal splint therapy are both effective and safe methods for treating ADDWoR.

Keywords: Temporomandibular disorders; Anterior disc displacement without reduction; Sodium hyaluronate; Splint

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1. Introduction

Temporomandibular disorders (TMD) refer to the structural, functional, and organic changes in the temporomandibular joint (TMJ) and surrounding masticatory muscles. Patients mainly present with masticatory muscle and joint pain, snapping of opening and closing mouth joints, and mandibular movement disorders. Severe cases may involve headaches, earaches, dizziness, and hearing impairment. The causes of TMD are complex. Bite splint treatment can increase mouth opening and relieve joint pain, with an efficacy of 70% to 90% [1]. In this study, 30 patients with anterior disc displacement without reduction (ADDWoR) were treated with an injection of sodium hyaluronate into the upper cavity of the TMJ combined with a bite pad, and the results were analyzed.

2. Materials and methods

2.1. Collection of clinical data

The sodium hyaluronate injection used in this study was supplied by Shanghai Jingfeng Pharmaceutical Co., Ltd. (molecular weight: 600,000 to 1.5 million, dose: 25 mg). A TMJ square ruler was used to measure the mouth opening. The injection was performed using a disposable 5 mL sterile syringe. The injection site was sterilized with iodophor cotton balls, alcohol cotton balls, and 5 mL of 2% lidocaine.

2.1.1. General information of the patients

This study included 30 ADDWoR patients, all of whom were treated in the TMJ specialist outpatient clinics from November 2018 to November 2019. The subjects consisted of 3 males and 27 females, aged 15 to 61 years (mean: 27.50 ± 11.49 years). Among them were 9 cases on the left side, 13 on the right side, and 8 on both sides. The course of disease ranged from 1 month to 6 months.

2.1.2. Inclusion and exclusion criteria

The inclusion criteria were obvious clinical symptoms and signs of TMD: (1) Pain or tenderness in the TMJ area, (2) popping sound when opening and closing the mouth, (3) limited mouth opening, (4) X-ray film (Scholler-position) showed narrowing of retroarticular space and widening of anterior space or other relevant signs in radiography or MRI examination (**Figure 1**) that indicates TMD, (6) received physical therapy, hot compress, denture repair and other treatments but showed no improvement.

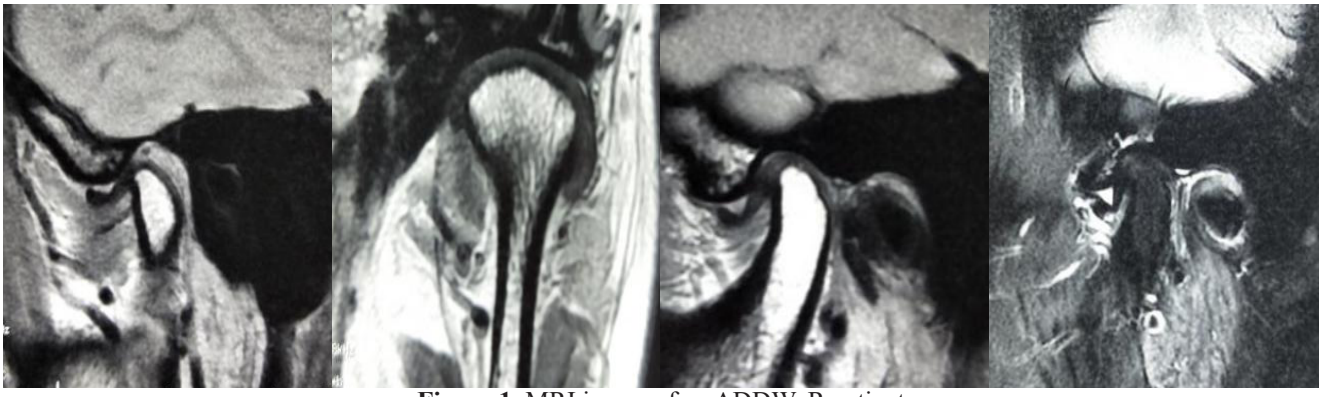

Figure 1. MRI image of an ADDWoR patient

Exclusion criteria: (1) acute TMJ disorders, (2) TMJ dislocation, (3) disease duration of less than a month.

The 30 patients were divided into a treatment group and a control group, with 15 patients in each group. The treatment group consisted of 1 male and 14 females, aged 27.67 ± 13.67; the control group consisted of 2 males and 13 females, aged 29.38 ± 10.96. There was no significant difference in the general information of both groups ($P > 0.05$), as shown in **Table 1**.

Table 1. Comparison of general information between the two groups (mean ± standard deviation)

Group	Treatment group (n = 15)	Control group (n = 15)	Total (n = 30)	P-value
Age	27.67 ± 13.67	29.38 ± 10.96	27.50 ± 11.49	0.938
Male (%)	1 (7%)	2 (15%)	3 (10%)	1
Female (%)	14 (93%)	13 (85%)	27 (90%)	
Bilateral	4	4	8	.
Left side	5	4	9	.
Right side	6	7	13	.

2.2. Method

The treatment group was treated with an injection of sodium hyaluronate into the upper cavity of the TMJ + bite pad. (1) Supra-articular cavity injection method (**Figure 2**): The patient lied in a supine position, and the skin was draped with routine disinfection. The patient was directed to open their mouth as wide as possible. The midpoint of the tragus was connected to the lateral canthus, and the needle's location was determined by palpating the glenoid fossa and condyle, 1 cm in front of the tragus. A 5# injection needle was employed to inject 1 mL of lidocaine into the posterior condylar area. Subsequently, the needle was withdrawn from the subcutaneous tissue and then reinserted, advancing forward, upward, and slightly inward. The needle traversed the posterior region of the joint capsule along the posterior edge of the condyle. After confirming the absence of blood during aspiration, 2 mL of 2% lidocaine was injected, and further aspiration was performed without encountering resistance. After confirming that the needle had entered the upper joint cavity, rinsing and expansion were performed repeatedly to absorb all the injected lidocaine. The needle was then replaced and 2 mL of sodium hyaluronate was injected. The patient was instructed to open and close the mouth several times to facilitate even coating of the drug on the articular cartilage surface. This process was repeated once every 2 weeks, and two such sessions constituted a course of treatment. After each intra-articular injection, the patient was instructed to perform mouth opening and closing exercises. A mandibular stabilization splint was placed in the patient's mouth throughout the process to ensure stability (**Figure 3**). A bite splint was made for the patient. To make the stable bite splint, the wax piece that occupies the central occlusal position to the upper and lower jaw plaster models was transferred and fixed onto a semi-adjustable articulator (**Figure 4**), and a transparent resin-stabilized bite splint was made, which covered the entire dentition of the maxilla or mandible [2]. Its occlusal surface was smooth; there was no interlacing between the cusps and fossae, and the front teeth were in light contact. The thickness of the central fossa of the second molar of the bite splint was kept at about 2 mm, which was smaller than the interocclusal space. When adjusting the occlusion, the functional tips of the mandibular or maxillary dentition should form point-like even contact with the bite splint. The part where the bite splint touches the tooth cusps cannot form a lock on the tooth cusps. The occlusal surface of the bite splint was wide and smooth. When the mandible moves forward, the posterior teeth must be separated, with only the anterior teeth in slight contact. The bite splint was worn for 3 months, for no less than 10 hours every day, and bite adjustment was performed regularly.

The control group was treated with a simple intra-articular injection of sodium hyaluronate, with follow-up consultation once every 2 weeks to evaluate the therapeutic effect. The total course of treatment was 3 months.

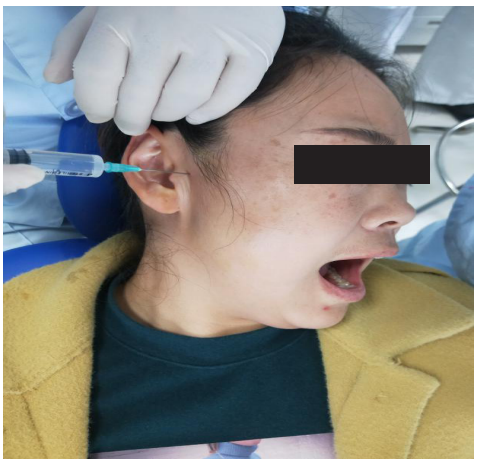

Figure 2. Sodium hyaluronate injection at the TMJ

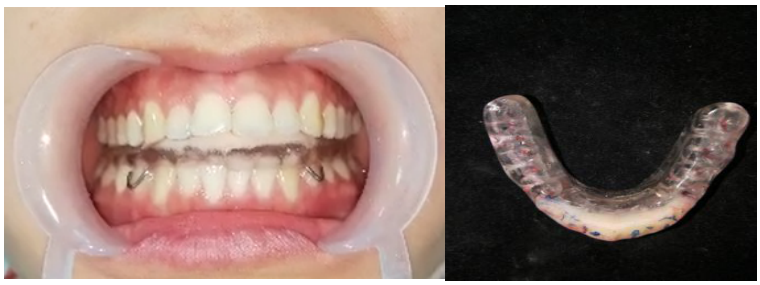

Figure 3. Bite splint

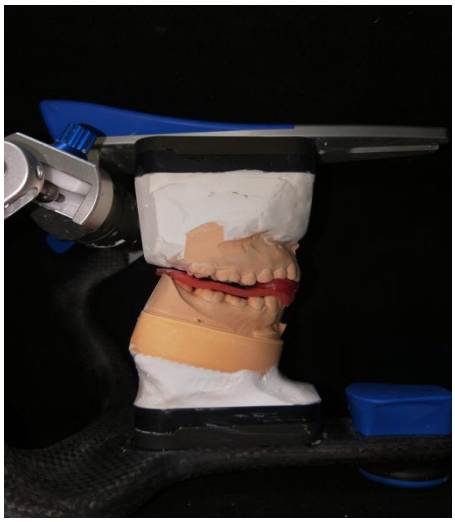

Figure 4. A pair of dental model casts on an articulator

2.3. Efficacy evaluation

Relevant indicators were recorded before treatment and 3 months after treatment, which included maximum active opening (mm) and joint pain. These indicators were used to evaluate the efficacy of the treatment.

2.3.1. Maximum mouth opening

The maximum mouth opening was measured as the distance between the incisal edges minus the overbite value. The influence of different overbite depths on the actual opening had been eliminated.

2.3.2. Joint pain

(1) Effective: clinical symptoms disappeared entirely. (2) Ineffective: Pain and joint movement disorders disappeared or reduced for a short period but reappeared, or no improvement at all.

2.4. Statistical analysis

SPSS24.0 software was used for statistical analysis. The measurement data were expressed as mean ± standard deviation. The mouth opening conformed to the normal distribution. The groups were compared by *t*-test and general linear regression analysis. The pain index was compared. χ^2 test analysis and binary logistic regression

analysis were used. The test standard $\alpha = 0.05$, and $P < 0.05$ means the difference is statistically significant.

3. Results

3.1. Before treatment

Before the treatment, there was no significant difference in the maximum mouth opening between the treatment group and the control group ($P > 0.05$). As shown in **Table 2**, there was no significant difference between the treatment group and the control group in terms of pain area ($P > 0.05$)

Table 2. Pain evaluation before treatment

Indicator		Treatment group	Control group	Total
Pain area	No pain	2	1	3
	Left side	5	4	9
	Right side	7	9	16
	Bilateral	1	1	2
n		15	15	30

3.2. Comparison between before and after treatment

3.2.1. Mouth opening and pain improvement

The maximum mouth opening increased and joint pain decreased gradually after each treatment session. Among the 30 patients, the joint pain of 22 patients disappeared after treatment, while it persisted for 8 patients. The comparison of mouth opening and joint pain before and after treatment is shown in **Table 3**.

3.2.2. Comparison of treatment efficacy

After treatment, the mouth opening and pain of all patients improved $P < 0.001$. The maximum active mouth openings after treatment in the treatment and control groups were 38.53 ± 5.05 mm and 38.33 ± 3.31 mm, respectively. The changes in mouth openings of the treatment group and control group were 10.27 ± 5.82 mm and 10.87 ± 5.34 mm, respectively, and there was no significant difference between the two groups $P > 0.05$. The patients also significantly reduced after treatment $P < 0.001$. The efficacy of pain relief in the treatment group and the control group were 80% and 67%, respectively; the difference in the efficacy between both groups was not statistically significant. Further details are shown in **Table 3**.

Table 3. Comparison of treatment efficacy between the two groups (mean ± standard deviation)

Variable		Treatment group	Control group	Total	t/χ^2		*P*	
					Treatment group	Control group	Treatment group	Control group
Mouth opening (mm)	Before treatment	28.27 ± 5.81	27.47 ± 4.93	27.87 ± 5.31	-6.827	-7.876	< 0.001	< 0.001
	After treatment	38.53 ± 5.05	38.33 ± 3.31	38.43 ± 4.20				
	Difference between before and after treatment	10.27 ± 5.82	10.87 ± 5.34	10.57 ± 5.50	-0.294		> 0.05	
Joint pain efficacy	Effective	12	10	22	0.682		> 0.05	
	Ineffective	3	5	8				
	Total	15	15	30				

4. Discussion

ADDWoR of the TMJ means that the articular disc stays in front of the transverse ridge of the condyle in both closed and open positions, causing the condyle to be unable to slide and rotate normally, resulting in a series of symptoms involving the TMJ and/or masticatory muscles and their surrounding tissue structures [3]. Its main clinical manifestations are restricted opening, joint pain, joint locking, etc.

ADDWoR is commonly treated with bite splint treatment, sodium hyaluronate intra-articular injection, or both treatments combined. Bite splint treatment is the most common among all treatments. For acute ADDWoR with a duration of less than 1 month, the main goal of treatment is to increase the mouth opening. Manual articular disc reduction is a quick, effective, and non-invasive solution that not only relieves clinical symptoms but also achieves an anatomical cure. Follow-up is usually combined with sodium hyaluronate injection treatment or a combination of bite splints.

Hyaluronic acid (HA) is secreted by synovial B-type cells and can be found in the synovial fluid as sodium hyaluronate. It is one of the main components of the synovial fluid and plays a vital role in joint protection, nutrition, and function maintenance [4]. HA has high viscoelasticity. When the condyle moves rapidly and generates a shear force on the articular disc, the internal solution provides elasticity, thereby buffering and reducing the vibration of the joint, which in turn reduces the collision of the condyle, articular disc, joint capsule, and other structures. The synovial fluid also acts as a molecular sieve, which not only allows nutrients to pass through the cartilage but also can also serve as a nutrient for the natural barrier of joints and inhibit the synthesis of cartilage proteoglycans in chondrocytes [5]. A study in 2011 showed that injection of sodium hyaluronate into the TMJ cavity can reduce the joint surface's friction coefficient, thus relieving joint pain, making it one of the effective methods for treating TMD [6]. Since sodium hyaluronate does not result in antigenicity, chemotactic effect, and foreign body reaction, it can be injected repeatedly, so it is favored in clinical practices. The treatment plan of the patients in this study involved repeated flushing of the joint cavity to clean out the inflammatory mediators and fibrous adhesion substances in the diseased joint cavity, expanding the volume of the joint cavity, pain relief, and increasing mouth opening.

The main mechanism of the bite splint treatment includes the removal of early contact occlusal interference during centric occlusion, the removal of occlusal interference during non-centric movements, and the establishment of a stable posterior teeth support to support the joint and reduction of the condyle's rotational pressure. It can reduce abnormal muscle activities and adjust neuromuscular reflexes to keep the TMJ stable and achieve the best occlusion state.

The efficacy of bite splint + sodium hyaluronate intracavitary injection compared to sodium hyaluronate intracavitary injection alone in treating ADDWoR was compared. The results showed there was no statistically significant difference in the efficacy between the two types of treatment. The mouth opening and pain of all patients were significantly improved after treatment ($P < 0.001$). In short, injection of sodium hyaluronate into the upper cavity of the TMJ and bite splint treatment are effective and safe methods for treating ADDWoR. The cause of ADDWoR is complex; the treatment process requires good patient compliance, and the selection of treatment methods should be done based on the patient's clinical symptoms. Due to the small sample size included in this study, further randomized controlled studies need to be conducted to verify the results of this study.

Disclosure statement

The authors declare no conflict of interest.

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