

Progress in the Study of Temporomandibular Joint Lavage in Temporomandibular Joint Disorder

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Abstract: With the continuous development and progress of medicine, there are many methods for the treatment of temporomandibular disorders, among which temporomandibular joint lavage is also constantly developed. In the past century, through the efforts of some scholars and clinical summary, the understanding of this disease has been deepened and broadened. At present, through continuous exploration of the treatment methods, the lavage is relatively mature, and has achieved good clinical results. In this paper, the application of temporomandibular joint lavage in the treatment of temporomandibular joint disorders, its treatment methods, treatment mechanism, the auxiliary of other drugs, indications, complications and so on were discussed.

Keywords: temporomandibular joint lavage, temporomandibular joint disorder, arthrocentesis

Introduction

Temporomandibular disorders are very common in today's life, and there are many treatment methods. Temporomandibular joint lavage has been one of the methods for the treatment of temporomandibular disorders. At the same time, temporomandibular joint lavage has also been effective in cases of local joint pain and limited joint movement, such as atresia, osteoarthritis, and various inflammatory diseases.¹ Compared with non-surgical treatment, temporomandibular joint irrigation has better relieved the pain of patients, but without complicated surgical treatment.² In many cases that cannot be treated conservatively but are not suitable for surgery, temporomandibular joint lavage is undoubtedly a better treatment method. It can relieve small adhesions, remove part of the tissue debris in the joint cavity, inflammatory pain mediators, etc., which is not only less traumatic but also effectively relieve the symptoms of patients.³

Temporomandibular Joint Disorder(TMD)

TMD is one of the common diseases of oral and maxillofacial region.^{4,5} It is also the second most common musculoskeletal disorder causing pain and disability.^{6,7} TMD is not a single disease, but a general term for a class of diseases whose cause is not clear, but with common pathogenesis and main clinical symptoms. It often occurs in young and middle-aged people between 20 and 40 years old. In general, the incidence is higher in adults/elderly than in children/adolescents.⁸ According to the diagnostic criteria for TMD (DC/TMD), it is usually classified into three categories. The first type is muscle disorders, which include myofascial pain with or without limitation of mouth opening; the second category was disc displacement with or without limitation of mouth opening. The third category is arthralgia, arthritis, and arthralgia.⁹

Common Cause of TMD

This disease is closely related to the function of the various structures of the temporomandibular joint (condyle process, articular disc of mandible, articular fossa of mandible, anadesma, muscle, tooth), one of the anatomical, functional

abnormalities, or the occurrence of stress, trauma can lead to the disease. In addition to biological causes, there are psychosocial, microtrauma, anatomical factors, and endogenous immunity that are associated with TMD. Studies have shown that depression triples the incidence of TMD, and anxiety increases facial pain by 1.8 times and so on.¹⁰

Common Symptoms

Clinically, masticatory muscle and joint pain, headache, joint clicking or bruit, abnormal mandibular movement (abnormal mouth opening, one-time, or intermittent locking during mouth movement), orofacial pain, otalgia, tinnitus, etc. TMD patients may present overlapping symptoms with other chronic pain conditions, including headache, fibromyalgia, and neurological conditions, probably through the phenomenon of central sensitization (mainly allodynia and hyperalgesia).¹¹

How to Treat

For patients with TMD, not everyone needs treatment, only 5% to 10% of the patients need treatment, and in 40% of the patients without TMD treatment, the symptoms were gradually relieved or even disappeared within the same time as those treated with TMD.¹² In general, there is not much difference between surgical and conservative treatment.¹³ Even if treatment is needed, conservative management is recommended in 50% to 90% of the patients.¹⁴ X-ray examination and magnetic resonance examination are often used in the diagnosis, and arthroscopy is necessary in a few patients. There are many treatment methods for TMD, for example, pharmacologic treatment, physical therapy, local block therapy, muscle training therapy, psychological support therapy, surgical treatment, intra-articular drug therapy, and irrigation therapy.¹⁵ Temporomandibular joint lavage plays a key role in inflammatory diseases, and it has achieved good results in clinical application.

Temporomandibular Joint Lavage

Development History of Temporomandibular Joint Lavage

Masatoshi Ohashi first used arthroscopy in the treatment of temporomandibular joint disease in 1975, and then Murakami et al¹⁶ used arthroscopy to irrigate the superior cavity of the temporomandibular joint to treat patients with anterior disc displacement without reduction (ADDWR) and achieved good results. Later, Nitzan found that arthroscopy did not change the position and morphology of the articular disc when he used arthroscopy to treat ADDWR. However, arthroscopy has more surgical limitations and requires complex surgical equipment.¹⁷ From then on, Nitzan proposed a less invasive joint puncture technique than arthroscopy (instead of arthroscopy, two needles were inserted directly into the joint cavity for irrigation).¹⁸ Until now, among the existing literature has proved that arthrocentesis is simpler, cheaper and has fewer complications than arthroscopic surgery.^{19–21}

The Mechanisms of Temporomandibular Joint Lavage

There are two main mechanisms of temporomandibular joint cavity lavage.

The first is to release small adhesions and remove inflammatory substances and pain factors. The rapid flow of lavage fluid in the joint cavity and the pressure of irrigation solution can break the small adhesions. At the same time, increasing the pressure of irrigation fluid can increase the range of motion of the joint disc, thereby increasing the opening of the mouth. In addition, patients with temporomandibular disorders caused by minor sports trauma lead to the destruction of the joint surface tissue and the exposure of articular cartilage blocking antigen, which causes the body's endogenous immune disease. The presence of strong inflammatory substances such as prostaglandin E2 and leukotriene B4 in joint fluid and ceruloplasmin accelerates the destruction of joint tissue and causes pain. Irrigation flushes these inflammatory factors out of the joint cavity.

The second is to eliminate the suction cup effect (abnormal functional movements of the mandible, such as night molars and clench bite, lead to excessive joint load, which causes excessive negative pressure in the upper joint cavity.²² When the load is removed, the middle part of the articular disc is separated from the articular tubercle, while the periphery of the articular disc is still adsorbed on the surface of the tubercle and glenoid fossa, and the reduction and movement of the articular disc is limited. The lower head of the lateral pterygoid muscle pulls on the fixed joint disc, causing pain in the retrodisc area and joint capsule, which in turn causes central reflex restricted mouth opening) by relieving the negative pressure in the joint, reducing the viscosity of synovial fluid in the joint cavity, and destroying the cup suction effect between the joint disc and the glenoid fossa, so as to restore the joint mobility.²³

Specific Manipulate

Single-Needle or 2-Needle Technique

In the temporomandibular joint lavage, there are two methods commonly used, single-needle or 2-needle. The joint lavage was initially a single channel and then developed into a double channel. Both methods have their own advantages, although it is said that both puncture methods can achieve the purpose.²⁴ Although the double-needle technique can establish a complete irrigation channel, it has the disadvantages of low tolerance and difficulty to implement in the presence of intra-articular adhesion. According to the results of the current study, the single-needle technique is a good choice when the double-needle technique cannot be implemented.²⁵ The single-needle technique does not have these two problems, and the single needle can enter the joint cavity more accurately and stably (the entry of the second needle will affect the stability of the first needle). In addition, it has less trauma, less tissue damage, less discomfort, easy to operate and shorter operation time than the double needle technique.^{26,27} The experiment showed that the operation time of double needle was almost 1.7 times that of single needle. Pain with the two-needle technique decreased at 3 months but increased again after 6 months, whereas pain with the single-needle technique remained reduced after 6 months. Finally, the opening of the two-needle technique increased slightly after surgery, decreased after 1 week, increased again after 1 month, decreased after 3 months, and increased after 6 months, volatility and uncertainty are high. The single-needle technique decreased slightly after surgery, decreased after 1 week, increased after 1 month, and continued to increase after 6 months. Overall, the results were better with the single-needle technique.²⁸

The Pressure of Lavage

Scholars with different irrigation pressures have different views, which are mainly divided into two types: large pressure and small pressure. However, it is found that small pressure irrigation is not ideal for patients with severe adhesion. High pressure irrigation can remove the adhesion of the joint cavity and expand the joint cavity in patients with chronic strangulation. In the process of lavage, different operation methods can be used to create disparate pressure differences in the temporomandibular joint. The methods used in the experiment included intermittent pressurization of the water inlet or occlusion of the water outlet during the double-needle puncture, the pressure at the water inlet was as high as the patient could tolerate and maintained for 5 seconds before releasing the water outlet so as to achieve the purpose of treating temporomandibular joint disorders. The conventional intermittent compression method can be used as a general surgical method. The increased pressure lavage method is suitable for patients with severe joint lesions.²⁹

The Medicine and Dosage of Lavage

The commonly used temporomandibular joint irrigation fluid is 0.9% sodium chloride injection, lactated Ringer's solution and joint special anti-adhesion irrigation fluid (mainly carboxymethyl chitosan).³⁰ It has also been shown that ozonized water lavage has a better effect in the treatment of TMD.³¹

The total amount of lavage fluid varied from 25 mL to 400 mL. A cadaveric study showed that injection of 1 mL of 10 μ M methylene blue solution into the unilateral superior joint space of the temporomandibular jaw washed methylene blue out of the TMJ with only 25 mL of saline.³² Another experiment used a 2.4-mm needle to completely replace synovial fluid with saline to achieve 100% lavage with a minimum lavage volume of 109 mL.³³ Another study confirmed that there was no significant change in mouth opening from 100 mL to 250 mL, and the temporomandibular joint disorder was improved.³⁴ In addition, some scholars have demonstrated that the amount of lavage fluid to completely remove bradykinin, interleukin-6 and protein is about 300–400 mL.³⁵ However, there are still few clinical studies, and more clinical studies are needed to further understand the ideal irrigation volume of temporomandibular joint.

Device Used of the Puncture

The size of the syringe commonly used for TMJ injection is 18-gauge needle (No.12, OD 1.25 mm); 19-gauge needle (No.10, OD 1.08 mm); 20-gauge needle (No.9, OD 0.9 mm). 21-gauge needle (No.8, OD 0.81 mm). A 7-gauge needle with an external diameter of 0.7 mm is commonly used in China.³⁶ The reason is that the 7-gauge needle has a moderate diameter, which can provide sufficient puncture force during TMJ puncture without being too bulky, which is helpful for accurate puncture. At the same time, the 7-gauge needle is common in China and easy to obtain and use.

Operational Process

Both the upper and lower parts of the TMJ can be irrigated. At present, irrigation of the upper cavity is more common, because the upper cavity is wider and larger than the lower cavity, so the upper cavity is easier to enter the needle. The data analysis showed that irrigation of the lower cavity was more effective and could better relieve pain, but the technique required for irrigation of the lower cavity was higher.³⁷

The two-needle system and the single-needle system are operated in slightly different ways. For both single and double needles, anatomical landmarks were first determined by the line described by Nitzan from the lateral canthus to the last central point of the auricle (Holmund-Helsing line) [Figure 1].³⁸

Needle Technique

The double needle puncture technique is mainly used in Nitzan's two-needle Arthrocentesis technique. The patient needs to take the sitting position and close the mouth to draw the anatomical landmarks, and then puncture is performed according to the anatomical landmarks. The posterior puncture point is located between the anterior tragus and the posterior slope of the condyle, about 1 cm from the line between the midpoint of tragus and the lateral canthus. The anterior puncture point was located at the front of the condyle and the articular tubercle, about 0.5 cm in front of the posterior puncture point. After the puncture point was marked, the skin was routinely disinfected, and the patient was instructed to sit in the prescribed position, open the mouth wide, and tilt the head to the healthy side. A small amount of lidocaine was injected into the posterior puncture point, and then two needles were punctured into the supra articular cavity, respectively, with the needle approximately 20 mm to 25 mm deep.³⁹ Irrigating fluid was injected into the posterior needle, and the irrigating fluid was drained from the anterior head. The lavage was repeated several times until the lavage fluid was clear and the needle was pulled out to end the lavage. Local pressure was applied for 20 min after repeated irrigation. In the original irrigation technique, the doctor manually controlled the needle to inject the fluid into the joint cavity, which made the volume and speed of the irrigation fluid difficult to control and required the help of the surgical assistant or nurse during operation. Now there is a foot-controlled irrigation system, which consists of a long tube connecting the motor system at one end to the irrigation equipment at the other end. By controlling the pedal with the foot, the irrigating fluid can flow from the intravenous infusion bag to the motor system and then from the extension tube to the irrigation equipment, so that the doctor can control the flow of the irrigating fluid and obtain continuous and stable irrigation.⁴⁰

Single-Needle Technique [Figures 2 and 3]

There was no significant difference between the single-needle lavage technique and the double-needle lavage technique. Only the first needle of the double-needle lavage method (between the anterior tragus and the posterior slope of the condyle, about 1 cm from the tragus on the line between the midpoint of the tragus and the lateral canthus) was placed, and repeated suction



Figure 1 Anatomical landmarks.



Figure 2 Single-Needle Technique (1).



Figure 3 Single-Needle Technique (2).

was performed through this needle.³⁶ This study was approved by the Medical Ethics Committee of Hangzhou Lin 'an District Stomatological Hospital and conducted at Hangzhou Lin 'an Stomatological Hospital in Zhejiang Province. The patient consented to the release of the associated photographs, and we confirmed the confidentiality of the patient's data.

Indication of Temporomandibular Joint Lavage

Temporomandibular joint lavage is mainly used for temporomandibular joint disorders, such as post-traumatic arthritis of the temporomandibular joint, synovial chondromatosis of the temporomandibular joint, fracture of the temporomandibular joint, chronic atresia, which has poor effect on injection treatment, serious pain, and joint cavity exudation.^{41–45} This is especially true for synovitis and osteoarthritis, which are not effective with physical therapy alone. But when conservative treatment is invalid or ineffective in patients with severe dysfunction, imaging examination in patients with temporomandibular joint structure obvious change or the temporomandibular joint organization has obvious physical damage, patients with temporomandibular disorders who are unable to live or work normally need timely surgical treatment.^{46,47}

Complication of Temporomandibular Joint Lavage

Common complications include pain, swelling, and narrowing of the opening, and rare complications include ipsilateral maxillary swelling, parapharyngeal swelling, and postoperative malocclusion, but most can be greatly reduced by strict operative techniques.⁴⁸ The following are the sources and causes of various complications:

1. Pain at the puncture site: puncture may cause damage to tissue, resulting in patients with mild pain.

2. Edema in the puncture area: edema is related to the perforation of the joint capsule itself or the injury of the joint capsule caused by repeated puncture of the joint capsule due to the inaccurate puncture position during the puncture process.⁴⁹
3. Dizziness: it is related to the inner ear reaction caused by too fast irrigation speed.^{49,50}
4. Superficial temporal artery injury: the superficial temporal artery is located in the puncture area, with a thin vessel wall, which is easily damaged and causes hematoma.
5. Parapharyngeal swelling: it is usually thought to be caused by extravasation of pus through the medial joint capsule.⁵¹
6. The otological complications: common ones include damage to the external auditory canal, partial hearing loss, and perforation of the tympanic membrane with a tear of the external auditory canal. It is usually caused by a doctor's error.^{49,52}
7. Trigeminal nerve injury: the auriculotemporal nerve in the trigeminal nerve has the greatest risk of injury, auriculotemporal nerve is superficial, and the branches of auriculotemporal nerve are easily damaged during the puncture process, it may be caused by excessive water pressure or fluid extravasation during irrigation of the joint cavity.⁵³
8. Intra-articular problems: these include hemarthrosis, arthritis and bacterial infection, is related to the lack of strict disinfection of the joint area, the contact of the injection needle with infectious substances and the deep tissue brought into the process of puncture.⁵⁰
9. Extradural haematoma: it is closely related to the anatomical structure of the temporomandibular joint; it may be that in the case of high-pressure lavage, fluid enters the dura mater through a fine channel in the bone, separating the dura from the skull, thus causing dural hemorrhage. It is rare in clinical practice, but it should be considered when the patient has headache or drowsiness.⁵⁴

Analgesics Used During the Irrigation

Some analgesics can be injected when the patient has pain or discomfort during lavage or after the end of lavage. For some common analgesics and anesthetics (bupivacaine, lidocaine, mepivacaine, and articaine), there was no statistically significant improvement in the range of motion of the jaw after local anesthesia was given in the joint, bupivacaine can provide temporary pain relief for up to 24 hours after injection and is currently only considered as a short-term pain relief measure after local intra-articular anesthesia.⁵⁵ Some scholars have studied the effect of Hyaluronic Acid (HA), Corticosteroids (CS) or Platelet-rich Plasma (PRP) injected at the time of lavage on the rehabilitation of patients.⁵⁶ The results show that there is no difference in the rehabilitation outcome after 2 years between the addition of HA or CS and the simple lavage, but it can reduce pain and inflammation for a month to 3 months after the irrigation is completed.³⁵ At the same time, some scholars have proposed that intra-articular steroid injection after surgery, although there is a trend of improvement, its therapeutic response is very dependent on the patient's own conditions and is affected by many variables, so it is not the best method to use.⁵⁷ It has also been shown that when duloxetine is injected after lavage, much less pain is observed, and the desired effect is achieved faster.⁵⁸ In recent years, transfusion of blood products has become a more popular topic than hyaluronic acid.⁵⁹ The addition of PRP to lavage can increase the degree of mouth opening and reduce the degree of pain in the later rehabilitation compared with lavage alone.^{60,61}

The Future of Temporomandibular Junction Irrigation

Temporomandibular joint disorder (TMJ) is a very common disease in clinic. Especially for middle-aged and elderly people, only conservative treatment cannot achieve the ideal effect. However, its tissue recovery ability is not strong, leading to a high risk of open surgical treatment. Therefore, the temporomandibular joint lavage can make up for the shortcomings of the two methods. At present, the application of temporomandibular joint lavage in temporomandibular disorders has been very common, and satisfactory clinical results have been achieved. After lavage, the degree of mouth opening was significantly increased and the pain was relieved, which was convenient for subsequent treatment.

However, the changes and effects of disc position and disc morphology after lavage await further investigation. A 2015 study found that in postoperative lavage joint deformation has a tendency to further aggravate, the double plate area shape becomes similar to articular disc tissue; a 2017 study also proved that the joints after lavage dish shape recovery have no obvious effect, and even have a tendency to increase.^{62,63} However, the reasons for the elongation and

folding of the articular disc have not been elucidated accurately, and the adaptive reconstruction of the bilaminar zone has not been determined.

In the process of lavage, the choice of rinse amount is very different for disparate patients and diverse lavage methods, with a huge gap from tens to hundreds, but there are few studies on the ideal amount of temporomandibular joint lavage. Whether the ideal state after lavage can be achieved with less lavage volume remains to be studied.⁶⁴

At the same time, lavage inject drugs is also a key research direction, although some scholars think that hyaluronic acid is added to the process of irrigation, such as corticosteroids had no obvious effect. However, in recent years, some scholars believe that sodium hyaluronate can increase the opening of the mouth and reduce pain in patients with temporomandibular joint synovitis.^{65,66} In the treatment of temporomandibular joint osteoarthritis, joint lavage combined with autologous platelet-rich plasma injection can improve the clinical symptoms of patients of different ages.^{67,68} However, there are some limitations in most of these studies, and the sample size of these effective studies is small and the observation time is short. In clinical practice, we should increase the sample size and follow-up time, carry out research for a long time, as to provide theoretical basis for clinical rational making treatment plan.

For temporomandibular joint lavage, complications are rare, the symptoms are mild, and basically disappear within 2 weeks.^{45,69} But at the same time, many studies have shown more troublesome complications, such as epidural hematoma and superficial temporal artery injury.^{49,54} Therefore, it is also a problem to cooperate with the causes and treatment methods of these rare but troublesome complications.

In general, Temporomandibular joint irrigation therapy usually does not require multiple consecutive treatments, and in many studies, significant results can usually be achieved after a single lavage. If there is no relief from symptoms, re-irrigation may be considered, as it can reduce inflammation and restore the normal function of TMJ. Treatment intervals can be determined on a case-by-case basis, and a minimum interval of 1–2 months is generally recommended. However, there is no clear literature on whether multiple treatments should be performed.^{47,70}

Therefore, there are still many problems waiting to be solved for temporomandibular joint irrigation to achieve better therapeutic effects.

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