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REVIEW

Contemporary approach to the complex interdisciplinary treatment in patients with temporomandibular joint dysfunction

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ABSTRACT

The prevalence of temporomandibular joint (TMJ) disorders in the modern world is steadily increasing, and according to the World Health Organization, more than 78% of the working population suffers from muscular and joint disorders. The article reviews the problem of TMJ disorders complex therapy and describes modern treatment methods of TMJ dysfunction.

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The detailed description is provided for two approaches to the treatment of TMJ dysfunction: arthrocentesis and splint therapy. We have presented summarized data from clinical studies in which patients were treated for TMJ diseases with hyaluronic acid injections. The main types of occlusal splints and their characteristics, used in the treatment of TMJ dysfunction, are described. We conducted a comparison of both treatment methods for TMJ diseases and identified the key advantages and disadvantages of the reviewed approaches.

Both injection therapy (arthrocentesis) and splint therapy demonstrate high treatment success rates, but each method has its own features in clinical application. Given the high prevalence of TMJ disorders, the issue of developing an improved treatment protocol for these patients remains relevant.

Key Words: arthrocentesis; occlusal splint; splint therapy; treatment protocol; muscular and joint disorders; treatment protocol optimization

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Introduction

According to statistics, the prevalence of temporo-mandibular joint (TMJ) and masticatory muscles diseases in people of working age in different countries reaches 85%. The effectiveness of existing pharmaceutical treatment protocols for TMJ disorders remains insufficiently effective. These treatments often provide a localized or single-target effect, and the effect of pharmaceutical methods has not been sufficiently studied [1].

The prevalence of functional disorders of the dentoalveolar system ranges from 25 to 65% among patients seeking dental care, with muscle and joint dysfunction being the most prevalent, accounting for up to 90% of all TMJ pathologies [2].

Given the high prevalence, timely diagnosis, as well as understanding the etiology and pathogenesis of dysfunctional conditions of the dentoalveolar apparatus, neuromuscular and craniomandibular systems, the use of occlusal splints is an essential component of specialized dental care, including qualified, pathophysiology-based and etiology-driven complex treatment [3]. Non-inflammatory TMJ diseases are multifactorial, difficult to manage. These disorders carry a high risk of chronicity of the process, sensitization, recurrence, with the formation in a vicious circle and an altered response to therapy. The human body is a complex system which is regulated by neurohumoral mechanisms. Medication alone does not always yield a wished therapeutic effect, which is why the role of physiotherapeutic and device-based methods increases [4].

According to clinical guidelines, treatment of TMJ pain dysfunction syndrome includes conservative methods, which include pharmacotherapy, psychotherapy, conditioned reflex therapy, therapeutic exercise and massage, hardware treatment, temporary and permanent prosthetics, and surgical methods – arthrocentesis, arthrolavage, arthroscopy and open surgery. [5] Approaches to the treatment of TMJ disorders differ significantly in Russia and China. Russian protocols primarily utilize splint therapy, while in China protocols prioritizes injection methods. Thus, there is a need to find the most optimal protocol for treatment of dysfunctional conditions of the TMJ.

The aim of this article is to review the effectiveness of modern methods of treating patients with temporomandibular joint dysfunction – splint therapy and arthrocentesis – and to assess the possibility of their separate and combined use in general clinical practice.

The therapeutic efficacy of arthrocentesis with hyaluronic acid injection

Hyaluronic acid (HA) is a primary component of both the natural synovial fluid and the extracellular matrix of cartilage, synthesized by chondrocytes and fibroblasts within the synovium [6]. Intra-articular HA possesses a high molecular weight and concentration, enabling it to permeate the connective tissue matrix, inter-articular ligaments and cartilage surfaces. It provides essential viscoelasticity that that contributes to joint lubrication, mechanical protection and stability [7]. In contrast, the synovial fluid of patients with temporomandibular joint disorders (TMD) contains HA of lower molecular weight. This alteration results in a reduction of viscoelasticity and mechanical function of the TMJ. Furthermore, low-molecular-weight HA exhibits pro-inflammatory effects [8]. Consequently, arthrocentesis with HA injection serves as an effective therapeutic approach for managing TMD.

Pain is frequently the chief complaint that leads TMD patients to seek treatment. Arthrocentesis with HA injection has been shown to effectively alleviate joint pain. The Visual Analogic Scale (VAS) is a validated instrument widely used to assess the subjective intensity of pain in clinical practice. Santagata et al. employed the VAS to assess changes in pain at rest and during mastication following arthrocentesis with HA injection [9]. The results demonstrated a significant reduction in pain scores at the 6-month follow-up. The mean pain score at rest decreased from 6.4±2.5 pre-treatment to 0.7±0.5 post-treatment, while the score during mastication decreased from 8.1±1.7 to 0.9±0.6. This research shows the efficacy of the treatment in alleviating TMJ pain. This finding is consistent with those of previous studies, suggesting that arthrocentesis with HA injection provides effective analgesia [10, 11].

The dysfunction and functional limitation in the articular movement are common symptoms of TMD. Maximum mouth opening (MMO) is a key clinical indicator for assessing functional improvement in TMD patients. MMO, defined as the maximum interincisal distance, is approximately 40 mm in healthy adults [12]. In contrast, TMD patients often exhibit a reduced MMO relative to this reference value, accompanied by clinically significant limitation of mandibular movement [13]. The researches indicate that arthrocentesis with HA injection could effectively alleviate limitation of mouth opening in TMD [10, 12, 14]. A comparative study demonstrated that arthrocentesis with HA injection significantly improved maximum mouth opening. alone versus arthrocentesis with HA injection showed that intra-articular HA injection significantly improved MMO [11]. The HA group exhibited a greater mean increase in MMO (15.53±3.01 mm) compared to the control group (13.61±1.64 mm). The results demonstrate that the therapeutic effect of arthrocentesis with HA injection is superior to arthrocentesis alone. Furthermore, reducedof masticatory efficiency is commonly complaint in TMD patients. Santagata et al. assessed masticatory efficiency using a VAS scale from 0 to 10, the extremes of which were “eating only semi-liquid” (0 points) and “eating solid hard food” (10 points) [9]. Their results showed a marked improvement in the mean masticatory efficiency VAS score improved from 3.1±1.2 to 8.5±1.2. The increase

in masticatory efficiency signifies an enhanced ability to chew harder foods, reflecting improved overall TMJ function.

Arthrocentesis with HA injection effectively alleviates the TMJ pain and dysfunction in TMD patients. However, this minimally invasive procedure still has potential complications. In a study of arthrocentesis with HA injection, temporary swelling of the periarticular tissues was observed in 95.1% of the 433 patients, which completely resolved within a few days [14]. Furthermore, the transient ipsilateral open bite occurred in 68.8% of cases and persisted for several days. Temporary paresis of the frontalis and orbicularis oculi was reported in 65.1% of cases, regressing with the end of the local anesthesia effect. Another study also stated that temporary facial paresis caused by the local anesthetic is a common sequela of the procedure [15]. Overall, arthrocentesis with HA injection remains a safe treatment modality, as its most frequent complications are transient, minor, and self-limiting. Based on clinical experience, the clinicians can significantly minimize the incidence of these complications by refining their technique and possessing a thorough understanding of the regional anatomy.

The efficacy of splint therapy of temporomandibular diseases

The occlusal splint and, accordingly, splint therapy was proposed at the beginning of the 20th century. Today, a wide variety of occlusal splints modifications exist, which indicates the demand for this device in prosthetic dentistry practice [16, 17].

The widespread use of splint therapy is attributable to the reversible therapeutic effect of occlusal splint on the patient's dentoalveolar system. The reversible nature of the occlusal splint accounts for its wide range of clinical applications.

An occlusal splint is a removable structure (it can be hard, soft or hydrostatic) for the upper or lower jaw. It partially or completely covers the occlusal surface of all teeth and used to relax the masticatory muscles and change the position of the TMJ heads without altering with the occlusal surface of the teeth. Currently, the most common material for the production of occlusal splints using the analog method is acrylic resin, and in the digital protocol – polymethyl methacrylate [18–20]. Hard splints are preferable, as soft splints quickly deform and wear out [21–23].

Muscle deprogramming techniques are used for rational treatment and restructuring of the myotatic reflex. These techniques are indicated for conditions such as muscle-articular dysfunction, bruxism, hypertonicity of the masticatory muscles leading to pain. They are also used to determine the centric jaw relationship for mandibular centering, and for treating occlusal disorders [24].

A relieving and cushioning effect is essential for the masticatory muscles hypertonicity, which is why hydrostatic splints filled with water (Aqualizer) or hydrogel (Gelax) were developed. These devices provide a temporary muscle relaxation while simultaneously aligning all supercontacts. The Aqualizer splint is made of durable polyamide film. Its solder lines on the splint that contact the oral vestibule are covered with a protective layer of polyethylene foam, and the interior of the Aqualizer is filled with distilled water [25].

Khvatova V.A. and Chikunov S.O. identified four types of occlusal splints classified by function they perform and the design of the occlusal surface:

- disengaging (used for bruxism and decreased interalveolar height to protect teeth and soft tissues);
- relaxation (reduces muscle tone by centrically positioning the condyles);
- stabilizing (stabilizes the position of the mandible after normalizing muscle tone);
- repositioning (realigns the condyles of the mandible) [26].

According to international literature, the classification of splints has the following types: permissive splints, directive splints (non-permissive splints) and pseudo permissive splints [4].

These splints, made of rigid plastic and attached to the incisors, create a gap between the back teeth, preventing them from touching. This eliminates occlusal obstacles to the correct positioning of the condyles during mouth closure, and also relaxes the lateral pterygoid muscle and the anterior cervical muscles. This separation of the rear teeth decreases abnormal sensory input from the temporal muscles. Without this input, the body avoids a stress-related response that alters blood flow in the head [18]. The operating principle behind the nociceptive trigeminal inhibition tension suppression system splint is derived from this mechanism. The Jig-Lucia deprogrammer is a standard partial bite splint that is placed in the anterior region of the dentition and prevents the posterior teeth from closing. The splint should be worn for 30 minutes while the patient performs protrusive and retrusive movements of the mandible [24].

The following types of stabilizing splints are used in modern clinical practice:

1. Michigan splint (Ramfjord, Ash) for the upper jaw: it has a flat occlusal surface with slight imprints of the apices of the supporting buccal cusps of the lower premolars and molars. The inclined planes formed in the articulator ensure effective anterior-canine guidance and disocclusion of the posterior teeth in the anterior and lateral excursions.

2. Schulte interceptor plate (intended for use at night): on the upper jaw; clasp fixation on premolars; contact when closing the teeth with the flip-over part of the clasps.

3. The Drum Miniplast splint: This quickly manufactured, but has several drawbacks: correction of the occlusal surface leads to perforations, making it suitable only for short-term use. It features clasp-free fixation and is fabricated (vacuum-formed tray), the tray surface follows the contours of the occlusal surface. Because tray surface is uniform across the entire dental arch, disocclusion of the anterior teeth occurs.

4. Sved splint: for the upper jaw (anterior teeth by 1-2 mm vestibular overlap; two clasps on the molars; bite plate from canine to canine; posterior teeth in disocclusion with antagonists. Compression in the TMJ may increase pain. Short-term use is indicated. Long-term use may cause protrusion of the posterior teeth and overload of the anterior teeth.

5. Shore bite plate: for the upper jaw; wire clasps on the posterior teeth; palate completely closed; contact of the anterior teeth only. Use of this splint for more than 2 days is not recommended, as it may cause protrusion of the posterior teeth.

6. Slavicek splint: for the lower jaw; clasp-free fixation; uniform contacts of the apices of the supporting palatine tubercles; fronto-canine guidance is the same as on natural teeth. A lower jaw splint interferes less with the tongue, enhancing patient comfort. However, when the upper incisors are tilted orally, free forward sliding of the mandible for muscle relaxation and self-centering of the condyles is impossible.

7. Hawley bite plate: for the upper jaw; with wire clasps for the posterior teeth; bite plate from canine to canine; wire vestibular arch with U-shaped curves on the vestibular surface of the canines. The vestibular arch prevents the upper anterior teeth from shifting forward. Disadvantages: short-term use, as it dislocates the posterior teeth; complete palatal coverage [26].

Traditional splint therapy involves a two-phase approach. Firstly, a relaxation occlusal splint on the mandible for 1–3 months. Then, stabilizing occlusal splint for the next 1–3 months. All occlusal splints are made in an articulator using heat-polymerization with individual angle adjustment. Correction of splint surface is performed according to the scheme: the first correction is performed the day after application; subsequent corrections are performed every 2–4 weeks depending on the patient's complaints. Treatment progress is monitored using visual inspection, objective clinical methods, computer tomography and magnetic resonance imaging when indicated. The following step is the correction of occlusal-articulatory relationships using selective grinding [27].

Based on the results of recent research, occlusal splint may reduce masticatory muscle pain compared to no treatment. The clinical success of the splint therapy is determined by a reduction in the leading symptoms, namely an increase in comfortable and maximal mouth opening; decrease in TMJ clicking or noise, TMJ tenderness and pain score [28, 29].

Devi et al. conducted a study comparing different types of occlusal splints. They evaluated pre- and postoperative values of comfortable mouth opening, MMO, TMJ clicking and tenderness (graded 0–3), VAS pain score (0–10 cm), and total energy integral values of both TMJs. Patients were divided into three groups: anterior repositioning appliance group, centric stabilization splint (CSS), and soft splint (SS) groups. Statistically significant difference in pre- and post-treatment comfortable mouth opening, tenderness VAS, MMO values was obtained in all the three groups but patients in the CSS group demonstrated stable, clinically significant improvements, which were more pronounced at follow-up visits than those in the soft splint group. Therefore, the use of the CSS is recommended for patients with TMD to achieve faster and more effective results with minimal side effects [30].

It is worth noting that limited number of recent studies proves the efficacy of occlusion splints in the treatment of neurological disorders, such migraine, TMJ dysfunction, and bruxism [4]. Splint therapy not only reduces the intensity of pain but also improves psychoemotional well-being [31]. Consequently, it has been suggested that splint therapy can also be used in the complex therapy of tension type headache – one of the most common neurological disorders – since the pathogenesis of this disease, according to myofascial theory, is directly linked to the functional state of the pericranial muscles. The most interesting aspect of tension type headache treatment is the use of relaxation occlusal splint that works by reducing pericranial muscles tone and helps to gradually adjust the position of the temporomandibular joints to a more central, physiological position.

Diseases and conditions of the masticatory system that require the formation of a new dynamic stereotype of the muscle-joint complex usually require long-term treatment. Therefore, there is a need to use durable occlusal splints with enhanced strength characteristics and the ability to be adjusted when the dental condition changes in order to effectively affect the muscle component. To address this need, a new occlusal splint design has been proposed – a combined occlusal splint reinforced with a parameterized metal framework. This framework is 3D-printing from powdered titanium or cobalt-

chromium alloy and has a standardized design and can be customized for a specific patient at a clinical appointment [32, 33, 34].

The manufacturing technology of the framework and the combined occlusal splint is patented. The process involves two main stages: first, the framework is modeled in a computer-aided design system and manufactured by 3D-printing using selective laser melting technology; second, the occlusal surface is created by the lining of the framework with hot-curing acrylic resin or with a light-curing composite applied with an adhesive protocol. [35] The developed design of the occlusal splint has significant advantages in comparison with nalogues such as high structural strength due to reinforcement with a titanium frame; reduced thickness due to the creation of a mesh structure of the frame, manufactured by 3D printing, with a cross-section thickness of 0.3 to 0.5 millimeters; short manufacturing time, resulting from the parameterization of the frame design; the possibility of repair or relocation if necessary.

The presented data allows for a comparison of the characteristics of the two main treatment methods for temporomandibular joint disorders. A comparative assessment of these contemporary therapeutic approaches is provided in Table.

Table. A comparative assessment of arthrocentesis and splint-therapy of temporomandibular dysfunction

Parameters	Method of TMJ dysfunction	
	Arthrocentesis	**Splint-therapy**
Area of intervention	Intra-articular	Occlusal surface of the teeth
Main advantages	Rapid anti-inflammatory and analgesic effect	Non-invasive, reversible, predictable
Restrictions	Drug intolerance,allergy	Acute inflammatory process in the TMJ
Side effects	Trauma of the TMJ structures, allergy	No
Duration of therapeutic effect	Short-term	Long-term

Note: TMJ – temporomandibular joint.

Conclusion

In today's fast-paced world, the prevalence and severity of pathology of TMJ are increasing. However, existing concepts of dental treatment of disorders of TMJ do not always ensure its high treatment efficiency. Despite numerous studies, there are still no unified protocol for the treatment of TMJ dysfunction, and neither injection therapy nor splint therapy can be effective in 100% of cases. It can be concluded that these two methods can complement each other and be used in various combinations depending on the clinical situation.

Treatment of patients with TMJ disorders often remains complicated, long-term, sometimes ineffective. Therefore, further research into optimal therapy for TMJ disorders remains relevant. Collaborative Sino-Russian scientific research has the potential to enhance patient rehabilitation and the introduction of new medical services in practical healthcare for patients with TMJ dysfunction.

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