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SPLINT THERAPY IN CHILDHOOD - MECHANISMS OF ACTION, SPLINT TYPOLOGY, ORTHODONTIC RELEVANCE, AND EXPECTED BIOMECHANICAL EFFECTS

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Abstract: This article examines the mechanisms of action, typology, orthodontic relevance, and biomechanical effects of splint therapy in children and adolescents with temporomandibular joint (TMJ) dysfunctions. The study focuses on the role of splints as conservative and reversible treatment modalities aimed at reducing excessive joint loading, stabilizing neuromuscular function, and improving disc-condyle relationships during growth. Particular attention is given to stabilization splints and anterior repositioning splints (ARS), their clinical indications, and their influence on myogenic and disc-related disorders. The paper also discusses the importance of combining splint therapy with orthodontic and myofunctional treatment, as well as the risks associated with prolonged or improperly designed appliances in pediatric patients. The findings indicate that properly monitored splint therapy can effectively reduce pain, improve mandibular function, and support biomechanical balance in adolescents undergoing active craniofacial development.

Key words: Splint Therapy, Temporomandibular Joint, TMJ Dysfunction, Occlusal Splint, Anterior Repositioning Splint, Orthodontics, Adolescents, Pediatric Dentistry, Biomechanical Effects, Myogenic Pain

Introduction. Temporomandibular joint (TMJ) dysfunctions in children and adolescents represent a significant clinical challenge in modern pediatric dentistry and orthodontics. These disorders are commonly associated with pain, masticatory muscle hyperactivity, joint sounds, restricted mandibular movement, and functional disturbances that may negatively affect the quality of life of growing patients. During adolescence, rapid craniofacial growth and occlusal development create additional biomechanical stress on the temporomandibular joint, increasing the importance of early diagnosis and conservative therapeutic approaches [1, 2].

Among contemporary treatment methods, splint therapy occupies a central role due to its conservative and reversible nature. Occlusal splints are designed to reduce excessive stress on joint tissues, redistribute occlusal loads, stabilize neuromuscular activity, and create favorable conditions for physiological mandibular positioning. According to the recommendations of the American Academy of Pediatric Dentistry (AAPD), reversible interventions such as splint therapy, physical therapy, and behavioral management should be prioritized in children and adolescents, while irreversible occlusal procedures should generally be avoided [3, 4]. In growing patients, treatment planning must consider the stage of craniofacial development, occlusal status, and the potential risk of unwanted occlusal changes. The biomechanical and therapeutic effects of splint therapy depend on appliance design, duration of wear, and patient compliance [5]. Stabilization splints, particularly rigid full-coverage appliances, have demonstrated the ability to reduce stress within the TMJ, improve muscular balance, and decrease parafunctional activity. Anterior repositioning splints (ARS) are especially important in adolescents with disc displacement disorders, where they may contribute to symptom reduction and improved condylar positioning [6]. At the same time, prolonged or improperly monitored splint use may lead to occlusal side effects, emphasizing the need for regular clinical supervision and individualized treatment protocols. Therefore, understanding the mechanisms, indications, and biomechanical implications of splint therapy is essential for achieving successful outcomes in pediatric TMJ management [7, 8].

Materials and research methods. In pediatric practice, splint therapy belongs to a group of conservative, reversible interventions whose task is to relieve excessive stress on the tissues of the temporomandibular joint, reduce the hyperactivity of the masticatory muscles, stabilize the neuromuscular pattern and, in the presence of disc disorders, create conditions for a more physiological position of the disc and condyle during function. The American Academy of Pediatric Dentistry in its current "Best Practices" emphasizes that children and adolescents should prefer reversible methods (training and advice, physical therapy/physical therapy, splints), avoiding irreversible interventions and targeted occlusal "adjustments"; at the same time, the choice of design and mode of wearing should take into account the stage of growth and dental status (replacement bite, active orthodontics) and be accompanied by monitoring to prevent unintended occlusal shifts. Such regulations also set the evidence framework: minors have fewer confirmations than adults, and the clinician must combine the available clinical data with the principle of "minimally sufficient exposure." The mechanisms of action in a child's patient consist of three levels biomechanical, neuromuscular and biological.

Result and Discussion. At the biomechanical level, a full rigid coating (a stabilizing "Michigan" tire) redistributes and "softens" contact loads, increases joint clearance, aligns supercontacts and transforms disconnected occlusal contacts into a controlled sliding plane. Computational and experimental models with finite elements demonstrate a decrease in stresses in the area of the disc and the posterior bilaminar zone when wearing stabilization tires [9]. It is also shown that a thickness of 2 mm gives an optimal balance of unloading and comfort, and a further increase in thickness brings a decreasing increase in unloading and a greater risk of muscle adaptation in the wrong direction. This explains the classic "nocturnal" pattern of wearing in adolescents with control of the height of separation and uniformity of contacts we aim at unloading, and not at a prolonged change in the inter-jaw ratios. The anterior repositioning splint in adolescents occupies a special place at the junction of joint orthopedics and growth [10]. In clinical series and controlled studies in juvenile patients with reduced disc dislocation, a decrease in click, a decrease in pain, and a partial "centralization" of the condyle trajectory were observed on MRI after 6-12 months [11]. More recent work with longitudinal MRI evaluation indicates a decrease in the disc-condyle angle and displacement distance after ARS; at the same time, the authors honestly record cases of dislocation recurrence with decreased compliance or late initiation of treatment. In any case, ARS in adolescent practice is a tool that should be used in a dosed manner (usually night mode), with a clear weaning plan and parallel orthodontic tactics if the initial malocclusion supports joint overload [12].

The orthodontic relevance of splint therapy in puberty is twofold. Firstly, a properly selected stabilization splint in a patient with myogenic pain allows to "restore" the comfort and tolerability of orthodontic treatment, reducing the risks of exacerbations and "disruptions" of therapy. Secondly, in adolescents with disc disorders and a tendency to retrodeformation of the mandible, a combination of repositioning therapy and functional/orthodontic devices can support condillary regeneration and mitigate class II, as demonstrated in a randomized open-label study [13]: after surgical discorepositioning in adolescents, the addition of a postoperative occlusal splint was associated with a higher height of the "new bone" of the condyle and the best correction of the skeletal class for 12 months of follow-up. Although this design includes a surgical component and is not directly transferred to conservative ARS, the very principle of "creating and retaining" a joint lumen for regeneration is also useful in our "clean" splint logic with strict selection and monitoring [14]. The biomechanical expectations of a teenager from a splint, if formulated in a substantive way, are as follows. We expect a decrease in peak stresses in the disc and posterior zone, a more symmetrical trajectory of the condyle during opening and closing, a decrease in "sharp" contacts and laterotrusive interference, a decrease in EMG activity of the temporal and masticatory muscles with rigid full-contact structures, as well as the fact that in some patients with disc disorders, the click disappears or becomes less frequent. The final clinical points pain at rest/when chewing, the amplitude of active opening, the frequency and volume of articular sounds, functional indices, and quality of life demonstrate the greatest dynamics over the horizon of 6-12 weeks in myogenic forms and 3-6 months in disc forms, after which the decision to continue/remove the splint is made based on a combination of complaints, examination, and (if necessary) disk violations) MRI control [15]. Finite element models

and clinical series consistently show that the effect of "stress relaxation" and "neuromuscular stabilization" is the main material part of success.; everything else (including the "disk" component) depends on the phenotype, age, and compliance.

Conclusion. The evidence base is being updated quickly and requires careful interpretation in relation to adolescents. The 2024 Cochrane on Occlusal Interventions records low confidence in evidence for a number of adult outcomes; own RCTs and series are emerging for the juvenile population, including studies on ARS with MRI control and on postoperative occlusal splints as a factor in enhancing condillary regeneration in adolescents. The general vector is as follows: stabilization splints are a basic tool for myogenic pain; ARS is an option for disc phenotypes, taking into account risk and duration; The combination with myofunctional therapy increases the stability of the effect; partial coverage and prolonged continuous wearing in children is a risk factor for occlusive side effects that should be avoided.

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