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OPTIMIZING THERAPY FOR TEMPOROMANDIBULAR DISORDERS: A COMPREHENSIVE REVIEW OF DEPROGRAMMING SPLINTS AS THERAPEUTIC ADJUNCTS

Orthodontics

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ABSTRACT

Temporomandibular disorders (TMDs) constitute a complex group of musculoskeletal and functional disturbances involving the temporomandibular joint, masticatory muscles, and associated structures. The management of TMDs continues to evolve with occlusal splints remaining a cornerstone of conservative therapy. Among these, deprogramming splints have gained attention for their ability to promote neuromuscular relaxation and restore functional harmony. This review aims to provide a comprehensive overview of the principles, mechanisms, types, and clinical implications of deprogramming splints in the management of TMDs, based on current scientific evidence. Deprogramming splints effectively reduce occlusal interferences and masticatory muscle hyperactivity, thereby enhancing mandibular coordination and relieving pain. While current evidence supports their clinical usefulness, further standardized and longitudinal research is essential to establish definitive clinical protocols and optimize patient outcomes.

KEYWORDS

Temporomandibular Disorders, Deprogramming Splints, Occlusal Splint, Neuromuscular Reprogramming

INTRODUCTION

The temporomandibular joint (TMJ) is the anatomical site where the mandible articulates with the temporal bone of the skull. It is classified as a ginglymoarthrodial joint, allowing both hinge and gliding motions[1,2]. Temporomandibular disorders (TMDs) are characterized by abnormal mandibular movement, joint sounds, and discomfort or pain in the associated muscles or joint structures. Although symptoms can occur at any age, they are most common between 20 and 40 years[2]. Multiple etiological factors have been identified, including trauma, parafunctional habits such as bruxism, arthritis, malocclusion, and psychological stress[2]. A stable Orthopedic relationship between centric relation (CR) and maximum intercuspation (MI) is essential for proper masticatory function throughout life. Diagnostic mounting of casts and the use of a condylar position indicator (CPI) are useful for evaluating CR–MI discrepancies and identifying occlusal interferences[3,4].

While orthodontic treatment itself is neither a definitive cause nor a preventive measure for TMD[5], the orthodontist's responsibility includes supporting Orthopedic stability of the masticatory system. Achieving such stability may lower the risk of developing TMD. Occlusal splints are a conservative and reversible approach to reducing TMD symptoms, often improving muscle balance and lowering electrical activity in key masticatory muscles[6,7]. Research has shown significant reductions in pain and dysfunction in patients with bruxism and TMD following splint use[7].

The primary goal of splint therapy is to protect TMJ structures from harmful loading, encourage muscle relaxation, and facilitate correct mandibular positioning. Stabilization splints, in particular, are designed to disrupt habitual neuromuscular closure patterns, promoting muscle rest and potentially aiding in managing intracapsular disorders[8]. This review aims to clarify the selection and application of deprogramming splints, and consolidate available evidence to guide evidence-based clinical practice.

History

The introduction of splints for temporomandibular joint (TMJ) therapy can be traced back to the late 19th century. Kingsley (1877) was the first to describe intraoral appliances intended to influence TMJ function[9]. A few years later, Goodwillie (1881) presented a pivot device with extraoral components for managing TMJ arthritis[10]. By the mid-20th century, such appliances were increasingly adapted for repositioning the mandible and modifying vertical dimension. Thompson (1946) advocated mandibular rest and repositioning splints[11], while Shore (1959) designed auto-repositioning appliances that aimed to fully seat the condyle[12]. Around the same period, Sears (1956) reintroduced pivot appliances to reduce joint loading[13].

In the 1960s, Ramfjord provided strong evidence through electromyographic studies and promoted occlusal splints within gnathologic frameworks[14]. Soon after, Gelb (1977) developed the mandibular Orthopedic repositioning appliance (MORA), which attempted to bring the condyle forward into a supposedly more favourable position, though it sometimes altered occlusion irreversibly[15]. Later, Witzig and Spahl (1987) popularized functional appliances that combined splint therapy with Orthopedic and orthodontic principles to advance the jaw more assertively[16]. Across decades, despite significant variation in design and theoretical basis, splints consistently demonstrated a 70–90% effectiveness rate for TMD symptom relief. This consistency implies that their success may derive not only from mechanical adjustments but also from behavioural and cognitive influences[17].

Types of Occlusal Splints

Occlusal splints can be classified in several ways, with distinctions based on function, design, and material. Common categories include permissive splints, which allow free mandibular movement without guiding the condyle[3]; directive splints, which position the condyle–disc assembly in a targeted therapeutic position[3]; and pseudo-permissive splints, made from resilient materials for even occlusal contact[11].

For clarity, this review presents an overview of individual splint types commonly used for TMD management, emphasizing their mechanism of action, indications, and key design considerations.

Occlusal splints can be classified based on their functional design and therapeutic goals. Common systems categorize them as:

- Permissive splints: Allow free mandibular movement with uniform occlusal contact (e.g., Michigan splint)[10].
- Directive splints: Guide the condyle–disc assembly into a predetermined therapeutic position (e.g., anterior repositioning splint)[3].
- Pseudo-permissive splints: Made from flexible materials, designed for even occlusal contact (e.g., soft rubber splint)[11].

Table 1: Classification of Occlusal Splints

Splint Type	Purpose	Design / Coverage	Main Indications	Duration of Use	Evidence & Notes
Stabilization Splint (Michigan / Flat-plane)	Reduce parafunction, evenly distribute occlusal forces, provide joint & muscle rest position	Full-arch coverage (upper or lower); flat occlusal surface with even centric contacts	Myogenous TMD (muscle pain), bruxism, non-specific TMD pain	Medium–long term (often nightly for months or years)	Considered "gold standard" splint; strongest evidence for symptom relief

Deprogramming Splint (Anterior deprogrammer, Lucia jig, NTI-tss)	"Deprogram" habitual occlusal muscle patterns; relax elevator muscles; assist in centric relation registration; short-term relief of acute pain	Small anterior coverage (often just incisors) causing posterior disclusion	Diagnostic bite registration, initial management of acute myalgia/clenching	Very short-term only (hours–days, up to a few weeks)	Useful adjunct/diagnostic tool but not validated for long-term therapy; long-term wear may cause occlusal changes
Repositioning Splint (Anterior Repositioning)	Hold mandible in a new (usually anterior) position to reduce TMJ clicking/locking, especially disc displacement with reduction	Full-coverage splint with built-in anterior guidance to posture mandible forward	Internal derangement (disc displacement with/without reduction), acute closed lock	Short-term full-time wear (weeks) then wean or convert to stabilization splint	Can reduce acute symptoms but long-term outcomes & occlusal side effects are concerns

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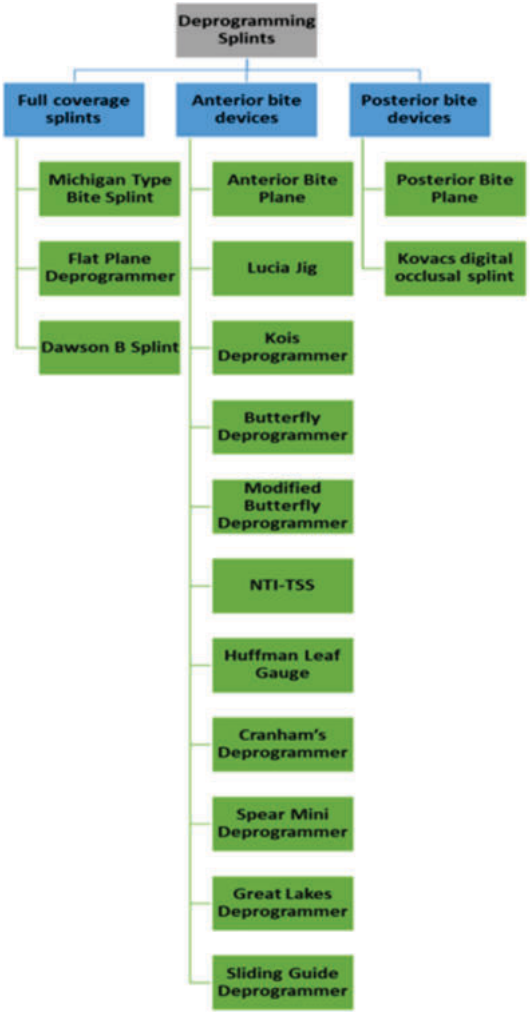
Alternative classification models, such as Freesmeyer's, divide appliances into reflex-type devices, stabilization appliances, and repositioning appliances[9]. For practical purposes, this review presents each deprogramming splint types with its defining features, intended use, and key clinical considerations.

For ease of explaining, we classify deprogramming splints into the following

Table 2: Classification of Deprogramming Splints



Michigan-Type Bite Splint

A widely used stabilization appliance, the Michigan splint can be fabricated for either the maxillary or mandibular arch, although the maxillary design is more common. Indications for a mandibular type include absent posterior teeth or cases where minimizing unwanted tooth movement is critical. The appliance eliminates posterior interferences, supports CR seating, facilitates muscle relaxation, and helps prevent wear from nocturnal bruxism. It incorporates freedom in centric and canine guidance[10–12].

Anterior Bite Plane

Primarily indicated for muscle-related TMD linked to occlusal instability or abrupt changes in occlusion, the anterior bite plane disengages posterior teeth to reduce muscle loading and strain. By limiting posterior contact, it discourages clenching and parafunctional habits [11,13].

Posterior Bite Plane

This appliance contacts only posterior teeth, disoccluding the anterior segment. It can be useful in cases requiring restoration of vertical dimension of occlusion (VDO) or significant anterior mandibular repositioning. Evidence for claims of enhanced athletic performance remains inconclusive[11].

Lucia Jig

A small acrylic platform placed on maxillary central incisors for a few minutes, the Lucia jig promotes neuromuscular relaxation by temporarily removing posterior contact. It allows assessment of the mandible's position in harmony with muscle activity in both healthy individuals and TMD patients[14,15].

Huffman Leaf Gauge

A stack of thin, gauged plastic leaves used to achieve precise, incremental anterior separation during CR record taking. The device relaxes elevator muscles and helps in obtaining accurate intermaxillary records without posterior interference[11].

NTI-TSS

A prefabricated anterior bite plane, like a stop covering maxillary central incisors, indicated for bruxism, TMD, and tension-type headaches. It is typically worn at night but prolonged use without posterior bite plane may lead to unwanted tooth movement[11].

Kois Deprogrammer

Consists of a palatal acrylic plate with a small anterior contact platform located behind the incisors. Used for short-term wear, it assists in differentiating occlusal dysfunction from parafunctional activity and facilitates accurate CR registration[16].

Butterfly Deprogrammer

A midline ramp appliance that provides single-point anterior contact, reducing elevator muscle activity. It avoids covering occlusal surfaces entirely, and has been associated with symptom relief in many TMD cases when followed by appropriate protective splint therapy [17–21].

Modified Butterfly Deprogrammer

An adaptation of the original butterfly design, this version increases the number of anterior contact points to achieve faster neuromuscular relaxation[22].

Sliding Guide Deprogrammer

A prefabricated appliance available in various sizes, featuring a guide surface and scale markings. Used for brief sessions, it maintains posterior disocclusion during neuromuscular deprogramming[23].

Cranham's Deprogrammer
An anterior stop appliance that prevents posterior occlusion to remove proprioceptive input from those teeth. It is used both diagnostically for CR registration and therapeutically for muscle relaxation [24].

Spear Mini Deprogrammer
A maxillary appliance with an anterior bite platform extending canine to canine, providing full coverage to prevent supra-eruption. It is effective for muscle deprogramming and occlusal diagnosis [25].

Great Lakes Deprogrammer
A prefabricated anterior appliance covering premolar-to-premolar segments, with a flat bite ramp for lower incisor contact. Used mainly for short-term therapy in deep-bite cases or muscle hyperactivity[3].

Flat Plane Deprogrammer
Also known as a Michigan or stabilization splint, it is fabricated from hard acrylic to provide even occlusal contact and posterior disocclusion in excursions. It may be used for both diagnostic and long-term therapeutic purposes[1,3].

Dawson B Splint
A dual-arch appliance with a small anterior contact element, designed to deprogram muscles and stabilize occlusion. Both arches are fitted with splints, which are worn simultaneously[3].

Kovacs Digital Occlusal Splint (KDOS)
Designed using digital scanning and CAD/CAM fabrication for high precision. Clinical studies report improvements in pain, joint sounds, and mouth opening. It is not recommended for patients with advanced degenerative changes[26,27].

Anterior Repositioning Splint (ARS)
Guides the mandible into a forward position to reduce disc displacement with reduction. Particularly beneficial in adolescents, it may promote condylar remodelling, although recurrence is possible without subsequent occlusal correction[28-31].

Table 2: Summery

Type of Splint	Indication	Mechanism	Advantages & Disadvantages
Michigan-Type Bite Splint	Occlusal instability, bruxism, CR–MI discrepancy[10,11]	Eliminates interferences, supports CR seating, muscle relaxation[10,12]	Adv: Well-studied, effective for bruxism and TMD[10,12] Disadv: Requires full arch coverage, increased bulkiness.
Anterior Bite Plane	Muscle-related TMD, occlusal instability[11,13]	Discludes posterior teeth, reduces elevator muscle load[11]	Adv: Simple design, reduces clenching[11]. Disadv: Long-term use risks posterior supra-eruption[13].
Posterior Bite Plane	Increase VDO, mandibular repositioning [11]	Contacts only posterior teeth, anterior disclusion [11]	Adv: Useful for VDO restoration [11] Disadv: Prolonged use may cause anterior intrusion [11]
Lucia Jig	Short-term neuromuscular deprogramming[14,15]	Removes posterior contact, allows muscle relaxation[15]	Adv: Quick chairside diagnostic tool[14]. Disadv: Short-term use only[15].
Huffman Leaf Gauge	Accurate CR recording [11]	Gradual anterior separation, relaxes elevator muscles [11]	Adv: Inexpensive, precise CR recording [11] Disadv: Only used for diagnostic purpose, not therapeutic[11]
NTI-TSS	Bruxism, TMD, tension headaches [11]	Anterior bite stop reduces parafunction [11]	Adv: Small, easy to use, good patient compliance [11] Disadv: Risk of posterior supra-eruption[11]
Kois Deprogrammer	Differentiate occlusal vs. parafunctional issues [16]	Small anterior platform disrupts habitual closure [16]	Adv: Reliable for CR records [16] Disadv: Short-term use only [16]
Butterfly Deprogrammer	Muscle hyperactivity, TMD relief [17-21]	Single-point anterior contact reduces muscle activity [18,19]	Adv: Effective in pain relief[20,21] Disadv: Risk of unwanted tooth movement [17].
Modified Butterfly Deprogrammer	Faster muscle deprogramming [22]	Multiple anterior contact points [22,66]	Adv: Quicker relief [22,66] Disadv: Risk of unwanted tooth movement [22,66]
Sliding Guide Deprogrammer	Neuromuscular deprogramming [23]	Maintains posterior disclusion with guide surface [23]	Adv: Prefabricated, easy to apply [23] Disadv: Short-term use only [23]
Cranham's Deprogrammer	Muscle relaxation, CR registration [24]	Anterior stop removes posterior proprioception [24]	Adv: Accurate CR recording [24] Disadv: Not suitable for long-term wear [24]
Spear Mini Deprogrammer	Occlusal diagnosis, muscle relaxation[25]	Anterior bite platform prevents supra-eruption [25]	Adv: Prevents supra-eruption [25] Disadv: Requires lab fabrication [25]
Great Lakes Deprogrammer	Deep-bite, muscle hyperactivity [3]	Flat bite ramp for anterior contact [3]	Adv: Prefabricated, simple to use [3] Disadv: Short-term use only [3]
Flat Plane Deprogrammer	Occlusal stabilization, TMD management [1,3]	Even contact in CR, posterior disclusion in excursions[1,3]	Adv: Long-term therapeutic use possible[1,3] Disadv: Bulkier, requires adjustments[1,3]
Dawson B Splint	Muscle deprogramming, stabilization[3]	Dual-arch splint with anterior contact[3]	Adv: Comprehensive deprogramming effect[3] Disadv: Complex fabrication[3]
Kovacs Digital Occlusal Splint (KDOS)	TMD pain, joint sounds, limited opening[26,27]	Digitally fabricated for precise fit[26]	Adv: Highly accurate fit, improved outcomes[26] Disadv: Expensive, contraindicated in osteoarthritis[27]
Anterior Repositioning Splint (ARS)	Disc displacement with reduction[28-31]	Positions mandible forward to improve disc-condyle relationship[28,29]	Adv: Effective in disc recapture29 Disadv: High recurrence without further treatment[30,31]

DISCUSSION

The role of occlusal splints in the management of temporomandibular disorders (TMDs) continues to be debated despite their widespread use in clinical practice. The most recent Cochrane review by Al-Moraissi[41] et al in 2024 concluded that, the evidence supporting occlusal interventions remains uncertain, with low- to very-low–certainty data suggesting only modest benefits in reducing pain during chewing compared to no treatment or minimal interventions[41]. This uncertainty reflects methodological limitations across studies, including small sample sizes, heterogeneous outcome measures, and variable diagnostic criteria.

Several systematic reviews have reinforced this conclusion, highlighting that while splints may provide short-term pain relief in certain subgroups-particularly patients with myogenous TMD-there is insufficient evidence to recommend their generalized use in TMD[42,43]. Moreover, comparisons between splints and other conservative modalities, such as manual therapy or exercise, suggest little difference in clinical outcomes, implying that splints may not be superior to alternative non-invasive treatments[44].

The specific design of splints has also been investigated. Reviews focusing on anterior repositioning splints (ARS) indicate potential benefits for patients with disc displacement with reduction; however, the evidence base is still limited and controversial, preventing firm recommendations for the same[45,46]. Similarly, recent studies comparing

digital and conventionally fabricated splints report comparable outcomes, suggesting that digital workflows may provide a practical alternative without compromising therapeutic efficacy[47,48].

Despite the widespread clinical adoption of deprogramming splints, current evidence reveals several methodological and interpretive limitations. Most available studies are conducted with limited population diversity, reducing external validity[49,50]. Additionally, inconsistent diagnostic criteria for temporomandibular disorders (TMD) across studies make comparative interpretation difficult[51]. Variations in splint design, fabrication technique, and clinician-adjusted protocols further contribute to inconsistent outcomes[52]. Only a minority of randomized controlled trials include placebo or sham appliances, making it difficult to distinguish between true therapeutic benefit and placebo response[53].

A key limitation involves the short duration of follow-up in most studies. Given the chronic, fluctuating nature of TMD, transient symptom relief may not equate to sustained therapeutic success[54,55]. Long-term evaluations assessing muscle relaxation, occlusal stability, and relapse following splint discontinuation are limited[56]. Furthermore, while pain reduction remains the most frequently reported outcome, functional parameters such as mandibular kinematics, muscle coordination, and patient-centered quality-of-life measures are rarely examined[57].

Future investigations should focus on multi-center randomized controlled trials utilizing standardized diagnostic systems like the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) to ensure uniformity and reproducibility[58]. Comparative trials assessing different deprogramming designs—such as Kois deprogrammer, Lucia jig, and NTI-tss—would clarify design-dependent outcomes and optimal wear regimens[59]. Incorporating objective electromyography (EMG) and MRI imaging would enhance understanding of neuromuscular adaptation mechanisms[60].

The emergence of digital workflows and 3D printing offers promising advancements in precision fabrication, fit, and patient comfort[61]. Integration of intraoral sensors and biofeedback systems may further improve compliance and provide real-time monitoring of masticatory muscle activity[62,63]. Future hybrid devices could combine diagnostic and therapeutic functions, providing a dynamic, evidence-based approach to occlusal therapy[64].

CONCLUSION

Taking all facts into account, the available evidence suggests that deprogramming splints may have a role in selected patient population, particularly those with myogenic pain or specific disc derangements. However, the lack of high-quality, standardized trials limits the ability to draw definitive conclusions. Future research should prioritize robust randomized controlled trials with uniform diagnostic criteria, longer follow-up periods, and standardized outcome reporting. Until such data are available, clinicians should consider deprogramming splints as part of a multidisciplinary approach to TMD management, individualized to symptoms of the patient; combined with behavioral, physical, and pharmacological therapies when appropriate.

While deprogramming splints remain a valuable diagnostic and therapeutic adjunct in TMD management, their long-term efficacy depends on rigorous, standardized, and multidisciplinary research. Advancements in digital dentistry, biomechanical analysis, and behavioural integration will help transform deprogramming splints from empirically guided aids into precision-based, scientifically validated treatment tools[65-67].

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