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Evidence-Based Selection of Occlusal Splints for Temporomandibular Disorders (TMDs): A Critical Review and Update

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ABSTRACT

Occlusal splints are widely used for conservative management of temporomandibular disorders (TMDs), but evidence on the effectiveness of different splint types across TMD subtypes remains variable. TMDs involve musculoskeletal and intra-articular conditions of the temporomandibular joint (TMJ) and related structures. We conducted a targeted search of PubMed, Scopus, and Web of Science using keywords including "temporomandibular disorders," "occlusal splint," "stabilization splint," and "anterior repositioning splint." Adult randomized controlled trials, systematic reviews, and meta-analyses with clearly defined TMDs were included whereas, case reports, paediatric, and non-English studies were excluded. Articles were screened for splint type, TMD subtype, and clinical outcomes to guide evidence-based recommendations. Stabilization splints show clear benefit in myogenous TMDs with bruxism or muscle hyperactivity, whereas anterior repositioning splints provide short-term improvement in disc displacement with reduction. Digital splints achieve outcomes comparable to conventional acrylic devices with improved precision. Heterogeneity in diagnostic criteria, splint design, adjustment protocols, follow-up duration, and outcome measures limits evidence quality. Current data support individualized splint selection based on TMD subtype and symptoms, ideally within a multimodal treatment approach, and highlight the need for standardized diagnostics, core outcome measures, and long-term evaluation.

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1. INTRODUCTION

The Temporomandibular disorders (TMDs) constitute one of the most common causes of orofacial pain not related to odontogenic pathology (Schiffman et al., 2014). Symptoms typically include pain during mandibular function, joint noises, limitation of mouth opening, headache, tinnitus, and functional impairment affecting mastication and speech. The conceptual understanding of TMDs has evolved, with contemporary models acknowledging the interplay between biomechanical factors, peripheral nociception, central sensitization, oral parafunctional behaviours, and psychosocial contributors including stress and anxiety (Greene & Manfredini, 2020; List & Jensen, 2017). Epidemiological studies suggest that a proportion of adults experience clinically significant TMD symptoms, with some progressing to chronic pain states affecting quality of life (List & Jensen, 2017).

The first-line therapeutic approach to TMDs emphasizes conservative and reversible modalities, including patient education, analgesics, physiotherapy (jaw exercise), behavioural interventions, and occlusal splints (Al-Moraissi et al., 2020). Splint therapy is widely adopted due to its non-invasive nature, reversible, ease of delivery, and potential to modify harmful oral behaviours. Over time, the rationale for splint therapy has broadened from attempts to permanently alter occlusion and joint mechanics toward an understanding that splints may act through neuromuscular modulation, reduction of peripheral nociceptive input, cognitive awareness of parafunctional activity, and mechanical unloading of the joint (Chan et al., 2022). Despite widespread clinical use, substantial debate persists regarding the indications for specific splint designs, and high-quality evidence stratified by clinical subtype remains limited. Occlusal splints are removable intraoral devices designed to modify occlusal relationship, reduce parafunctional activity and protect the dentition. Common type of include stabilization splints, anterior repositioning splints and soft splints, each differing in design and mechanism of action depending on the clinical indication (The Glossary of Prosthodontic Terms 2023; Chan et al., 2022) This review aims to synthesise current evidence on the effectiveness of different occlusal splint types across specific TMD subtype and provide evidence-based clinical recommendations.

2. METHODOLOGY

A targeted search of PubMed, Scopus, and Web of Science was conducted for studies published between 2000-2025. Search strings included combination of Boolean operators such as (" temporomandibular disorders' OR "TMD") AND (" occlusal splint" OR "stabilization splint" OR "anterior repositioning splint"). A total of 132 articles were identified. Following the title and abstract screening, 48 studies were assessed for eligibility, of which 22 studies were included based on predefined criteria. Inclusion criteria compromised randomized controlled trials and systematic review involving adult populations with clearly defined TMD subtypes. Exclusion criteria include case reports, paediatric populations, non-English publication, and studies lacking clear diagnostic classifications. Screening was performed in two stages: initial title and abstract screening followed by full-text review. Although a formal PRISMA flow diagram and risk-of-bias assessment were not conducted, study quality and methodology variability were considered during interpretation of findings. "Twenty-two studies fulfilled the inclusion criteria. As this is a narrative review, Table 1 presents representative randomized controlled trials that illustrate the principal evidence discussed in this review, while the remaining included studies are synthesised throughout the text."

Table 1. Summary of Included Primary Studies

Author (Year)	Study Design	Sample Size	TMD Subtype	Intervention	Comparator	Follow-up	Key Outcomes
Niemelä et al.	Randomized Controlled Trial	80	Mixed TMD	Stabilization splint	Control / other conservative therapy	3 months	Significant reduction in pain, improved mandibular function
Kurt et al.	Randomized Controlled Trial	~60	Disc displacement with reduction	Stabilization splint, ARS	Behavioural therapy	Not specified	Both splints reduced pain; ARS superior for clicking and function
Poorna et al.	Randomized Controlled Trial	60	TMD (mixed)	Soft vs Hard splint	Between groups	Not specified	Both effective; hard splints provided earlier relief
Sikora et al.	Controlled Clinical Study	Not specified	TMD	Stabilization splint	Baseline comparison	Not specified	Improved jaw mobility; reduced inflammatory biomarkers

3. DIAGNOSTIC SUBTYPE AND THEIR SIGNIFICANCE FOR SPLINT THERAPY

Differentiating between TMDs subtypes is crucial for selective and rational splint therapy. Broadly, two categories are recognized: myogenous TMDs, characterized by pain originating in the masticatory muscles, muscular hyperactivity, and often sleep-related bruxism; and arthrogenous TMDs, involving pathology within the TMJ, including disc displacement, synovitis, capsulitis, and degenerative joint disease. Mixed presentations are common, and overlapping symptomatology may complicate diagnostic clarity.

The introduction of validated diagnostic frameworks, including the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), has significantly improved research consistency and clinical diagnostic capability by enabling clearer classification and standardized outcome measurement (Schiffman et al., 2014). However, heterogeneity in diagnostic application persists. The introduction of validated diagnostic framework such as the (DC/TMD) has improved standardisation in both research and clinical diagnosis. However, variability in the application of these criteria across the studies persists, which may still contribute to heterogeneity in patient selection and report outcome (Schiffman et al., 2014). The importance of precise diagnosis cannot be overstated, as splint mechanisms differ depending on whether the primary driver is muscular hyperactivity versus intra-articular mechanical interference.

4. TYPES OF OCCLUSAL SPLINTS AND PROPOSED MECHANISMS OF ACTION

The Glossary of Prosthodontic Terms 2023 (Tenth Edition) defines an occlusal splint (often termed an occlusal device) as a removable artificial occlusal surface used for diagnostic or therapeutic purposes that

alters or influences the spatial relationship between the mandible and the maxilla (i.e., the bite relationship). It may be used for occlusal stabilization, management of temporomandibular disorders, or to prevent dental wear ("The Glossary of Prosthodontic Terms 2023: Tenth Edition," 2023).

Soft splints or hydrostatic splints, fabricated from resilient materials, are commonly prescribed for nocturnal bruxism. They may reduce peak occlusal forces during sleep and improve patient comfort (List & Jensen, 2017). Although soft splints are more comfortable, their compressible nature can alter the bite and reduce mandibular stability, sometimes increasing muscle hyperactivity, joint loading, or clenching, which may worsen TMD symptoms. In contrast, hard splints provide stable occlusal contacts that better distribute forces, supporting more effective symptom management (Poorna et al., 2022). In a randomized controlled study comparing the effectiveness of soft and hard splints in the symptomatic management of TMDs, both treatment groups showed improvement in joint clicking, temporomandibular joint (TMJ) pain, and muscle pain, while no notable improvement was observed in restricted or deviated mouth opening. Patients treated with hard splints experienced earlier symptom relief at the initial follow-up; however, by the later evaluation, there was no meaningful difference in outcomes between the hard and soft splint groups. Overall, both soft and hard stabilization splints were effective for managing TMD symptoms, with hard splints providing faster initial improvement (Guo et al., 2021; Poorna et al., 2022).

Hard stabilization splints are the most widely used splints and are fabricated from rigid acrylic. They are adjusted to create uniform occlusal contacts in centric relation, aiming to redistribute occlusal forces, reduce muscular co-contraction, minimize parafunctional loading and provide joint unloading (Niemelä et al., 2012; Sikora et al., 2025).

In a modified occlusal splint, the hard material on the occlusal surfaces provides stability and precise force transmission, while the soft material cushions tissue contacts to enhance comfort and patient compliance which is a key factor, as consistent use ensures effective control of occlusal forces, protects teeth and temporomandibular joints, and optimizes therapeutic outcomes. Unlike conventional hard splints, which primarily protect teeth but may reduce comfort or alter occlusion, modified splints have been shown to more effectively reduce clenching forces and alleviate TMD symptoms, including TMJ clicking, bruxism, and myofascial pain. Treatment success depends on splint design, usage protocol, and objective evaluation, underscoring the value of customized splint therapy for targeted management of TMDs (Prati et al., 2024).

A review on anterior repositioning splint (ARS) therapy for disc displacement–related TMDs highlighted its potential to improve the disc–condyle relationship, reduce joint loading, and relieve pain and functional limitations. Clinical evidence suggests ARS can reduce joint pain, clicking, and restricted mandibular movement, especially in patients with disc displacement with reduction. However, questions remain regarding optimal indications, treatment duration, and long-term effects, including occlusal changes (Guo et al., 2021). While beneficial for carefully selected patients, long-term stability is limited, and most existing studies are low-quality case analyses, underscoring the need for well-designed randomized controlled trials to establish clear clinical guidelines.

Digital and 3-dimensional (3D) printed splints have emerged through Computer-aided design / Computer-aided manufacturing (CAD/CAM) systems. These devices permit precise virtual adjustment and reproducibility, potentially allowing command of occlusal schemes and faster fabrication. While early results demonstrate comparable therapeutic outcomes to acrylic devices, long-term data remain limited (Eftimie et al., 2022).

Although initial splint concepts aimed to produce permanent occlusal modification, contemporary research suggests that efficacy may be mediated by alterations in sensory input and neuromuscular behavior, protection against overload, and increased awareness of daytime parafunctions, rather than static changes in occlusion.

While stabilization splints demonstrate consistent benefits in reducing myofascial pain and improving function, their superiority over other conservative therapies remains debated (Ebrahim et al., 2012; Al-Moraissi et al., 2020). Anterior repositioning splint provide targeted improvement in disc displacement with reduction but may be associated with concerns regarding long-term occlusal changes (Guo et al., 2021). Soft splints, although more comfortable, may increase muscle activity in certain patients, highlighting the importance of careful case selection (List & Jensen 2017; Poorna et al., 2022)

5. EVIDENCE FOR CLINICAL EFFECTIVENESS

Clinical trials evaluating occlusal splint therapy demonstrate generally favourable outcome, however, results may vary depending on the study design, patient selection and diagnostic subtype. For example, stabilization splints have shown significant reduction in myofascial pain and improvement in mandibular function in randomized controlled trial such as those by Niemela et al. (2012) and Sikora et al. (2025), both reporting measurable reduction in pain score and improve jaw mobility. Similarly, Kurt et al. (2011) demonstrated that stabilization splints were effective in reducing symptoms in patients with disc displacement and comparable improvement were also seen with behavioural therapy, suggesting a multifactorial therapeutic effect (Kurt et al., 2011). These findings suggest that although stabilization splints are effective, comparable improvements achieved with behavioural therapy indicate that symptom relief may not be solely attributable to the splint itself. Behavioural modification, patient education, and psychosocial factors may also contribute substantially to treatment outcomes.

In contrast, studies evaluating anterior repositioning splints (ARS) indicate more specific benefit in disc displacement with reduction. Kurt et al. (2011) reported significant reduction in joint clicking and functional limitation with ARS, while Guo et al. (2021) highlighted short-term improvement in condyle-disc relationship and pain reduction. However, variability in treatment during and follow up across these studies limit conclusion regarding long-term efficacy (Guo et al., 2021; Kurt et al., 2011)

Comparative trials assessing soft versus hard splints present mixed findings. Poorna et al. (2022) reported that both splint types significantly reduced TMJ pain and muscle discomfort with hard splints providing earlier symptom relief, whereas long term outcomes were comparable. Similar findings have

been reported in other comparative studies, suggesting that patient specific factors, including compliance and comfort, may influence treatment success (Poorna et al., 2022; Zhang et al., 2016). Furthermore, differences in splint material, occlusal design, adjustment protocols and patient compliance between studies may partly explain the variability in reported outcomes.

Overall, while multiple studies support the effectiveness of occlusal splints, difference in methodology, diagnostic stratification, splint design and follow up duration contribute to variability in reported outcomes (Niemela et al., 2012; Kurt et al., Poorna et al., 2022). These finding highlight the importance of interpreting results within the context of study design and reinforce the need for subtype specific treatment approaches.

Importantly, conflicting finding across studies indicate that while splint therapy demonstrates measurable benefits, comparable improvements have also been reported with counselling, physiotherapy and behavioural intervention Ebrahin et al., 2012: Zhang et al., 2016). This suggests that the magnitude of effects of occlusal splint may be modest and influenced by behavioural and psychosocial factors. Furthermore, although statistically significant improvement in pain and function are frequently reported, the clinical relevance of these changes may vary across studies.

The variability in clinical outcomes observed across studies can be better understood by considering relationship between TMD subtypes, underlying pathophysiology mechanism, and the corresponding mechanism of action of different occlusal splints, A mechanism-based approach highlights how targeted splint selection may improve treatment predictability. Based the synthesis of the included 22 RCTs and systematic reviews (e.g., Schiffman et al., 2014; Al-Moraissi et al., 2020; Guo et al., 2021). Based on synthesis of the included randomized controlled trials, systematic reviews and the DC/TMD framework, the authors developed an original mechanism-based evidence synthesis (Table 2). Table 2 is not reproduced from a single publication but represents the authors' interpretation of the available evidence.

Table 2. Mechanism Based Selection of Splints

TMD Subtype	Pathophysiology	Splint Type	Mechanism of Action	Clinical Outcome
Myogenous TMD	Muscle hyperactivity, bruxism, nociceptive input	Hard Stabilization Splint	Reduces muscle hyperactivity, redistributes occlusal load, decreases nociceptive input	↓ Pain, ↑ muscle coordination
Disc displacement with reduction	Condyle-disc incoordination, mechanical interference	Anterior Repositioning Splint (ARS)	Repositions condyle, reduces joint loading, improves disc alignment	↓ Clicking, ↑ function
Degenerative joint disease	Cartilage degradation, joint loading	Stabilization Splint ± Physiotherapy	Joint unloading, reduces mechanical stress	↓ Pain, improved joint stability

TMD Subtype	Pathophysiology	Splint Type	Mechanism of Action	Clinical Outcome
Bruxism dominant	Excessive occlusal force during sleep	Soft splint / Stabilization splint	Absorbs occlusal forces, protects dentition	↓ Tooth wear, ↓ muscle strain
Mixed TMD	Combined muscular + joint components	Stabilization splint	Provides neutral occlusion and stabilization	Symptom control

6. CLINICAL EFFECTIVENESS AND CRITICAL APPRAISAL OF THE EVIDENCE

Despite the generally supportive findings regarding splint therapy, the strength of evidence remains limited by methodological weaknesses. The most prominent limitation is diagnostic heterogeneity, with many studies enrolling mixed cohorts without adequate Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) categorization. Without precise subtype identification, the differential effects of splint types become obscured, reducing external validity (Greene & Manfredini, 2020; Schiffman et al., 2014). While Niemelä et al. (2012) demonstrated significant pain reduction using hard stabilization splints over 3 months, Kurt et al. (2011) observed that behavioural therapy achieved comparable long-term symptom relief, highlighting that non-mechanical psychosocial mechanisms significantly confound splint efficacy.

A second critical issue is the variation in splint design and adjustment protocols. For example, Poorna et al. compared soft and hard splints, whereas Niemelä et al. (2012). evaluated rigid stabilization splints alone. These differences in appliance material, occlusal contacts and treatment protocols reduce direct comparability across studies. Significant differences in acrylic thickness, occlusal schemes, guiding surfaces, and wearing schedules are observed across trials. Splint adjustment, which is essential for achieving therapeutic goals, is inconsistently described. Without detailed reporting, replication and meta-analysis become problematic (Al-Moraissi et al., 2020).

Outcome measurement lacks standardization, with differences in pain scales (VAS, NRS), measurement of mandibular opening, joint sound assessment, and quality-of-life instruments. In some cases, psychological variables such as anxiety and depression, which significantly impact TMD outcomes, are not documented (Ebrahim et al., 2012). The absence of core outcome sets reduces precision and comparability.

Short follow-up durations represent a significant limitation. Most reporting intervals span 6 to 12 weeks, limiting insight into long-term joint adaptation, the sustainability of pain reduction, and potential relapse. Chronic pain mechanisms, including central sensitization, likely require extended observation.

Furthermore, many studies reflect a predominantly biomechanical paradigm, emphasizing occlusal correction despite mounting evidence that chronic TMDs is heavily influenced by behavioural, sleep-related, and psychosocial factors (List & Jensen, 2017; Patra et al., 2025). This conceptual mismatch may explain the marginal differences observed between splints and counselling.

Recent RCTs involving digital splints show promising precision and patient comfort but lack large-scale RCTs with long-term follow-up (Eftimie et al., 2022). Interpreting early positive findings requires caution until further evidence emerges.

Overall, the evidence supports the use of splints as part of a multimodal management strategy, rather than as a standalone cure. Integration with physiotherapy, cognitive-behavioural support, stress management, and patient education provides a more comprehensive approach to treating TMDs.

Additionally, placebo effect may contribute to observed outcome of occlusal splint therapy, as patient awareness of wearing an intraoral appliance may alter parafunctional behaviour and pain perception (Ebrahim et al., 2012). Publication bias towards positive finding may further overestimate treatment efficacy, particularly in studies with short follow-up durations and subjective outcome measures.

7. TRANSLATIONAL VALUE OF OCCLUSAL SPLINTS

As illustrated in Table 2, the selection of occlusal splints should be guided by the underlying pathophysiology of the specific TMD subtype, allowing a more targeted and individualised therapeutic approach. In clinical practice, the selection of splint type should be determined by diagnostic subtype, symptom pattern, bruxism activity, and patient preference. Stabilization splints are generally preferred in myogenous TMDs involving muscular hyperactivity, where even occlusal contacts may reduce parafunctional load and promote masticatory muscle relaxation (Niemelä et al., 2012). Soft splints may be used for patients with predominant nocturnal bruxism or intolerance to rigid appliances, although evidence regarding durability is mixed (Zhang et al., 2016).

For disc displacement with reduction, especially when accompanied by clicking and intermittent locking, ARS may provide short-term improvement by altering the condyle-disc relationship (Guo et al., 2021). Regular reassessment is required to avoid occlusal changes.

In degenerative joint disease, where articular cartilage deterioration and joint remodelling are evident, stabilization splints combined with physiotherapy offer a conservative unloading approach and reduce joint pain (Patra et al., 2025). ARS are not indicated for degenerative disease.

Modified occlusal splints combine hard and soft components to optimize occlusion, reduce clenching, and relieve TMJ and muscular symptoms. By enhancing comfort and minimizing bite alterations, they

translate biomechanical insights into precise, patient-centred therapy, representing a significant advancement in the conservative management of TMDs (Prati et al., 2024).

Digital splints may provide improved comfort, precision, and reproducibility, though current evidence supports their use primarily as a technical enhancement, not a new therapeutic category (Eftimie et al., 2022). Table 3 summarises practical recommendations for splint selection based on clinical subtype.

Beyond pain reduction, occlusal splint therapy may contribute to improve the quality of lie QOL), especially through improved function and reduction of psychosocial stress (List & Jensen,2017). Patient compliance remains critical in determining treatment success, as inconsistent use may reduce the therapeutic effectiveness. Cost-effectiveness is also an important consideration, particularly for digital fabricated splints, which offer improved precision but may incur higher costs compared to conventional acrylic devices (Eftimie et al., 2022).

Table 3. Recommended Occlusal Splint Type Based on Temporomandibular Disorder Subtype,

TMD Subtype	Primary Therapeutic Goal	Recommended Splint Type	Evidence-Based Rationale
Myogenous TMD (muscle pain, bruxism)	Reduce muscle hyperactivity	Hard Stabilization Splint / Modified splint	Strong evidence for pain reduction and functional improvement (Niemelä et al., 2012; Prati et al., 2024)
Nocturnal bruxism dominant	Cushion occlusal load	Soft splint	Improves comfort and compliance; reduces peak occlusal forces (Poorna et al., 2022)
Disc displacement with reduction	Reduce joint interference and clicking	Anterior Repositioning Splint	Improves disc-condyle relationship and joint symptoms (Kurt et al., 2011; Guo et al., 2021)
Degenerative joint disease	Reduce joint loading	Stabilization splint ± physiotherapy	Conservative joint unloading approach (Patra et al., 2025)
Mixed TMD symptoms	Stabilize occlusion	Stabilization splint	Neutral approach before targeted therapy
Chronic pain with psychosocial component	Behavioural modulation	Splint (adjunct only)	Requires multimodal approach; splint alone insufficient

8. CONCLUSION

Occlusal splints remain a key conservative therapy for TMDs when tailored to diagnostic subtypes. Stabilization splints benefit myogenous TMDs, particularly with parafunctional habits, while anterior repositioning splints improve symptoms in disc displacement with reduction. Integration within multimodal

care and advancements in digital fabrication may enhance outcomes, but standardized protocols, consistent outcomes, and long-term studies are needed to strengthen evidence and guide clinical practice. The recommendations presented in this review should therefore be interpreted as evidence-informed clinical guidance rather than prescriptive treatment protocols, recognising that individual patient factors remain central to splint selection. Future research should prioritize standardized diagnostic criteria, subtype-specific study design, and long-term evaluation to strengthen clinical evidence and guide more precise, evidence -based selection of occlusal splint therapy.

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10. CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest related to this work.

11. AUTHORS' CONTRIBUTIONS

Vinesh Raj conceptualised the study, developed the central research idea, conducted the literature search, synthesised the evidence, and drafted and revised the manuscript. Nur Syahirah Mohd Nazar contributed to data screening, extraction of relevant studies, and critical appraisal of the literature. Faezah Rokhani assisted in literature review, organisation of evidence according to TMD subtypes, and manuscript editing. Meghna Gohain provided expert input on temporomandibular disorders, contributed to interpretation of findings, and critically revised the manuscript for intellectual content. Lim Ghee Seong contributed clinical perspectives on occlusal splint therapy, reviewed the manuscript for restorative relevance, and provided final technical input. All authors reviewed and approved the final version of the manuscript and agreed to its submission.

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APPENDIX

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