

Occlusal Reconstruction in the Management of Tooth Wear: A Review

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Abstract

Objective: Tooth wear (TW) is a prevalent condition commonly treated at dental clinics. Loss of occlusal vertical dimension (OVD) may develop from severe TW. The treatment of severe TW includes occlusal reconstruction, which involves increasing the patient's OVD. Following occlusal reconstruction, the patient's stomatognathic system, including nervous tissues, muscles, and joints will undergo corresponding changes. Understanding the changes in various parts of the stomatognathic system following occlusal reconstruction can help standardize the management approach for severe TW. This review provides current scientific evidence on increasing OVD through occlusal reconstruction in TW management and an update on the effects of occlusal reconstruction on the stomatognathic system. **Methodology:** We conducted a review of the available articles searched using PubMed and Scopus. The articles searched were from 2014 until 2023. **Result:** A total of 159 articles were obtained. After reviewing titles and abstracts, 55 articles were included for full-text reading, and 42 were excluded based on predefined criteria, resulting in a total of 13 articles for this study. **Conclusion:** Occlusal reconstruction can be performed using different methods with no conclusive evidence favoring one treatment approach over another. Determining the appropriate increase in OVD during occlusal reconstruction varies based on each patient's restorative requirements. Following occlusal reconstruction, patients experience discomfort in the stomatognathic system, but these symptoms including TMJ pain and masticatory muscle dysfunction resolve within three months. Occlusal reconstruction has been shown to be effective in alleviating symptoms associated with severe TW which helps to maintain a high quality of life for TW patients especially the elderly.

Keywords: Tooth Wear, Occlusal Reconstruction, Temporomandibular Joint Disorders, Vertical Dimension, Dental Occlusion, Masticatory Muscles.

INTRODUCTION

Tooth wear (TW) is defined as the loss of mineralized tooth substance on the tooth surface caused by physical or chemical processes, excluding cases of caries, resorption, or trauma.^[1,2] TW is a frequent clinical issue encountered by dentists in daily practice, with a global incidence ranging from 64.7% to nearly 100%.^[3] TW progresses with age; thus, both its incidence and severity are generally higher in older adults than in younger populations. TW, or the irreversible loss of dental hard tissue, arises from physiological activities such as mastication and

friction between adjacent teeth.^[4] It can also result from non-physiological activities and habit-related changes, known as pathological TW^[5] which includes erosion, abrasion, attrition, and abfraction.^[6-8] In response to TW, teeth undergo continuous eruption to preserve the occlusal vertical dimension (OVD), defined as the distance between the upper and lower jaws when the teeth are in

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Submitted: 21st May, 2025

Received: 29th May, 2025

Accepted: 02nd July, 2025

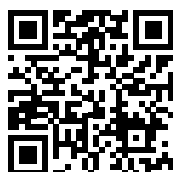
Published: 03rd July, 2025

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How to Cite This Article: Cui J, Ariffin A, Ramli R. Occlusal Reconstruction in the Management of Tooth Wear: A Review. *J Nat Sc Biol Med* 2025;16(2):84-93

Access This Article Online

Quick Response Code:



Website:

www.jnsbm.org

DOI:

<https://doi.org/10.5281/zenodo.15871354>

maximum contact.^[9] TW and continuous eruption are natural physiological phenomena that occur throughout life.^[4] When wear and eruption are balanced, the OVD remains within a normal range. However, if the rate of wear surpasses the rate of eruption, as observed in cases of attrition (Figure 1) or erosion (Figure 2), excessive tooth wear can lead

to dentin hypersensitivity,^[10] crown shortening, pulpitis, pulp necrosis,^[10,11] impaired masticatory function, loss of OVD (Figure 3), and temporomandibular joint disorder (TMD).^[12] TMD is often associated with symptoms such as pain, abnormal jaw movement, and clicking or bruit in the temporomandibular joint (TMJ) area.^[12]



Figure 1: Occlusal View of a 75-year-old Male Patient Presenting with Generalized Attrition of the Mandibular Dentition.



Figure 2: Occlusal View of a 45-year-old Male Patient Presenting with Generalized Erosion of the Mandibular Dentition.



Figure 3: Frontal View of a 45-year-old Male Patient Presenting with Generalized TW of the Upper and Lower Dentition due to Gastroesophageal Reflux Disease.

Decreased OVD particularly impacts patient aesthetics and comfort,^[13] often manifesting as drooping mouth corners,^[14] deepening of the chin-labial sulcus, protruding lips,^[15] and an aged facial appearance that can affect social

interactions.^[16] TW also impairs chewing function,^[11] which can reduce appetite and subsequently lead to malnutrition. Furthermore, TW is closely linked to sleep disorders, oral dryness, orofacial pain, and other

conditions.^[17] Patients with TW often experience TMJ and masticatory muscle pain,^[12] which are the primary reasons they seek dental care. These symptoms are significant and require dentists to plan treatments that effectively relieve pain and restore chewing function.

Occlusal reconstruction is one of the main treatment strategies for TW.^[18] It involves comprehensive dental therapy, including occlusal adjustment, orthodontic alignment,^[19] prosthetic restoration, and other procedures.^[13] While occlusal reconstruction has shown improvement in many patients with TW,^[20-22] it can also impact surrounding structures, particularly the masticatory muscles and TMJ.^[23,24] Since changes to these structures may lead to discomfort and pain, it is essential to ensure that masticatory muscle and TMJ function are preserved.^[25] Ultimately, successful occlusal reconstruction requires restoring lost dental structures and alleviating symptoms caused by TW without introducing new issues.^[19]

This article reviews current scientific evidence on increasing OVD in TW management and provides an update on the effects of occlusal reconstruction on the stomatognathic system.

MATERIALS AND METHODS

An electronic database search on occlusal reconstruction was conducted using PubMed and Scopus (2014-2023). Search terms included “tooth wear,” “vertical dimension of occlusion,” “temporomandibular disorders,” “masseter muscle,” and “pain.” Articles reviewed included case reports and human clinical studies on occlusal reconstruction through dental restorations published in English. Studies on occlusal reconstruction through oral surgery, orthodontics, oral implantology, or those addressing TW without occlusal reconstruction were excluded. The article retrieval process is illustrated in Figure 4.

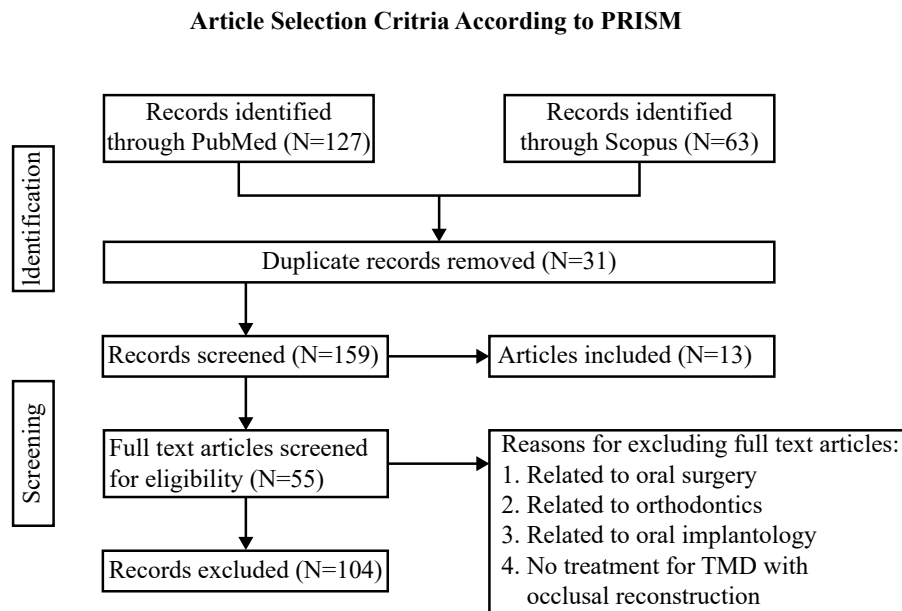


Figure 4: Article Selection Process Following PRISMA 2020 Guidelines^[26].

RESULTS

The search provided 190 results, 31 were duplicates. Articles included in this review were human clinical studies including randomized controlled clinical trials, controlled clinical trials, and case reports, published in English language and studies that involved increasing the OVD by placing dental restorations. After reading the abstract, a further 55 papers were identified for full text analysis. Then, we excluded the papers on occlusal reconstruction through surgery, orthodontics, implantology, and those without treatment of TMD. A final total of 13 papers were included in the review.

DISCUSSION

Occlusal Reconstruction

Occlusal reconstruction involves not only rebuilding and

restoring worn teeth but also preserving the overall health of the stomatognathic system.^[27] The aim is to re-establish an oral functional state where the teeth, periodontal structures, masticatory muscles, TMJ, and associated nerve tissues of the stomatognathic system work in a synchronized and harmonious manner.^[14] Indications for occlusal reconstruction include loss of OVD, severe bruxism, TMD, limited space for restorations, and TW that impairs function or aesthetics.^[14] During occlusal reconstruction, accurate diagnosis of the underlying cause is essential, along with careful observation of intraoral and extraoral conditions and any changes within the stomatognathic system.^[18]

METHODS FOR OCCLUSAL RECONSTRUCTION

Various methods can be used for occlusal reconstruction,

including direct composite resin restoration, occlusal splints (Figure 5a ,5b and 5c), removable dentures (Figure 6a, 6b, and 6c), and ceramic crowns (Figure 7a, 7b and 7c).^[6,15,28] Presently, there is no conclusive evidence favoring one treatment approach over another for TW, as each method offers distinct advantages and disadvantages (Table 1).



Figure 5a: Frontal View of a 46-year-old Female Patient Presenting with Generalized Attrition of the Lower Dentition.



Figure 5b: The Lower Dentition of the Patient Depicted in Figure 5a.



Figure 5c: Frontal View of the Patient Depicted in Figure 5a after Undergoing Occlusal Reconstruction with an Occlusal Splint for the Anterior Teeth and Premolars.



Figure 6a: Frontal View of a 75-year-old Male Patient Presenting with Generalized Attrition And Erosion in the Upper and Lower Dentition.



Figure 6b: Frontal View of the Patient in Figure 6a after Occlusal Reconstruction Using A Combination of a Removable Denture and Ceramic Crowns.



Figure 6c: Lateral View of the Patient in Figure 6a after Occlusal Reconstruction, Featuring A Removable Denture for the Maxillary Lateral Incisor, Canine, Premolars, and Molars, with Ceramic Crowns on the Remaining Teeth.



Figure 7a: Frontal View of a 59-year-old Male Patient Presenting with Generalized Attrition of the Upper and Lower Dentition.



Figure 7b: The Upper Dentition of the Patient Depicted in Figure 7a.



Figure 7c: Frontal View of the Patient in Figure 7a Following Occlusal Reconstruction with Ceramic Crowns for all Teeth.

Table 1: Indications for Use, Advantages and Disadvantages of Different Methods in Occlusal Reconstruction.

Material/Method ^[29]	Indication for Use	Advantages	Disadvantages
Composite resin	When TW begins to deteriorate, or if a patient accidentally damages his/her teeth through excessive chewing or grinding	Less intervention on teeth, ^[29] relatively cheap, convenient, ^[5] and high patient satisfaction	Not wear-resistant, short lifespan, poor mechanical properties, and is easy to change color after restoration. The technique is very sensitive and there is a risk of microleakage and secondary caries ^[30]
Occlusal splint	Acclimate patients to the new OVD before occlusal reconstruction; ^[31] noninvasiveness, low cost, ^[33] more bruxism and those who frequently grind or clench their teeth ^[32]	Simplicity, reversibility, noninvasiveness, low cost, ^[33] more acceptable to patients and easily fabricated ^[34]	Requires more time for occlusal adjustment, and may chip or break in cases of extreme teeth grinding. Swallowing, lip sealing, or speech may be impeded if the splint is too thick ^[34]
Removable denture	When the span of missing teeth is large (missing 3 or more adjacent teeth), fixed dentures cannot be used to avoid poor prognosis	Cheap, ^[35] convenient, and hygienic; can be readjusted and repaired; ^[36] less tooth intervention ^[37]	Metal materials have poor biocompatibility, large size and inferior chewing functions to ceramic crowns, nausea and slurred pronunciation when first wear, cause alveolar bone atrophy; inadequate wear resistance ^[37]
Ceramic crown	Generalized tooth wear and decreased OVD may opt to ceramic crown due to its excellent aesthetics and durability ^[5]	Biocompatible, non-toxic, and hypoallergenic, ^[38] fewer chairside adjustments, good aesthetics ^[39] and durability, a superior marginal fit, can be made digitally, ^[40] higher patient satisfaction, high precision and comfort	Expensive, difficult to change or adjust once installed, ^[41] requires natural tooth reduction, ^[19] prone to breaking when subjected to extreme forces

Composite resin, for instance, is relatively affordable and requires minimal tooth intervention, making it a convenient option for patients.^[5] However, its limited mechanical properties have led to the increased use of ceramic crowns, which are biocompatible, non-toxic, hypoallergenic, and provide a more natural appearance.^[38] Although ceramic crowns are more costly to construct, they offer superior aesthetics and durability.^[42]

While composite resin and zirconia crowns focus on individual tooth restoration, removable dentures are preferable when addressing TW in three or more adjacent teeth.

For patients with generalized TW, such as those with moderate to severe bruxism, occlusal splints protect the teeth from unconscious grinding or clenching, particularly during sleep.^[43] Two types of occlusal splints are available: hard and soft. Hard splints are most commonly worn at night to maintain a neutral jaw position, thereby relieving pressure.^[44] However, hard splints, made from rigid acrylic, can be somewhat uncomfortable. Soft splints, on the other hand, improve patient comfort and offer excellent color stability, transparency, resistance to abrasion, wear, and stains, as well as long-lasting durability and protection against cracking from aging.^[45,46] In cases where multiple teeth are missing, a combination of fixed and removable

dentures may be considered for TW treatment, particularly in patients with extensive tooth loss.

Regardless of the method employed, the initial step in occlusal reconstruction involves determining the mandibular position and OVD,^[35] which are essential for all subsequent treatment stages.^[16] Further details on OVD are discussed below.

Occlusal Vertical Dimension (OVD)

Determining a patient's OVD is widely acknowledged as one of the major challenges in occlusal reconstruction.^[28] Currently, there are no definitive guidelines to establish the ideal OVD increase for each patient.^[20] For patients with TW but stable OVD and no TMD symptoms, altering the OVD provides limited benefit.^[28] However, for patients experiencing severe TW, accompanied by OVD reduction and TMD symptoms, increasing the OVD becomes essential.^[31]

OVD is the distance between the upper and lower jaws when the teeth are in maximum contact.^[9] Determining OVD can involve evaluating morphological or facial proportions, physiological factors, phonetics,^[47] and cephalometric analysis.^[48] Although various methods exist, no single method reliably provides accurate and consistent

OVD measurements.^[48] Consequently, clinicians need to understand each method's principles and integrate them where possible to achieve greater accuracy according to the patient's individual needs.

OVD Measurement and Determination

Several methods exist for measuring OVD. One approach involves transferring the initial OVD to a new denture using cephalometric analysis,^[49] profilometry, and intraoral measurements.^[50] Another approach assesses OVD by observing facial aesthetics, mandibular resting position, swallowing patterns,^[27,28] and phonetics.^[51] For increased accuracy, clinicians should employ multiple methods. A

minimally invasive approach should also be prioritized to meet both aesthetic and functional patient needs.^[52] OVD can be reduced or lost due to various factors, including TW. Patients with reduced OVD typically exhibit a reduced facial angle and height. Restoring the facial angle and height by reestablishing occlusion at an increased OVD is often feasible.^[53] Increasing the OVD can provide additional space for restorative materials,^[6] correct anterior and posterior tooth relationships,^[15] and reduce the need for tooth grinding or root canal treatment.^[5] Table 2 summarizes the methods for occlusal reconstruction, the height and time required for adaptation to an increased OVD, and the outcomes and conclusions from selected studies.

Table 2: Summary of Selected Articles on OVD Increase for Tooth Wear Management.

Authors (Year)	Methods of Occlusal Reconstruction	Increased Height	Time to Adapt	Study Outcome and Conclusion
Pissiotis <i>et al.</i> ^[28]	Occlusal splint, removable denture and fixed restoration	1.8-6.0 mm	2-6 weeks	The patients adapted to the increased OVD with no TMD symptoms after an adaptation period. Adaptation capability and muscle plasticity of the stomatognathic system allows for a range of different OVDs to be comfortably tolerated by the patients.
Goel <i>et al.</i> ^[24]	Occlusal splint	3 mm	8 weeks	Splints helped in achieving a harmonious effect on muscle activity of individuals and helped them in adapting to a new OVD.
Tecco <i>et al.</i> ^[23]	Occlusal splints	Not given	3 months	There is no single accurate method for determining the vertical occlusal dimension. Patients with TMD achieved a significant improvement in their symptoms after wearing occlusal splints.
Albagieh <i>et al.</i> ^[34]	Occlusal splints	Not given	Not given	Occlusal reconstruction can treat bruxism, headaches, postural imbalances and decreased OVD related to TMD. Occlusal splint can increase occlusal stability, and reduce muscular tension.
Al-Rawas <i>et al.</i> ^[37]	Composite resin, occlusal splints and removable denture	4 mm	3 months	Occlusal reconstruction increased the patient's restorative space. The degree of TW and the patient's aesthetic requirements should be considered when increasing the OVD.
Constantinescu <i>et al.</i> ^[15]	Occlusal splints and ceramic crown	7 mm	Not given	Occlusal reconstruction provides a state of functional and biological efficiency by harmonizing the complexity of each structure: teeth, periodontium, the masticatory muscles, and the TMJ.
Shopova and Mladenov ^[54]	Occlusal splint and ceramic crown	6 mm	3 months	Combining analog and digital measurement technology, the defects of the patient's dental arch and dental hard tissue are repaired. The patient's OVD and the physiological position of TMJ were restored, achieving a satisfactory treatment outcome for the patient.
Venugopalan <i>et al.</i> ^[55]	Occlusal splint	4 mm	1 week	There is statistically significant decrease in muscle activity of the anterior temporalis as well as masseter with the use of occlusal splints.
Mohapatra <i>et al.</i> ^[25]	Occlusal splint and ceramic crown	3 mm	4 weeks	The phase of occlusal splint allows time for neuromuscular adjustment to increase vertical dimension and helps to determine patient's compatibility to the new position.
Tonlorenzi <i>et al.</i> ^[9]	Occlusal splint	Not given	3 months	High oral splints have been shown to be a promising therapeutic aid for the treatment of TMD and correlated pain syndromes.
Guguvcevski <i>et al.</i> ^[56]	Occlusal splint, removable denture and fixed restoration	8.5 mm	3.5 months	Definitive prosthetic treatment of TMD can be done after the use of occlusal splint. The occlusal splint induces positive remodeling of the periodontal tissue and condylar cartilage. The patients experience less pain and improve oral function and comfort.
Moreno-Hay and Okeson ^[57]	Occlusal splint	5 mm	4 weeks	Occlusal splints caused short and transient discomfort; a new interocclusal rest space was re-established after increasing the OVD. There is a great degree of adaptability in masticatory muscles following changes in OVD.
Burke ^[6]	Composite resin	Not given	3 months	Resin composite restorations placed at an increased OVD may be a viable and minimally interventional treatment option for the treatment of tooth wear.

Increased Height for OVD in the Treatment of Tooth Wear

Determining the appropriate increase in OVD varies based on each patient's restorative requirements. Excessive increases in OVD are generally discouraged, as they can make teeth appear overly elongated and may compromise periodontal support and TMJ function. Among the studies reviewed, the maximum increase in occlusal height reported was 8.5 mm.^[56] If OVD is increased by occlusal reconstruction solely on the anterior teeth, the height

adjustment is more limited, allowing the posterior teeth to undergo physiological overeruption independently.^[48] When a greater increase in OVD is required, it can be achieved by adjusting the posterior teeth or the entire dental arch.

Adaptation Time for New OVD

Adaptation time refers to the period needed for the patient to acclimate to the new increased OVD and for any associated pain or discomfort to resolve. Most

studies report adaptation times ranging from two weeks to three months,^[9,23,57] depending on the severity of TW and the extent of OVD loss. For cases where an occlusal splint is used to increase OVD, a three-month period is recommended before finalizing treatment.^[9,58] Another study suggests a shorter adaptation period of eight weeks prior to final rehabilitation.^[24] In patients experiencing pain in the masseter and temporalis muscles due to decreased OVD, wearing an occlusal splint for just one week has been found to relieve symptoms.^[55]

Increasing OVD by Occlusal Reconstruction: The Outcomes

Occlusal reconstruction, when combined with other therapeutic approaches, is effective in managing bruxism and TMD associated with reduced OVD.^[54] Specifically, increasing OVD with an occlusal splint has been shown to improve occlusal stability, reduce muscle tension, and decrease the activity of the anterior temporalis and masseter muscles.^[55] Additionally, occlusal reconstruction can positively influence periodontal tissue and condylar cartilage, improving oral function and patient comfort.^[56] Following an OVD increase, patients may undergo an adaptation period. The plasticity of muscles and the adaptive capacity of the stomatognathic system support patient adjustment to varying OVD levels.^[28] After occlusal reconstruction, some patients experience mild, temporary symptoms such as muscle discomfort, TMJ pain, cheek biting, and speech issues.^[24] However, these symptoms are typically self-limiting and generally do not lead to significant complications.^[57]

EFFECTS OF OCCLUSAL RECONSTRUCTION ON STOMATOGNATHIC SYSTEM

Temporomandibular Joint

Tooth wear (TW) from gnashing and clenching not only reduces OVD but can also traumatize the TMJ. TMJ pain is one of the primary symptoms of TMD, with other symptoms including rapid fatigue in the masticatory muscles, clicking or popping sounds in the TMJ, tinnitus, difficulty in chewing,^[16] and in severe cases, inflammation at the corners of the mouth.^[56] Multiple studies have established a direct link between changes in OVD and the development of TMD,^[9,59] suggesting that correcting OVD can significantly alleviate TMD symptoms. In this context, wearing an occlusal splint for 6–8 months has been shown to notably reduce TMD symptoms, including TMJ pain and clicking sounds.^[23] For patients with reduced OVD and TMD, the function of the masticatory muscles also improves following splint application, with symptoms such as masticatory muscle pain and fatigue often reducing or resolving completely.^[57]

Masseter Muscle

The adaptability of the stomatognathic system and the elasticity of masticatory muscles enable patients to adjust to a certain range of OVD.^[58] Changes in OVD

significantly impact two key masticatory muscles: the temporalis and masseter.^[24] During mastication, the temporalis muscle lifts and retracts the mandible, while the masseter muscle elevates it. When a patient's OVD decreases, the condyle is forced upward and backward, causing the temporalis and masseter muscles to remain in a contracted state, leading to significant hyperactivity.^[55] This hyperactivity may result in muscle spasms and pain in the temporalis and masseter muscles. In patients with reduced OVD, the use of occlusal splints has been shown to reduce electromyography (EMG) activity in the temporalis and masseter muscles,^[60] decreasing muscle contraction and associated pain. In this regard, occlusal splints have been demonstrated to relax the masticatory muscles effectively.^[61]

EMG serves as a reliable clinical indicator for evaluating the stomatognathic system, assessing masticatory muscle efficiency, and monitoring the effectiveness of occlusal splints.^[24] When OVD is increased, the fibers of the masseter muscle stretch and relax,^[62] resulting in lengthening of the masseter muscle, a primary adaptation mechanism following occlusal reconstruction.^[15,24] Concurrently, EMG activity is also reduced.^[60]

Studies have shown that increasing OVD through adaptive changes^[63] in the TMJ and masticatory muscles is both safe and feasible, with patients generally adapting to the new OVD.^[9,57] Symptoms related to increased OVD usually subside within a few weeks,^[24,25,28] after which permanent restorations can be placed, reviewed, and adjusted as needed.^[20]

Occlusal Reconstruction and Pain

The stomatognathic system comprises not only complex biomechanical movements but also intricate neural reflex activities. For example, in masticatory movements, neurofeedback-regulated activity is essential for coordinated jaw movement. This system is closely connected to the central nervous system, particularly to the trigeminal nerve-related pathways.^[9]

As discussed, increasing OVD through occlusal reconstruction stretches and contracts the masseter muscle. One study found that when the masseter muscle is stretched briefly, leading to contraction, mechanical hyperalgesia can develop in the muscle, lasting for hours or even days.^[64] Research using animal models has also shown that occlusal interference can induce hyperalgesia, suggesting a central sensitization mechanism is involved.^[65]

After occlusal reconstruction, the TMJ often returns to a centric position, and the contraction force of masticatory muscle fibers reduces, eventually restoring them to their normal resting length. This adjustment also lowers EMG activity in both the masseter and temporalis muscles. These adaptive changes contribute to improved mandibular movement, reduced pain intensity and frequency, and overall relief from TMJ-related muscle pain.^[9] Given that pain can significantly impact a patient's quality of life, these improvements after occlusal reconstruction can significantly improve well-being.^[66]

CONCLUSION

Occlusal reconstruction is a procedure aimed at restoring normal OVD and establishing a proper occlusal relationship in patients with TW. Various methods are available for occlusal reconstruction; however, ceramic crowns are often preferred by patients due to their aesthetic appeal and durability, which increase comfort and satisfaction. Though occlusal reconstruction may initially lead to symptoms such as discomfort in the masticatory muscles, TMJ pain, cheek biting, and minor speech difficulties, these symptoms typically resolve within three months. In the long term, occlusal reconstruction has proven effective in alleviating TMD symptoms related to TW, including TMJ pain and dysfunction of the masticatory muscles. As cases of TW increase, particularly with the global population's rising life expectancy, ensuring effective treatment for TW is vital to maintaining a high quality of life for the elderly.

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Writing of the Original Manuscript: Cui Jie

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Project Funding

None.

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