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CASE REPORT

Multidisciplinary approach with botulinum toxin (BTX) and 3D printing stabilization splint in cases of temporomandibular joint osteoarthritis exacerbated by bruxism

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ABSTRACT

Temporomandibular joint disorder (TMD) is a multifactorial condition involving the masticatory muscles and temporomandibular joint. Temporomandibular joint osteoarthritis (TMJ OA), is a degenerative joint disorder marked by articular surface erosion, crepitus, and joint pain. Parafunctional habits such as bruxism can exacerbate OA by increasing biomechanical load on the TMJ, accelerating joint degeneration, and worsening symptoms. Conservative treatments such as stabilization splints are commonly used in TMD management. Recently, botulinum toxin (BTX) type A has gained attention as an adjunct therapy for reducing excessive masticatory muscle activity. This report aims to describe the multidisciplinary management of a complex TMD case using 3D-printed stabilization splints combined with BTX type A injections. A 24-year-old female presented with jaw pain and crepitation sounds upon mouth opening. She reported a history of bruxism and unilateral mastication. Cone-beam computed tomography (CBCT) revealed condylar erosion, osteophyte formation, and flattening. Clinical and radiographic findings confirmed myofascial pain and arthralgia with TMJ OA exacerbated by bruxism. Treatment included a custom 3D-printed stabilization splint and BTX type A injection into the masseter muscle. After 1 week, mouth opening improved from 34 mm to 35 mm, and to 38 mm after 1 month. The patient reported decreased pain during mastication and waking, along with reduced bruxism frequency. A multidisciplinary approach involving 3D-printed stabilization splints and BTX type A injections is effective in alleviating pain and improving function in complex TMD cases associated with bruxism. (IJP 2025;7(1):77-81)

Introduction

Temporomandibular joint disorder (TMD) is a musculoskeletal disorder involving the temporomandibular joint (TMJ), masticatory muscles, and supporting structures.[1,2] Temporomandibular joint disorder (TMD) is the second most common musculoskeletal condition after low back pain and can affect 5–12% of the population.3 One of the most common forms of TMD is temporomandibular joint osteoarthritis (TMJ OA), a degenerative joint disorder characterized by damage to the articular cartilage, subchondral bone remodelling, osteophyte formation, and clinical symptoms such as pain, crepitus, and limited jaw movement.[3,4]

OA TMJ caused by excessive functional load can lead to joint tissue collapse and condylar resorption, resulting in morphological changes in the TMJ and subsequent ramus reduction. TMJ-OA can also be triggered by sleep bruxism (SB), awake bruxism (AB), and chewing-side preference (CSP), which cause increased muscle tension and excessive load on the temporomandibular joint. Bruxism is a physiologically dysfunctional chewing muscle activity that occurs unconsciously, both during sleep and while awake.[3,5] This activity causes increased biomechanical pressure on the TMJ and masticatory muscles, which in the long term can accelerate the degenerative process and exacerbate TMD symptoms.[6] Patients with bruxism or TMD often show abnormal biological mechanics in the TMJ, which can trigger the development of osteoarthritis (OA) accompanied by pain and decreased mandibular function.[3] Given these various etiological factors, an appropriate approach to managing TMD is important to prevent the progression of joint damage and improve the patient's quality of life.

TMD management aims to relieve pain, restore joint function, and prevent further damage. Conservative approaches are the first choice in therapy, one of which is through the use of occlusal splints. Splints work by balancing occlusal relationships, reducing muscle load, and relieving pressure on the TMJ.[7] With advances in digital technology, splints can now be manufactured using 3D printing methods, which allow for high precision, more efficient production times, and optimal patient comfort.[8] In addition to mechanical therapy, pharmacological approaches have also been widely developed. Botulinum toxin type A (BTX-A) injections have proven effective in reducing excessive masticatory muscle activity and alleviating pain in TMD patients associated with bruxism. BTX-A works by inhibiting the release of acetylcholine at the neuromuscular synapse, causing muscle relaxation and reducing pain transmission.[9,10]

Based on this, this case report aims to describe a multidisciplinary approach in the treatment of OA TMJ aggravated by bruxism,

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Table 1. Results of muscle examination and functional manipulation related to TMD and TMJ examination .

Examination	Region	
	KA	KI
Temporalis	Ant : 1 Medium : 0 Post : 0	Front : 0 Med : 0 Post : 1
Temporal Tendon	0	1
Lateral pterygoid	0	0
Masseter	Superior : 0 Middle : 0 Inferior : 0	Superior : 2 Middle : 2 Inferior : 1
Submandibular region	1	0
Sternocleidomastoideus	Posterior : 0 Anterior : 2 Clavicle : 0	Posterior : 1 Anterior : 0 Clavicle : 0
Splenius Capitis	1	-
Trapezius	1	0
Maximum pain-free mouth opening (mm)	34 mm	
Maximum mouth opening with pain (mm)	42.6 mm	
Maximum mouth opening with operator assistance (mm)	48.4 mm	
Lateral Movement	10 mm	12 mm
TMJ Pain	0	0
TMJ sounds	Open : + Close : -	Open : + Close:
Headache	-	-
Tinitus	-	-
Static Occlusion	Right : Class I Angle (molar relationship)	
Dynamic Occlusion	Canine Guidance Left : Class I angle (molar relationship); Class I angle (group funtion) Overbite : 4 mm Overjet : 2 mm	
Midline RB at maximum opening	Deviation to the left during maximum	

with a combination of 3D-printed occlusal splints and BTX-A injections, and to evaluate its effectiveness in relieving clinical symptoms.

Case Report

A 24-year-old female patient came to the Dental and Oral Hospital (RSGM) of the Universitas Sumatera Utara (USU) complaining of pain in the front and back of her left ear and a clicking sound when opening her mouth. The anamnesis examination revealed that the patient had a history of bad habits, including bruxism, chewing on the left side, and experiencing a brief locking of the jaw while yawning. Clinical examination revealed crepitus in the right and left TMJ when opening the mouth. The patient's maximum pain-free mouth opening was 34 mm, with pain at 42.6 mm, and with operator assistance at 48.4 mm.

Several questions were asked to patients based on the Criteria for Temporomandibular Disorder (DC/TMD) to obtain a TMJ health history with the aim of assisting in classifying the type of temporomandibular disorder (TMD) during examination of the muscles around the face, neck, and TMJ. Extraoral examination showed symmetry in facial shape figure 1. On Axis I examination, palpation was performed on the extraoral and intraoral muscles. Palpation examination was performed on the extraoral muscles (such as the masseter, temporal, sternocleidomastoid, posterior stylohyoid, medial/suprahyoid/digastric anterior pterygoid, splenius capitis, and trapezius) and intraoral muscles (such as the temporal tendon and lateral pterygoid area) associated with TMD, with scores recorded according to the DC/TMD criteria (0: no pain; 1: mild pain; 2: moderate pain; 3: severe pain). Additionally, various vertical movements are examined (such as maximum mouth opening with and without pain assistance, and without pain; left and right lateral movements; protrusive movements; and examination of the midline of the lower jaw and mouth opening pattern). Palpation examination for TMJ pain was also performed, including intra-auricular and extra-auricular palpation, as well as joint sound examination. Based on the Axis II examination, the Anxiety questionnaire yielded a score of 7, indicating moderate anxiety (score 6-9). The patient health questionnaire with physical symptoms produced a score of 11, indicating moderate physical symptoms (score 10-15), while the oral cavity behavior questionnaire produced a score of 18, indicating bad habits in TMD patients (score 17-24).

Intraoral examination figure 2 and panoramic radiographic analysis figure 3 show attrition of teeth 33-43. The patient's periodontal condition is good. Based on the panoramic radiograph, the size of the condyle on the left side is larger than on the right side, with no impacted teeth, no pathological abnormalities, and a curved antegonial line indicating a clenching habit figure 3A. From the TMJ radiograph figure 3B, it was observed that when the mouth was closed, both the right and left mandibular condyles were within the glenoid fossa. When the mouth was open, both the right and left mandibular condyles were located in front of the eminence. The CBCT examination results figure 4 showed that there was an asymmetrical condyle position, flattening of the right and left condyles, erosion of the articular surface cortex of the right and left condyles, and osteophytes on the left condyle. Based on the occlusal classification, the molar relationship on the right and left sides is Angle Class I; the canine relationship on the right and left sides is Angle Class I; with an overbite of 4 mm and an overjet of 3 mm, there is a deflection to the left when opening the mouth. The results of the examination mentioned above are presented in table 1.

Based on the above examination results, the patient's diagnosis is myofascial pain and arthralgia accompanied by subluxation and osteoarthritis (OA)

Figure 1. Front and side profiles of the patient.

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Figure 2. **Intraoral examination.**

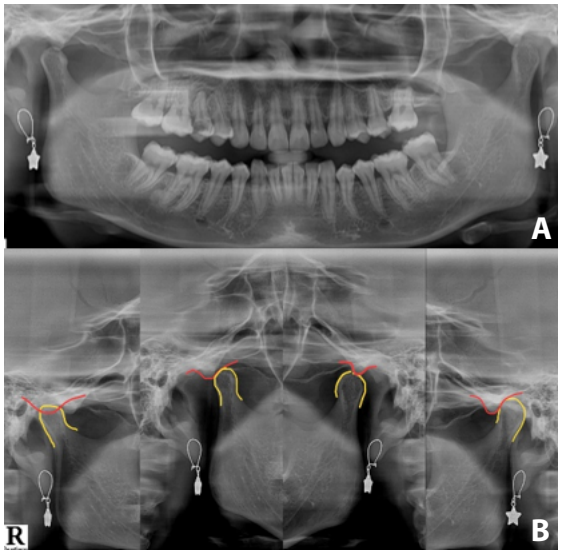

Figure 3. **A. Panoramic radiograph, B. TMJ radiography**

Figure 4. **CBCT image.**

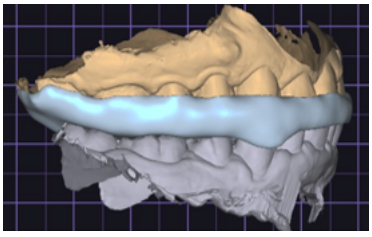

Figure 5. **Stabilization splint using 3D printing procedur.**

caused by the bad habits of bruxism and chewing on only one side. On palpation of the masticatory muscles, there was pain in the right masseter muscle, the temporalis muscle, the left temporalis tendon, and the right medial pterygoid muscle. On palpation of the extraoral muscles, there was pain in the right anterior and left posterior sternocleidomastoid muscles, the right splenius capitis muscle, and the right trapezius muscle. On palpation of the left extra-auricular area, there was pain. When opening the mouth, there was crepitus in the left TMJ.

The first treatment, called phase one treatment, performed on patients includes: Communication: discussing the anatomy related to crepitus sounds so that patients do not feel anxious and experience reversible disorders that may be related to bad habits such as grinding teeth while sleeping and chewing on one side; Physical therapy: botulinum toxin injections to relax the masseter and temporal muscles; Use of an occlusal splint: in this case, a stabilization splint is the treatment of choice for phase I because there are no restrictions on mouth opening and jaw locking when opening and closing the mouth.

The benefits of using a stabilization splint are to reduce the load on the temporomandibular joint (TMJ) during function; return the lower jaw to its normal position; restore the balance of jaw muscle tone; eliminate clicking sounds; and eliminate various complaints and symptoms of TMJ dysfunction.

The procedure for creating a 3D-printed stabilization splint is as follows: Creating a centric relation guide using Lucia/Anterior Jig with self-cure acrylic; Digital printing on the maxilla, mandible, and vestibular aspect (buccal registration) with the aid of an anterior jig; Importing the scan file into CAD software; Sending the STL file to the lab; Designing the splint using CAD; Processing the stabilization splint via 3D printing.

Placement of stabilization splints with attention to adaptation and retention; splint thickness must be appropriate for the free space; occlusal contact in the centric relation position and canine guidance occlusal scheme; instruct the patient to wear the splint for 24 hours. Stabilization splints are used for a minimum of 2 months and worn at all times except when eating figure 5. Patients are instructed to return for a follow-up one week after splint placement, and an examination is conducted to assess post-placement complaints, including: examination of complaints related to splint placement, checking for traumatic occlusal contact on the stabilization splint using articulating paper; examination for crepitus sounds; examination of deflection when opening and closing the mouth; a 2-week follow-up after placement to re-evaluate complaints from the first follow-up and subsequent follow-ups until the patient's complaints resolve.

Physical therapy is performed by injecting botulinum toxin (BTX) figure 6 as follows: Apply topical

Figure 6. BTX injection.

anesthesia to the temporalis and masseter muscles; Dilute 100 U of botulinum toxin with 2 ml of saline solution; Position the patient sitting upright; Mark the injection sites on the temporal and masseter muscles; Inject 30 units into each side of the masseter muscle and 20 units into each side of the temporal muscle using a 1 ml syringe with a 26-gauge needle (13 mm long); Instruct the patient not to lie down for at least 4 hours after treatment.

The results of the examination after 2 weeks showed that, based on subjective assessment, there was a reduction in pain in the jaw joint area, and upon waking up, the patient no longer felt stiffness. The habit of grinding teeth was prevented by the use of a stabilization splint, so that the patient consciously remembered not to do this behaviour. Based on objective examination, pain-free mouth opening increased from 34 mm before treatment to 35 mm in the first week after the splint was applied. This demonstrates the effectiveness of using a stabilization splint in conjunction with botulinum toxin (BTX) injections in reducing pain in cases of temporomandibular joint disorder (TMD).

Discussion

Temporomandibular joint osteoarthritis (TMJ OA) is a chronic degenerative disorder characterized by structural changes in the articular cartilage, subchondral bone, and surrounding soft tissues. The etiology of TMJ OA is multifactorial, including excessive functional load, trauma, occlusal abnormalities, and parafunctional habits such as bruxism. Repetitive and non-physiological biomechanical stress is the main trigger for local inflammatory responses and joint tissue degradation.[3,4] These factors trigger the molecular mechanisms underlying joint damage in TMJ OA.

Pathophysiologically, chronic mechanical stress on the joints activates inflammatory pathways that trigger the release of proinflammatory mediators such as TNF-α and IL-1β, stimulate the production of cartilage degradation enzymes (e.g., MMPs), and cause progressive damage to joint structures. This damage manifests as articular surface erosion, subchondral sclerosis, and osteophyte formation, which are clinically associated with pain, limited jaw movement, and crepitus.[3,4] The clinical presentation of OA-TMJ often includes preauricular pain, clicking or crepitus when opening the mouth, and mandibular dysfunction. In this case, the patient exhibited typical symptoms of temporomandibular joint osteoarthritis such as mandibular deflection, limited mouth opening, and bilateral crepitus. Radiographic examination using CBCT showed flattening, articular erosion, and osteophyte formation, consistent with the characteristics of temporomandibular joint osteoarthritis.[5]

Bruxism is a predisposing and perpetuating factor, an unconscious parafunctional activity of the masticatory muscles that occurs both during sleep (sleep bruxism) and while awake (awake bruxism). Its etiology is complex, involving neurological, psychological, and peripheral aspects.[5,6] Bruxism activity increases static and dynamic loads on the TMJ and stimulates degenerative processes through increased intra-articular pressure and repeated microtrauma.[4,6]

The relationship between bruxism and TMJ-OA is close. Several studies have shown that the excessive load caused by bruxism can lead to maladaptive changes in joint tissue, accelerate the onset of degenerative changes such as osteophytes and cartilage erosion, and exacerbate symptoms of pain and mandibular dysfunction.[3-5] The patient in this case report also had a long-standing habit of bruxism, which likely exacerbated the TMJ osteoarthritis he experienced.

Conservative management is the recommended first step in the management of TMD and TMJ-OA. Occlusal splints are one of the main modalities, serving to balance occlusion, reduce masticatory muscle activity, and distribute pressure evenly on the joint.[7] The application of digital technology in the manufacture of 3D splints offers advantages in terms of precision, time efficiency, and patient comfort.[8]

In this case, a CAD-CAM-based stabilization splint was used and printed with 3D printing technology. The splint was used continuously to reduce the load on the TMJ and prevent traumatic contact that triggers bruxism. Evaluations after 1 week and 1 month showed significant improvement in terms of pain and mouth opening ability. As an additional therapy, botulinum toxin type A (BTX-A) injections into the masseter and temporalis muscles have proven to be an effective approach. BTX-A works by inhibiting the release of acetylcholine at the neuromuscular synapse, causing muscle relaxation and reducing hyperactive chewing muscle activity.[9] A meta-analysis shows that BTX-A provides short-term benefits in reducing pain and muscle tension in TMD patients associated with bruxism.[10]

The combination of stabilization splints and BTX-A injections in this case showed satisfactory results, with a reduction in subjective pain, an increase in pain-free mouth opening, and patient awareness of their parafunctional habits. This multidisciplinary approach is in line with the principles of modern TMD

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therapy, which emphasizes individualization and integration of various therapeutic modalities.[1,2,7]

Conclusion

Temporomandibular joint osteoarthritis (TMJ-OA) aggravated by bruxism requires multidisciplinary management. The combination of digital occlusal splints and type A botulinum toxin injections has been proven effective in reducing pain, improving mandibular function, and suppressing excessive masticatory muscle activity. This therapy is an efficient alternative treatment option that can improve the quality of life of patients with complex TMD.

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