Journal of Dentistry and Multidisciplinary Sciences

http://www.aimspress.com/journal/jdms

JDMS, 2(1): 91–101.
DOI: 10.3934/jdms.2026010
Received: 10 July 2026
Revised: 12 September 2026
Accepted: 09 October 2026
Published: 21 October 2026

Case report

Use of a CAD/CAM-fabricated PMMA occlusal splint in a patient with temporomandibular dysfunction associated with rheumatoid arthritis: a case report with an 8-month follow-up

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Abstract: Rheumatoid arthritis (RA) is an autoimmune disease characterized by persistent synovial inflammation and progressive damage to joint structures. The temporomandibular joint (TMJ) may be affected during the course of the disease and present with pain, joint noises, stiffness, and functional alterations. In absence of surgical indication, management includes conservative strategies, such as occlusal splints. A 61-year-old female patient diagnosed with RA in 2004 came to the clinic complaining of audible joint noises when opening and closing her mouth, especially while eating. Clinical examination revealed pain on palpation and bilateral joint noises, with a maximum mouth opening of 36 mm. Imaging studies showed no evident morphological bone changes in the mandibular condyles. Conservative treatment was indicated using a rigid polymethyl methacrylate (PMMA) maxillary stabilization splint, digitally designed (CAD/CAM) and used at night. At the eight-month

follow-up, mandibular mobility remained unchanged, while pain on palpation of the masticatory muscles decreased. Right TMJ noise was detected only during closing, and the initially audible joint noise was no longer perceptible. This case documents clinical evolution during the use of an PMMA occlusal splint as part of the conservative management of temporomandibular dysfunction associated with RA; however, findings should be interpreted considering the limitations inherent in a case report.

Keywords: CAD/CAM; polymethyl methacrylate; occlusal splint; temporomandibular dysfunction; rheumatoid arthritis

1. Introduction

Rheumatoid arthritis (RA) is a systemic autoimmune disease characterized by a persistent synovial inflammation that compromises joint structures [1]. This impacts patient's daily activities and quality of life [2]. RA affects approximately 0.24%–2% of the world population [3], with a prevalence of 0.16%–0.46% in Latin America [4]. The temporomandibular joint (TMJ) may also be involved during the evolution of the disease. Patients with TMJ involvement can present with pain, joint sounds during mandibular movements, stiffness, tinnitus, and reduced mouth opening. These manifestations may interfere with functions such as chewing and speaking, particularly in patients with greater disease activity or more advanced joint involvement [5].

TMJ involvement in patients with RA may be difficult to recognize at an early stage, as structural joint changes can develop gradually with few or no evident clinical symptoms. For this reason, imaging studies are essential for identifying changes that are not always clinically apparent [6]. Among the most common findings are irregularities on the condylar surface, areas of erosion, progressive flattening, and narrowing of the joint space. In more advanced stages, these changes may be accompanied by occlusal alterations, such as the development of an anterior open bite, and, in rare cases, may progress to TMJ ankylosis [7].

The management of temporomandibular dysfunction (TMD) associated with RA will depend on the severity and progression of the disease; generally, when the disease is very advanced, the approaches typically implemented are joint lavage and orthognathic or joint surgery; when there are no surgical indications, available options are more conservative, such as hygiene and dietary guidelines, nonsteroidal anti-inflammatory drugs, and occlusal splints, as these represent a noninvasive alternative aimed at reducing joint overload, promoting better distribution of occlusal contacts, and contributing to pain control, with the ultimate goal of improving the patient's mandibular function [8].

Although polymethyl methacrylate (PMMA) has long been used for occlusal splints, digital CAD/CAM fabrication may provide advantages in terms of manufacturing precision, reproducibility, and control of the occlusal design. The rigidity and dimensional stability of PMMA also help maintain stable occlusal contacts during prolonged use and provide resistance to deformation and wear compared with more flexible thermoplastic materials [9].

In this context, digitally fabricated rigid stabilization splints may represent a conservative option for managing TMD in patients with RA. However, their use in this specific clinical setting remains poorly documented. This case report describes the clinical and functional course of a patient with RA-associated TMD treated with a CAD/CAM-fabricated PMMA stabilization splint, providing additional clinical evidence on its use and 8-month follow-up.

2. Case report

A 61-year-old female patient diagnosed with RA in 2004 came to the clinic complaining of audible joint noises when opening and closing her mouth, especially while eating. The patient expressed concern that people near her could hear these noises, even from a distance of approximately 1 m.

On physical examination, the patient presented with obvious hand deformities secondary to RA (Figure 1). At the time of the consultation, she was undergoing systemic drug therapy, which had recently been modified by her rheumatologist, switching from abatacept to baricitinib, in combination with methotrexate, folic acid, deflazacort, risedronate, and calcium and vitamin D supplements, indicating active but controlled systemic disease.

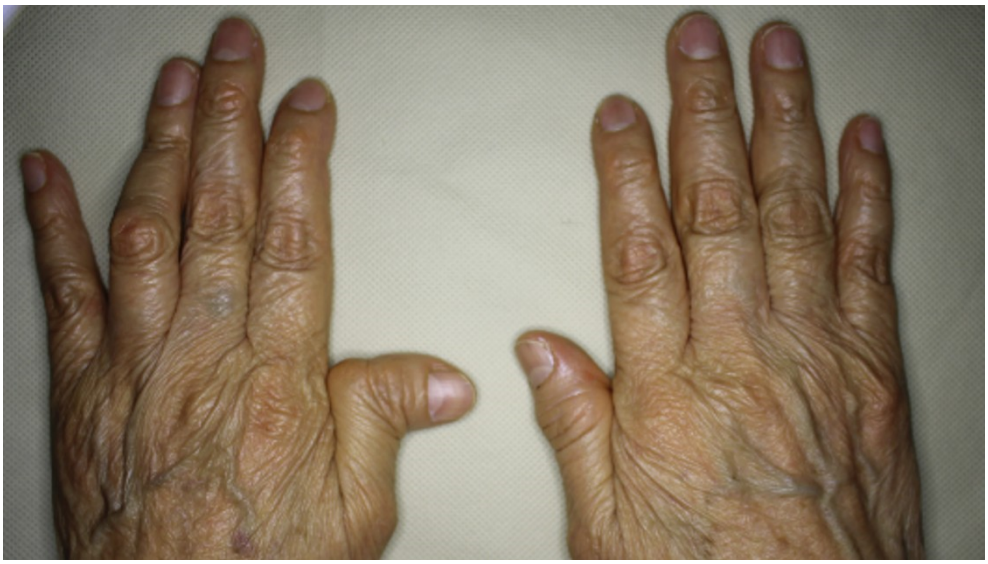


Figure 1. Rheumatoid arthritis involvement in hand joints.

The evaluation of the temporomandibular joint was conducted using a simplified clinical history adapted from the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) [10]. The examination included the opening pattern, range of mandibular movement, pain on palpation of the joint capsule, joint noises during opening and closing, and palpation of the masticatory muscles. Pain intensity was assessed using the visual analog scale (VAS).

At the initial evaluation, maximum mouth opening was 36 mm, with 6 mm of protrusion and 7 mm of lateral excursion on both sides. The opening pattern was symmetrical (Figure 2). Palpation of the joint capsule elicited pain in the right TMJ, whereas minimal pain was reported on the left. Stethoscope examination detected joint noises in the right TMJ during both opening and closing and in the left TMJ during opening only. Pain on palpation was also identified in several masticatory muscles, particularly in the external pterygoid region (Table 1). Based on clinical history, the component of TMD was classified as arthrogenic with reduction.

Imaging studies were also performed, including a computed tomography scan, a lateral skull radiograph, and an orthopantomogram, which revealed no morphological abnormalities in the mandibular condyles (Figure 3).

Based on the clinical examination and the imaging studies performed, it was determined that the presented symptoms corresponded to TMD associated with a history of RA. Since there were no

findings indicating the need for surgical treatment at that time, a conservative approach was chosen, aimed primarily at reducing the functional load on the TMJ.



Figure 2. Mandibular movements.

Table 1. Comparison of clinical findings at baseline and at the 8-month follow-up.

Clinical parameter	Baseline	8-month follow-up
Maximum mouth opening	36 mm	36 mm
Protrusion	6 mm	6 mm
Right lateral excursion	7 mm	7 mm
Left lateral excursion	7 mm	7 mm
Opening pattern	Symmetrical	Symmetrical
Joint noise, right TMJ	Opening and closing	Closing
Joint noise, left TMJ	Opening	Opening
Joint noise perceptible to the patient and others	Present	Not perceptible
Pain on palpation of the right joint capsule	Present	Present
Pain on palpation of the left joint capsule	Minimal	Minimal
Pain on palpation of the masticatory muscles	Present	Decreased

Note: Abbreviations: TMJ, temporomandibular joint.

Therefore, the fabrication of an occlusal splint was indicated. Digital models of both arches were obtained using a Helios 500 intraoral scanner (Eighteeth, Sifary Medical, China) (Figure 4). Based on these records, a rigid stabilization splint for the maxillary arch was designed using 3Shape Splint Studio, with an overall thickness of 2.5 mm and a minimum thickness of 1.5 mm. The occlusal scheme was configured according to a mutually protected occlusion concept using the "Raise to antagonist cusp tips" function and a virtual articulator. Guiding ramps of approximately 10°–15° were designed in the canine and anterior regions. The "Adapt to Antagonist" function was used to adjust the contacts with the opposing arch while maintaining the anterior and canine guidance and posterior contacts in centric relation. The final design had an approximate thickness of 1.5 mm in the posterior region and 3 mm in the canine and anterior guidance areas. The splint was milled from a PMMA disc (Forever Young, Aidite) using a PM7 milling machine (Ivoclar). After placement, the fit and occlusal contacts were verified

clinically and adjusted as needed to obtain uniform contacts between the mandibular cusps and the occlusal surface of the splint.

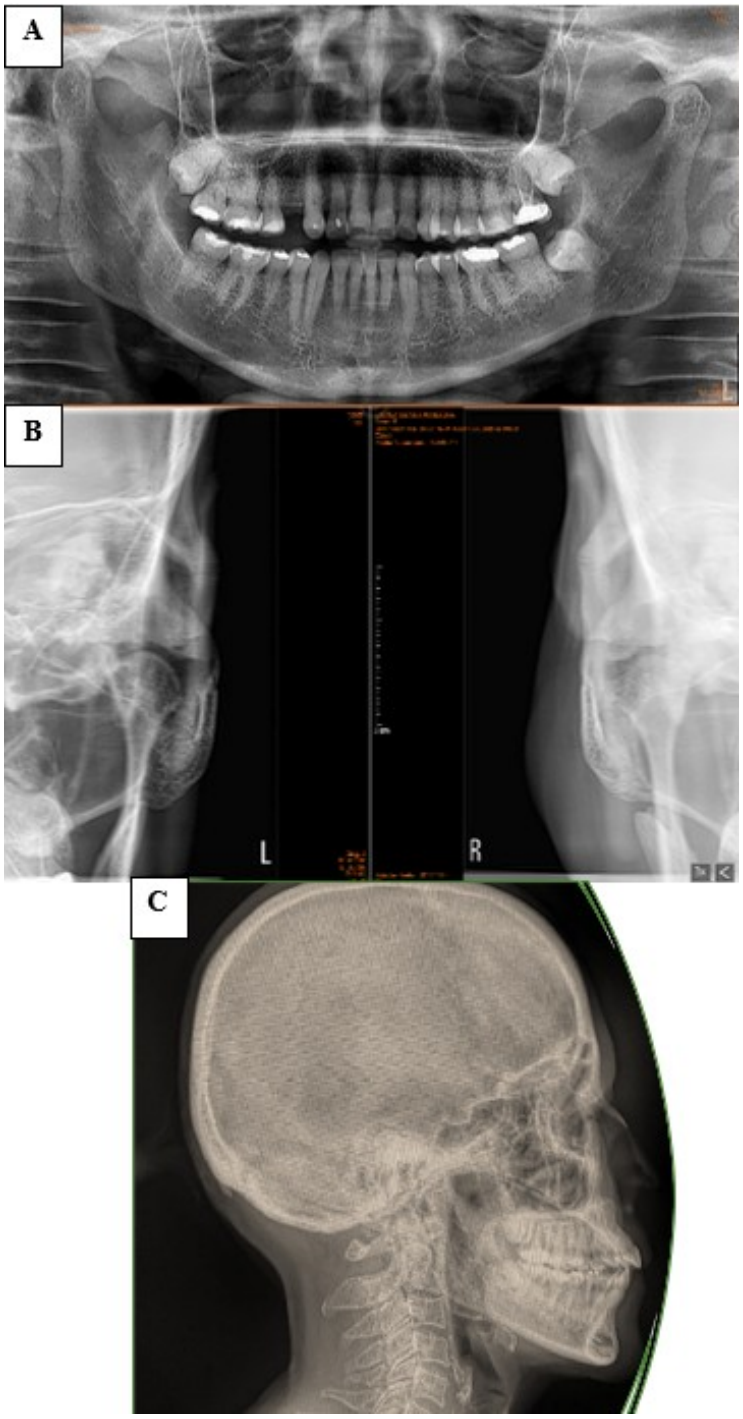


Figure 3. Imaging studies. A) Panoramic radiograph, B) computed tomography, and C) lateral skull radiograph.

The fit of the splint was checked, and some areas requiring minor adjustments were identified; these adjustments were made to eliminate excessive retention and facilitate removal (Figure 5). Oral hygiene measures and their continuous use during the night were recommended.

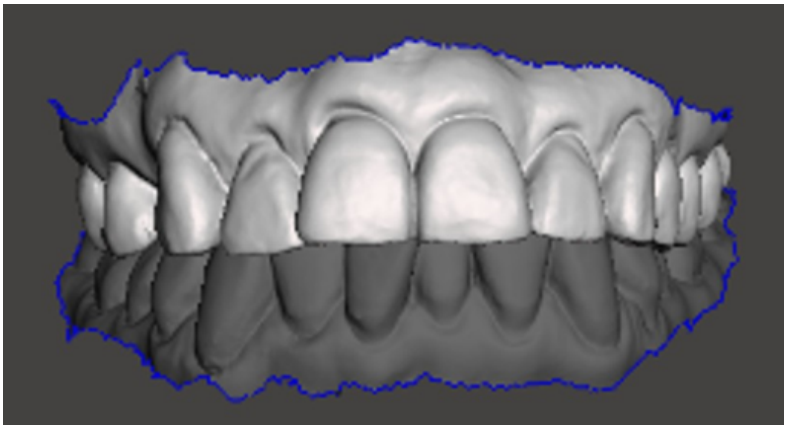


Figure 4. Intraoral scanning of the design of the PMMA occlusal splint.

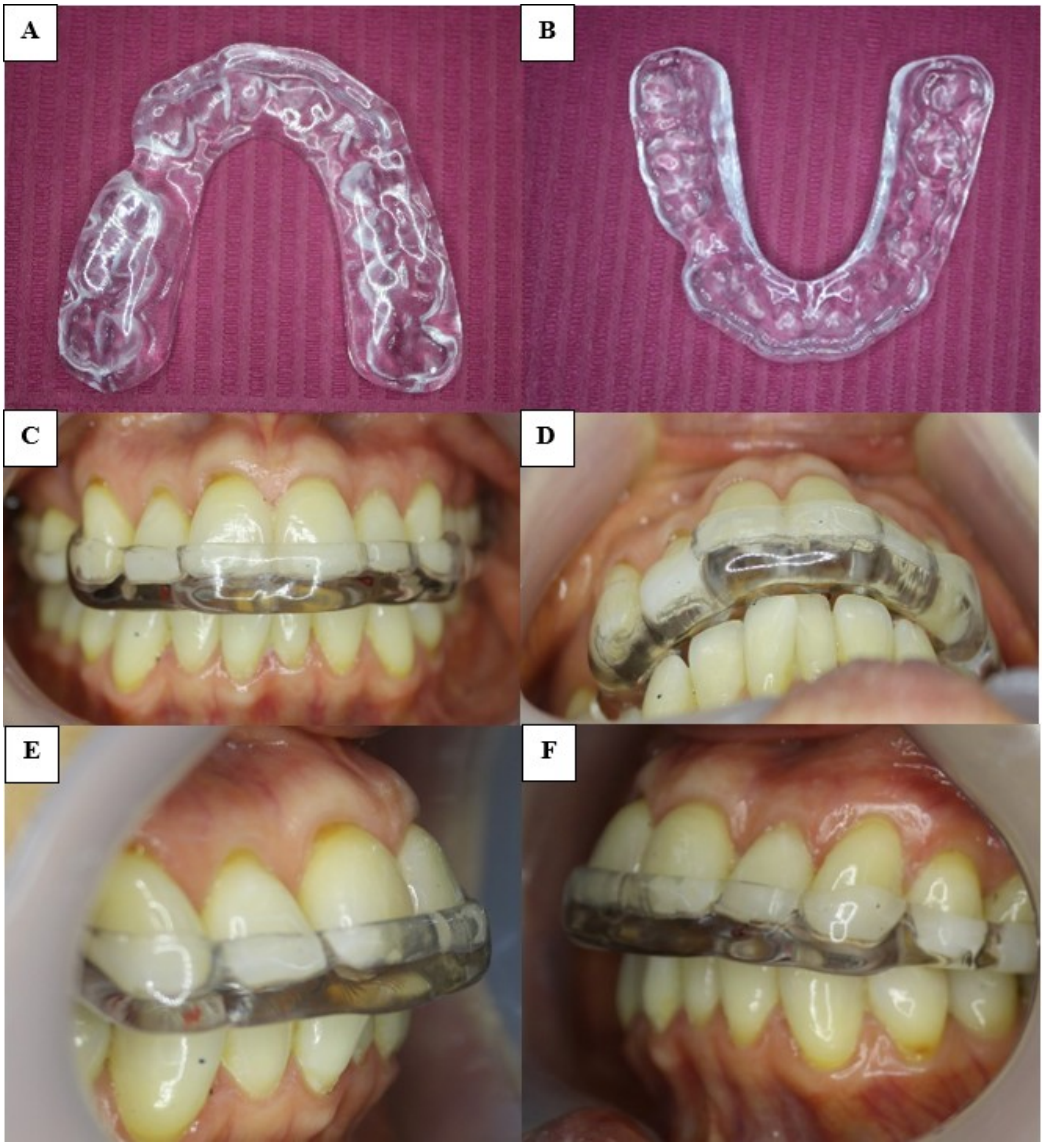


Figure 5. Placement and adaptation of occlusal splint. A,B) Occlusal splint before placement and C–F) after placement.

2.1. Clinical follow-up over 8 months

Clinical evolution was assessed through follow-up appointments programmed over an 8-month period. At the 1-month follow-up, the fit of the splint was checked, and some areas requiring minor adjustments were identified; these adjustments were made at that moment (Figure 6). In the following months of use (Figure 7), mandibular mobility remained unchanged from baseline, with a maximum mouth opening of 36 mm, protrusion of 6 mm, and lateral excursions of 7 mm on both sides, with a symmetrical opening pattern. Joint noise in the right TMJ, initially detected during both opening and closing, was detected only during closing, whereas the noise in the left TMJ persisted during opening. The audible joint noise that had prompted the patient to seek care was no longer perceptible. Pain on palpation of the right joint capsule remained present, while it was minimal on the left. Pain on palpation of the previously symptomatic masticatory muscles decreased compared with the initial evaluation (Table 1).

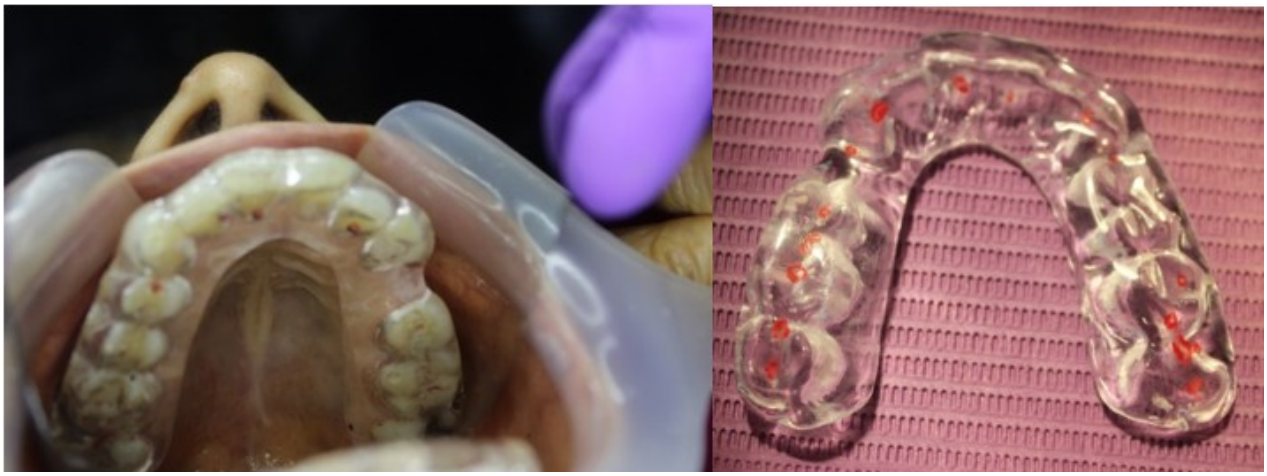


Figure 6. One month of follow-up with the use of the PMMA occlusal splint.

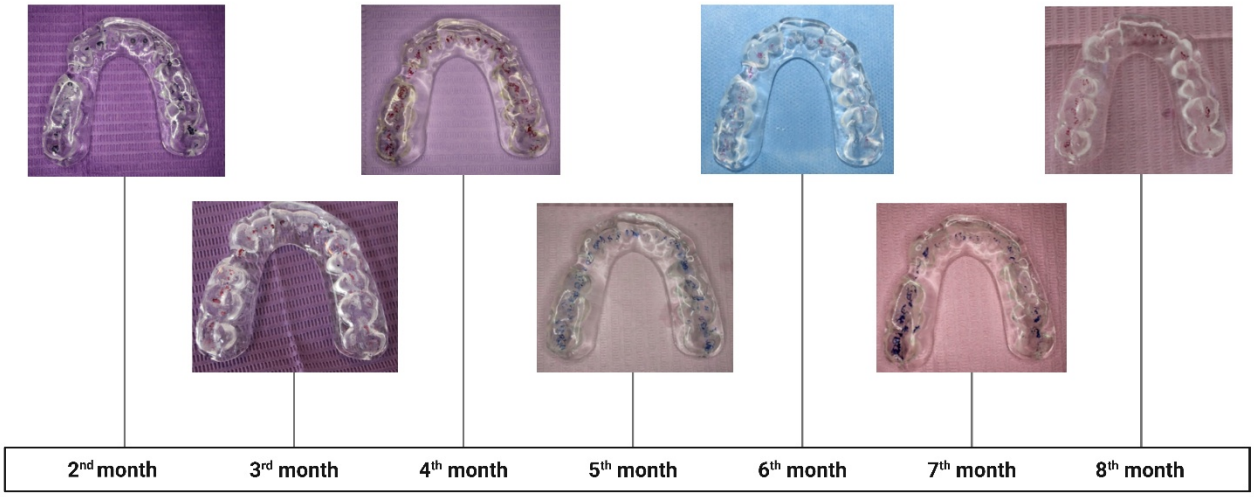


Figure 7. Occlusal adjustments during the 8 months of follow-up, with the main objective of maintaining the stability and correct functioning of the splint.

3. Discussion

In this clinical case, the patient with RA presented with pain and joint noises in both TMJs, as well as pain on palpation of the masticatory muscles. These findings are part of the temporomandibular manifestations described in patients with RA [11,12]. However, the available imaging studies showed no evident bone changes in the mandibular condyles. The presence of clinical signs and symptoms in the absence of obvious bone alterations reinforces the importance of assessing the TMJ during the evaluation of these patients, as TMJ affection may not be evident based solely on radiographic findings [11].

An important aspect of the patient's clinical evolution is the change from abatacept to baricitinib. Baricitinib can reduce RA activity and its clinical manifestations [13]. Furthermore, increased RA activity has been related to pain and other temporomandibular manifestations [14]. Therefore, systemic treatment may also have contributed to the reduction in pain observed during follow-up. Since RA activity parameters were not available before and after the medication change, it is not possible to determine the contribution of systemic treatment and the occlusal splint to the observed changes.

Because the TMJ is a synovial joint, it can be affected during the course of RA, and a higher frequency of clinical and radiographic abnormalities has been reported in these patients than in individuals without RA [15]. Management should take into account both systemic control of the disease and local TMJ manifestations, resorting to conservative measures when the clinical condition permits [8]. Specific evidence regarding the long-term use of occlusal splints in patients with RA is limited. Kuroda et al. described the initial use of a splint for eight months in a patient with RA and severe condylar resorption, followed by conservative orthodontic treatment; after five years of retention, the occlusion remained stable, and no progression of condylar resorption was observed [16]. These results show that conservative management may be an alternative in selected cases, although they do not allow clinical evolution to be attributed solely to the splint. In our report, the reduction in muscle pain and changes in joint noises also occurred during splint use, but these findings should be interpreted in conjunction with systemic treatment for RA.

Hand deformities associated with RA can compromise manual dexterity and function, even in patients with adequate disease control [17]. This could affect the handling of devices such as an occlusal splint. Our patient did not report any difficulties in inserting, removing, or cleaning the splint during follow-up, although these aspects were not specifically evaluated.

The material and manufacturing method are also important factors when selecting an occlusal splint. In this case, CAD/CAM-milled PMMA was used. A systematic review found that PMMA-based materials exhibit favorable mechanical properties, particularly in terms of hardness, wear resistance, flexural strength, and fracture toughness, while 3D-printed resins showed greater water absorption and solubility [9]. Similarly, Abad-Coronel et al. observed greater fracture resistance in CAD/CAM-milled splints compared to flexible, 3D-printed, and conventional acrylic splints [18]. These characteristics may promote the device's integrity during use; however, the material's mechanical advantages do not necessarily implicate better clinical outcomes.

3.1. Limitations

This report has several limitations, which we highlight below:

1) No detailed information was available regarding RA activity, such as DAS28, rheumatoid factor, anti-CCP antibodies, ESR, and CRP [19]. Although the patient had been diagnosed in 2004, the absence of these data impeded establishing disease activity at the time of evaluation and exploring its

possible relationship with temporomandibular manifestations.

2) The recent switch from abatacept to baricitinib at the time of the initial evaluation should also be taken into account. Since RA activity parameters were not available during follow-up, it was not possible to determine whether the clinical changes observed were related to the use of the splint, to systemic treatment, or to both. Therefore, these changes cannot be attributed exclusively to the occlusal intervention.

3) Computed tomography allowed assessment of the bone components of the TMJ, but there were no previous studies available to compare possible structural changes over time. Magnetic resonance imaging was not performed either, which limited the evaluation of the articular disc and other soft-tissue structures. Therefore, it was not possible to assess internal alterations of the TMJ or their possible progression in relation to RA.

4) The eight-month follow-up allowed clinical evolution during splint use to be documented, but did not determine whether the observed changes are maintained in the long term, especially in a chronic and progressive disease such as RA. A longer follow-up would allow assessing its evolution and possible changes in temporomandibular function.

4. Conclusions

This case shows the clinical evolution of a patient with RA and TMD treated conservatively with a PMMA occlusal splint. At the eight-month follow-up, the patient presented with reduced pain on palpation of the masticatory muscles. Articular noises in the right TMJ, initially present during opening and closing, were detected only during closing, while in the left TMJ, they persisted during opening. The noise, which was initially perceptible to the patient and other people, was no longer audible. Mandibular mobility remained unchanged. Studies with larger sample sizes are required to determine the potential benefit of this intervention in patients with RA.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Patient informed consent

The study participant provided informed written consent prior to study enrollment.

CARE Checklist (2016) statement

The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

Authors' contributions

Miriam Violeta Alvarado-López: Writing—review and editing, Writing—original draft preparation, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Soledad Leyva-Mena: Writing—review and editing, Writing—original draft

preparation, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Diana Guadalupe Agüero-Castañeda: Writing—review and editing, Writing—original draft preparation, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Miguel Ángel Sánchez-Bello: Writing—review and editing, Writing—original draft preparation, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Lilibeth-Stephania Escoto-Vasquez: Writing—review and editing, Writing—original draft preparation, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Artak Heboyan: Writing—review and editing, Writing—original draft preparation, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Mario Alberto Alarcón-Sánchez: Writing—review and editing, Writing—original draft preparation, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

Artak Heboyan is an editorial board member for *Journal of Dentistry and Multidisciplinary Sciences* and was not involved in the editorial review or the decision to publish this article. All authors report no relevant conflicts of interest to this article.

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