MedNEXT
Journal of Medical an Health Sciences

SYSTEMATIC REVIEW

DOI: 10.54448/mdnt24S209

Major considerations and outcomes of clinical studies on the treatment of temporomandibular disorders using prostheses: a systematic review

Vitor Eberharte Gubert[1,2*], Viccenzo Mercante[1,2], Victor Hugo Bernardes Polidoro[1,2], Janaina Cardoso Moreira[1,2]

[1] UNORTE - University Center of Northern São Paulo, Dentistry Department, São José do Rio Preto, São Paulo, Brazil.
[2] UNIPOS - Post Graduate and Continuing Education, Dentistry Department, São José do Rio Preto, São Paulo, Brazil.

*Corresponding author: Vitor Eberharte Gubert.
Unorte/Unipos - Postgraduate and continuing education,
Sao Jose do Rio Preto, Sao Paulo, Brazil.
E-mail: vitoreberharte@gmail.com

DOI: https://doi.org/10.54448/mdnt24S209
Received: 03-04-2024; Revised: 05-12-2024; Accepted: 05-16-2024; Published: 05-21-2024; MedNEXT-id: e24S209

Editor: Idiberto José Zotarelli Filho, MSc., Ph.D., Post-Doctoral.

Abstract

Introduction: The temporomandibular joint (TMJ) can be affected by end-stage pathologies, such as arthritic disease, trauma, and ankylosis. Around 70% of the general population has suffered at least one symptom of temporomandibular disorder (TMD), which constitutes TMJ disease that may be related to the joints, muscles, ligaments, bones, teeth, and psychological aspects. As a treatment, the implantation of a total alloplastic TMJ prosthesis is an innovative approach. **Objective:** It was to present the main considerations and outcomes of clinical studies on the treatments of temporomandibular disorders using customized or prefabricated prostheses. **Methods:** The PRISMA Platform systematic review rules were followed. The search was carried out from February to April 2024 in the Web of Science, Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** A total of 121 articles were found, 40 articles were evaluated in full and 21 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 22 studies with a high risk of bias and 10 studies that did not meet GRADE and AMSTAR-2. Most studies did not show homogeneity in their results, with X^2=57.8%>50%. It was concluded that stock and CAD/CAM prostheses suggested great improvements in mouth opening and pain reduction as a result of the rehabilitation of TMJ function. The results showed comparable data for both types of prosthesis design at 6 months postoperatively. However, the additional advantages of custom prosthetics, along with increasing access to digital technology, will likely result in custom devices dominating the market in TMJ total joint replacement systems. The custom-made combined prosthesis with custom design and 3D printing fabrication represents a safe and reliable implantable reconstruction method for combined TMJ-skull base injuries.

Keywords: Temporomandibular joint. Temporomandibular disorder. Clinical studies. Customized prostheses. Prefabricated prostheses.

Introduction

The temporomandibular joint (TMJ) is one of the most complex structures to study, requiring that the occlusion, joint, muscles, ligaments, and psychological factors are in complete harmony. In line with this, the person mustn't have harmful habits to all of these structures cited [1,2]. In this sense, the TMJ can be affected by end-stage pathologies, such as arthritic disease, trauma, and ankylosis [2,3].

The main debilitating symptoms result in limited mouth opening and pain. The TMJ prosthesis is indicated for diseases that result in anatomical changes and aims to restore joint function with pain relief. Significant advances have been made in the design of TMJ prostheses due to 3D printing [3,4].

In this context, temporomandibular disorder (TMD)

configures TMJ diseases that may be related to the joints, muscles, ligaments, bones, teeth, and psychological aspects. However, TMD can be divided into two large subgroups: those originating from joint problems, that is, those in which the signs and symptoms are related to the TMJ, and those of muscular origin, where their relationship is associated with the structures of the stomatognathic system [3-5].

Furthermore, patients with TMD often suffer from chronic pain, but severe pain can lead to a reduced quality of life. According to studies, around 70% of the general population has suffered at least one symptom of this disorder at some stage in their lives; however, only about 5% of them seek treatment. Furthermore, TMD has a very broad interpretation and represents a population that has been suffering from muscle and/or joint pain. It is observed that women are 4 times more affected by TMD than men [2,5]. As a treatment, the implantation of a total alloplastic TMJ prosthesis is an innovative approach for end-stage TMD [6-8]. There are two types of systems prefabricated (stock) and custom computer-aided design/computer-aided manufacturing (CAD/CAM) devices [5,9-12].

As literary support, a study carried out a systematic review and meta-analysis on TMJ prosthesis as a treatment option after mandibular condyle fracture, showing that TMJ prosthesis appears to be reserved for patients with persistent pain, bony or fibrous ankylosis or osteomyelitis after primary closed or open treatment of mandibular condyle fractures [13].

Therefore, the present study aims to present the main considerations and outcomes of clinical studies on the treatments of temporomandibular disorders using customized or prefabricated prostheses.

Methods

Study Design

The present study followed the international systematic review model, following the rules of PRISMA (preferred reporting items for systematic reviews and meta-analysis). Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. Accessed on: 03/10/2024. The methodological quality standards of AMSTAR-2 (Assessing the methodological quality of systematic reviews) were also followed. Available at: https://amstar.ca/. Accessed on: 03/10/2024.

Data Sources and Research Strategy

The literary search process was carried out from February to April 2024 and was developed based on Web of Science, Scopus, PubMed, Lilacs, Ebsco, Scielo, and Google Scholar, covering scientific articles from various to the present. The descriptors (MeSH Terms) were used: "Temporomandibular joint. Temporomandibular disorder. Clinical studies. Customized prostheses. Prefabricated prostheses", and using the Boolean "and" between the MeSH terms and "or" between historical discoveries.

Study Quality and Risk of Bias

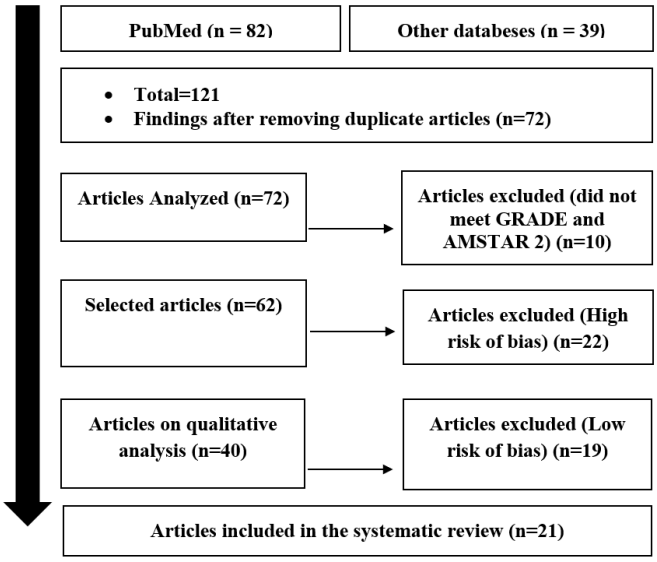
Quality was classified as high, moderate, low, or very low in terms of risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. The low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using the Cohen test (d).

Results and Discussion

Summary of Findings

A total of 121 articles were found that were subjected to eligibility analysis, with 21 final studies being selected to compose the results of this systematic review. The studies listed were of medium to high quality (Figure 1), considering the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational. The biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies showed homogeneity in their results, with X^2=57.8%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 22 studies with a high risk of bias and 10 studies that did not meet GRADE and AMSTAR-2.

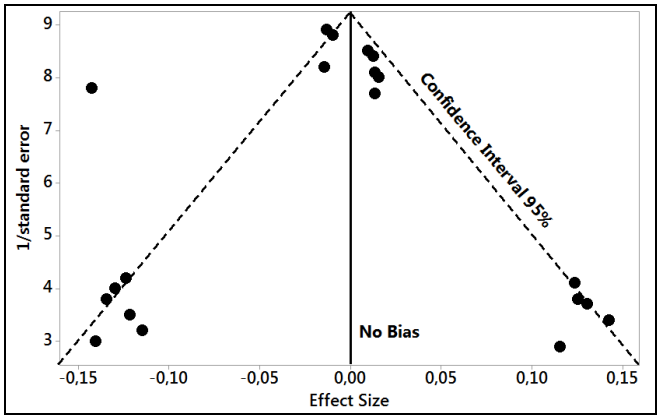
Figure 1. Article selection and exclusion process.



Source: Own authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using the Cohen Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both between studies with a small sample size (lower precision) that are shown at the bottom of the graph and in studies with a large sample size that are presented at the top.

Figure 2. The symmetric funnel plot suggests no risk of bias among the small sample size studies that are shown at the bottom of the graph. High confidence and high recommendation studies are shown above the graph (n=21 studies).



Source: Own authorship.

Major Clinical Outcomes

TMD can manifest itself in the chewing muscle, TMJ, ear, mouth, tooth, and skull. The change in masticatory muscles caused by TMD is characterized by pain associated with the soft and hard tissues of the head, face, neck, and other intraoral structures [14]. The etiology is multifactorial and TMJ problems can be divided into muscle disorders, and joint disorders, with muscle disorders affecting chewing muscles, including myofascial pain, myositis, and trismus, while joint pain encompasses problems that occur within the joint capsule, and these changes are in the shape of the articular surfaces due to remodeling of the articular disc surfaces causing disc displacements [15].

Added to this, TMD has a direct impact on the lives of people who are affected by this type of injury. This pain affects the daily lives and work activities of these people, reducing their quality of life and productivity. Other problems that may occur are ear pain (otalgia), sensation of ear fullness, sensation of decreased hearing acuity, tinnitus, dizziness, and vertigo [16].

Limitation of mandibular movements, abnormal static and dynamic occlusion may also occur, and there may also be the presence of joint noises (such as clicking and/or crepitus) [16]. The click may or may not occur with pain and with a double click when opening and closing the mouth, which characterizes a displacement of the articular disc with possible reduction, and the asymptomatic silent articulation with limitation of mouth opening is an indication of a possible displacement of the articular disc without reduction. And when recurrent encryption occurs, it is an indication of osteoarthritis. For a correct and accurate diagnosis of TMD, and correct treatment, the assessment of all symptoms aligned with teamwork is essential for the successful treatment of TMDs, in which each professional will work in their area of competence [17].

In this scenario, the stomatognathic system is extremely important in the physiological interconnection with its constituent elements and the central nervous system (CNS), and the proprioceptors present in the soft tissues, muscles, temporomandibular joint (TMJ), and periodontal membrane. Interference can lead the chewing muscles to adapt their function to protect the SS, taking the jaw to a position with different dental contacts, which can cause damage to the TMJ. This damage can generate parafunction or temporomandibular dysfunction (TMD) [17,18].

While stock devices are prefabricated and available in different standard shapes and sizes, each CAD/CAM component is manufactured using the patient's individual DICOM (Digital Imaging and Communications in Medicine) data. This system is designed for the patient's specific situation and should provide a perfect fit. However, the communicating articular surfaces of the fossa and condyle of the implant are standardized, as in the stock system [19-24].

In this aspect, the treatment of TMD is diverse and depends on the type of disease, as well as the duration and subjective level of pain. Alloplastic reconstruction can be advantageous in achieving rapid improvement in symptoms and rapid rehabilitation of masticatory function [25]. Treatment of functional TMD is commonly based on conservative therapy, including physical therapy, pain therapy, and splint therapy [26]. Depending on the severity of the TMD, treatment varies in the degree of surgical invasion. An effective method for achieving rapid improvements in mouth opening and pain reduction is TMJ reconstruction using an alloplastic total prosthetic joint replacement (TJR). This invasive approach is still considered the last resort for the treatment of TMD [27-33].

In this context, the complete resection of the diseased joint and the implantation of a fossa and a condyle component is an invasive and irreversible

procedure. There are clear indications for the use of a TJR ATM, for example, diseases involving bone loss and failure of conservative treatment, restricted mouth opening, occlusal failure, or high levels of pain [17].

In general, two different types of prosthetics for total prosthetic joint replacement of the TMJ (total prosthetic joint replacement, TJR system) are available, the stock system and custom computer-aided design/computer-aided manufacturing (CAD/CAM systems). Stock devices are prefabricated and available in different standard shapes and standard sizes. The CAD/CAM component is manufactured using the patient's individual DICOM data (Digital Imaging and Communications in Medicine). The TJR system is developed for the specific patient situation and must provide a perfect fit. However, the communicating articular surfaces of the fossa and condyle of the implant are standardized, as in the stock system [19].

Also, a study described the customized management of TMJ ankylosis using digitally created 3D cutting and positioning surgical guides to assist in determining the position and dimensions of osteotomies as an auxiliary tool in the management of TMJ ankylosis, enabling the installation of customized prostheses in a single stage. This technique has the advantage of allowing the installation of customized TMJ prostheses in a single stage, allowing greater predictability, shorter surgical time, and lower morbidity, in addition to being relatively simple and easy to handle by young surgeons [34].

Conclusion

It was concluded that stock and CAD/CAM prostheses suggested great improvements in mouth opening and pain reduction as a result of the rehabilitation of TMJ function. The results showed comparable data for both types of prosthesis design at 6 months postoperatively. However, the additional advantages of custom prosthetics, along with increasing access to digital technology, will likely result in custom devices dominating the market in TMJ total joint replacement systems. The custom-made combined prosthesis with custom design and 3D printing fabrication represents a safe and reliable implantable reconstruction method for combined TMJ-skull base injuries.

CRediT

Author contributions: Conceptualization - Vitor Eberharte Gubert, Viccenzo Mercante, Victor Hugo Bernardes Polidoro; **Data curation -** Vitor Eberharte Gubert, Viccenzo Mercante; **Formal Analysis -** Victor Hugo Bernardes Polidoro, Janaina Cardoso Moreira; **Investigation -** Vitor Eberharte Gubert, Viccenzo Mercante, Victor Hugo Bernardes Polidoro; **Methodology -** Victor Hugo Bernardes Polidoro; **Project administration -** Janaina Cardoso Moreira; **Supervision -** Janaina Cardoso Moreira; **Writing - original draft -** Vitor Eberharte Gubert; **Writing- review & editing -** Viccenzo Mercante, Janaina Cardoso Moreira.

Acknowledgment

Not applicable.

Ethical Approval

Not applicable.

Informed Consent

Not applicable.

Funding

Not applicable.

Data Sharing Statement

No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate@.

Peer Review Process

It was performed.

References

1. Romero-Reyes M, Bassiur JP. Temporomandibular Disorders, Bruxism and Headaches. Neurol Clin. 2024 May;42(2):573-584. doi: 10.1016/j.ncl.2023.12.010.
2. Hysa E, Lercara A, Cere A, Gotelli E, Gerli V, Paolino S, Pizzorni C, Sulli A, Smith V, Cutolo M. Temporomandibular disorders in immune-mediated rheumatic diseases of the adult: A systematic review. Semin Arthritis Rheum. 2023 Aug;61:152215. doi: 10.1016/j.semarthrit.2023.152215.
3. Busse JW, Casassus R, Carrasco-Labra A,

Durham J, Mock D, Zakrzewska JM, Palmer C, Samer CF, Coen M, Guevremont B, Hoppe T, Guyatt GH, Crandon HN, Yao L, Sadeghirad B, Vandvik PO, Siemieniuk RAC, Lytvyn L, Hunskaar BS, Agoritsas T. Management of chronic pain associated with temporomandibular disorders: a clinical practice guideline. BMJ. 2023 Dec 15;383:e076227. doi: 10.1136/bmj-2023-076227.

4. Patel K, Eley KA, Cascarini L, Watt-Smith S, Larkin M, Lloyd T, Maddocks C, McLaren E, Stovell R, McMillan R. Temporomandibular disorders-review of evidence-based management and a proposed multidisciplinary care pathway. Oral Surg Oral Med Oral Pathol Oral Radiol. 2023 Jul;136(1):54-69. doi: 10.1016/j.oooo.2023.02.001.
5. Zhang Y, Qian Y, Huo K, Liu J, Huang X, Bao J. Efficacy of laser therapy for temporomandibular disorders: A systematic review and meta-analysis. Complement Ther Med. 2023 Jun;74:102945. doi: 10.1016/j.ctim.2023.102945.
6. Ferneini EM. Temporomandibular Joint Disorders (TMD). J Oral Maxillofac Surg. 2021 Oct;79(10):2171-2172. doi: 10.1016/j.joms.2021.07.008.
7. Maini K, Dua A. Temporomandibular Syndrome. 2022 Apr 28. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan–. PMID: 31869076.
8. Wilkie G, Al-Ani Z. Temporomandibular joint anatomy, function and clinical relevance. Br Dent J. 2022 Oct;233(7):539-546. doi: 10.1038/s41415-022-5082-0. Epub 2022 Oct 14. PMID: 36241801.
9. Bach E, Breton P, Cousin AS, Louvrier A, Sigaux N. Prothèses d'articulation temporo-mandibulaire [Temporomandibular joint prostheses]. Rev Prat. 2020 Dec;70(10):1129-1133.
10. Namvar MA, Afkari BF, Moslemkhani C, Mansoori K, Dadashi M. The Relationship between Depression and Anxiety with Temporomandibular Disorder Symptoms in Dental Students. Maedica (Bucur). 2021 Dec;16(4):590-594. doi: 10.26574/maedica.2021.16.4.590.
11. Siegmund BJ, Winter K, Meyer-Marcotty P, Rustemeyer J. Reconstruction of the temporomandibular joint: a comparison between prefabricated and customized alloplastic prosthetic total joint systems. Int J Oral Maxillofac Surg. 2019 Aug;48(8):1066-1071. doi: 10.1016/j.ijom.2019.02.002.
12. Amarista FJ, Mercuri LG, Perez D. Temporomandibular Joint Prosthesis Revision and/or Replacement Survey and Review of the Literature. J Oral Maxillofac Surg. 2020 Oct;78(10):1692-1703. doi: 10.1016/j.joms.2020.05.021.
13. Niezen ET, van Minnen B, Bos RRM, Dijkstra PU. Temporomandibular joint prosthesis as treatment option for mandibular condyle fractures: a systematic review and meta-analysis. Int J Oral Maxillofac Surg. 2022 Jun 23:S0901-5027(22)00227-2. doi: 10.1016/j.ijom.2022.05.014.
14. Onel KB, Horton DB, Lovell DJ, Shenoi S, Cuello CA, Angeles-Han ST, Becker ML, Cron RQ, Feldman BM, Ferguson PJ, Gewanter H, Guzman J, Kimura Y, Lee T, Murphy K, Nigrovic PA, Ombrello MJ, Rabinovich CE, Tesher M, Twilt M, Klein-Gitelman M, Barbar-Smiley F, Cooper AM, Edelheit B, Gillispie-Taylor M, Hays K, Mannion ML, Peterson R, Flanagan E, Saad N, Sullivan N, Szymanski AM, Trachtman R, Turgunbaev M, Veiga K, Turner AS, Reston JT. 2021. American College of Rheumatology Guideline for the Treatment of Juvenile Idiopathic Arthritis: Therapeutic Approaches for Oligoarthritis, Temporomandibular Joint Arthritis, and Systemic Juvenile Idiopathic Arthritis. Arthritis Rheumatol. 2022 Apr;74(4):553-569. doi: 10.1002/art.42037.
15. Monje F. Temporomandibular Joint Surgery: Fascinating but Tackling Difficulties. Atlas Oral Maxillofac Surg Clin North Am. 2022 Sep;30(2):xi-xii. doi: 10.1016/j.cxom.2022.07.001.
16. Hatcher DC. Anatomy of the Mandible, Temporomandibular Joint, and Dentition. Neuroimaging Clin N Am. 2022 Nov;32(4):749-761. doi: 10.1016/j.nic.2022.07.009.
17. Delpachitra SN, Dimitroulis G. Osteoarthritis of the temporomandibular joint: a review of aetiology and pathogenesis. Br J Oral Maxillofac Surg. 2022 May;60(4):387-396. doi: 10.1016/j.bjoms.2021.06.017.
18. Cascone P, Spallaccia F, Vellone V. Temporomandibular Joint Surgery: Open Discopexy and "Functional Arthroplasty". Atlas Oral Maxillofac Surg Clin North Am. 2022 Sep;30(2):193-198. doi: 10.1016/j.cxom.2022.06.007.
19. Zhu T, Li C, Jia X, Li H, Feng Y, Ke J. Clinical Application of CAD/CAM-Guided Modified Dautrey's Procedure in Recurrent Temporomandibular Joint Luxation. J Craniofac Surg. 2022 Sep 30. doi:

10.1097/SCS.0000000000009012.
20. Lee SH, Ryu DJ, Kim HS, Kim HG, Huh JK. Alloplastic total temporomandibular joint replacement using stock prosthesis: a one-year follow-up report of two cases. J Korean Assoc Oral Maxillofac Surg. 2013 Dec;39(6):297-303. doi: 10.5125/jkaoms.2013.39.6.297.
21. Ramos AM, Mesnard M. The stock alloplastic temporomandibular joint implant can influence the behavior of the opposite native joint: A numerical study. J Craniomaxillofac Surg. 2015 Oct;43(8):1384-91. doi: 10.1016/j.jcms.2015.06.042.
22. Ackland D, Robinson D, Lee PVS, Dimitroulis G. Design and clinical outcome of a novel 3D-printed prosthetic joint replacement for the human temporomandibular joint. Clin Biomech (Bristol, Avon). 2018 Jul;56:52-60. doi: 10.1016/j.clinbiomech.2018.05.006.
23. Ackland DC, Robinson D, Redhead M, Lee PVS, Moskaljuk A, Dimitroulis G. A personalized 3D-printed prosthetic joint replacement for the human temporomandibular joint: From implant design to implantation. J Mech Behav Biomed Mater. 2017 May;69:404-411. doi: 10.1016/j.jmbbm.2017.01.048.
24. Rhee SH, Baek SH, Park SH, Kim JC, Jeong CG, Choi JY. Total joint reconstruction using computer-assisted surgery with stock prostheses for a patient with bilateral TMJ ankylosis. Maxillofac Plast Reconstr Surg. 2019 Oct 10;41(1):41. doi: 10.1186/s40902-019-0225-1.
25. Kamath AT, Kudva A, Singh A. Bilateral temporomandibular joint reconstructions with stock alloplastic prostheses on a distracted mandible - A case report. Cranio. 2022 Jul;40(4):365-372. doi: 10.1080/08869634.2020.1765600.
26. Lei J, Han J, Liu M, Zhang Y, Yap AU, Fu KY. Degenerative temporomandibular joint changes associated with recent-onset disc displacement without reduction in adolescents and young adults. J Craniomaxillofac Surg 2017;45:408–13.
27. Gerbino G, Zavaretto E, Bosco G, Berrone S, Ramieri G. Temporomandibular joint reconstruction with stock and custom-made devices: indications and results of a 14-year experience. J Craniomaxillofac Surg 2017;45:1710–5.
28. Gruber EA, McCullough J, Sidebottom AJ. Medium-term outcomes and complications after total replacement of the temporomandibular joint. Prospective outcome analysis after 3 and 5 years. Br J Oral Maxillofac Surg 2015;53:412–5.
29. Sidebottom AJ, Gruber E. One-year prospective outcome analysis and complications following total replacement of the temporomandibular joint with the TMJ Concepts system. Br J Oral Maxillofac Surg 2013;51:620–4.
30. Aagaard E, Thygesen T. A prospective, single-centre study on patient outcomes following temporomandibular joint replacement using a custom-made Biomet TMJ prosthesis. Int J Oral Maxillofac Surg 2014;43:1229–35.
31. Kalladka M, Quek S, Heir G, Eliav E, Mupparapu M, Viswanath A. Temporomandibular joint osteoarthritis: diagnosis and long-term conservative management: a topic review. J Indian Prosthodont Soc 2014;14:6–15.
32. Kanatsios S, Thomas AM, Tocaciu S. Comparative clinical outcomes between stock vs custom temporomandibular total joint replacement systems. J Craniomaxillofac Surg. 2022 Apr;50(4):322-327. doi: 10.1016/j.jcms.2022.02.003.
33. Brown ZL, Sarrami S, Perez DE. Will they fit? Determinants of the adaptability of stock TMJ prostheses where custom TMJ prostheses were utilized. Int J Oral Maxillofac Surg. 2021 Feb;50(2):220-226. doi: 10.1016/j.ijom.2020.05.009.
34. Franco JMPL, Bezerra TP, Pita-Neto ICP, da Silveira Santos DF, Rêgo RD. Treatment of the Temporomandibular Joint Ankylosis with a Customized Prosthesis in a Single Stage: The Use of 3D Cutting Guides and Virtual Surgical Planning. J Maxillofac Oral Surg. 2021 Dec;20(4):702-705. doi: 10.1007/s12663-021-01562-9.