ORIGINAL RESEARCH PAPER

Volume - 14 | Issue - 09 | September - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

TOTAL JOINT RECONSTRUCTION OF THE TEMPOROMANDIBULAR JOINT: A REVIEW ON CURRENT CONCEPTS AND CLINICAL OUTCOMES

Maxillofacial Surgery

Dr. Tharuna M P* Junior Resident, Department of Oral and Maxillofacial Surgery, Yenepoya Dental College and Hospital *Corresponding Author

Dr. H Hari Kishore Bhat Additional Professor, Department of Oral and Maxillofacial Surgery, Yenepoya Dental College and Hospital

Dr. Jagadish Chandra Professor and HOD, Department of Oral and Maxillofacial Surgery, Yenepoya Dental College and Hospital

ABSTRACT

The temporomandibular joint plays a vital role in mastication, speech, and airway function, and severe pathology can result in pain, restricted motion, and impaired quality of life. When conservative and autogenous grafting methods fail, total joint reconstruction with alloplastic prostheses provides a predictable and durable solution. This review summarizes current concepts in TMJ TJR, including anatomy, indications, evolution of techniques, prosthetic systems, outcomes, complications, and future perspectives. Modern CAD/CAM-based custom prostheses demonstrate high survival rates exceeding 90% at long-term follow-up, with substantial improvements in function and pain relief. Stock devices remain an alternative in selected cases, though custom systems provide superior adaptation. Complications such as infection, prosthesis loosening, and heterotopic ossification remain infrequent but clinically significant. Ongoing research in regenerative medicine, 3D bioprinting, advanced biomaterials, and artificial intelligence promises biologically adaptive reconstructions that may redefine the future of TMJ management.

KEYWORDS

Temporomandibular joint; Total joint reconstruction; Alloplastic prosthesis.

INTRODUCTION

The temporomandibular joint (TMJ) is a unique and complex synovial articulation that governs essential functions such as mastication, speech, swallowing, and airway stabilization. Due to this high functional demand, the TMJ is particularly vulnerable to degenerative, traumatic, inflammatory, and developmental disorders. Patients with advanced TMJ pathology often experience debilitating pain, reduced mandibular mobility, malocclusion, and psychosocial difficulties that significantly affect quality of life.[1]

Conservative management including physiotherapy, occlusal splints, pharmacological therapy, and minimally invasive procedures such as arthrocentesis and arthroscopy remains the first-line approach for most TMJ disorders. However, these modalities are insufficient in cases of severe structural compromise. In such instances, surgical reconstruction becomes necessary. Historically, autogenous grafts such as costochondral, sternoclavicular, or fibular grafts were employed for joint reconstruction, but limitations including donor site morbidity, unpredictable growth patterns, and risk of ankylosis recurrence prompted exploration of alternative strategies.[2]

Total joint reconstruction (TJR) with alloplastic prostheses has since emerged as the gold standard for end-stage TMJ disease. Modern prosthetic systems combine advanced biomaterials with computer-assisted planning and manufacturing to provide predictable, durable, and functional outcomes. This article provides an updated review of TMJ TJR, exploring anatomy, indications, historical evolution, prosthetic systems, surgical techniques, clinical outcomes, complications, and future directions.

Anatomical and Functional Considerations

The TMJ is distinctive in being a bilateral joint that functions synchronously on both sides of the mandible. Each joint comprises the mandibular condyle, the glenoid fossa of the temporal bone, and the articular disc, a fibrocartilaginous structure that cushions and guides mandibular movements.[3] The disc ensures smooth articulation by distributing loads across the joint surface.

The TMJ permits both hinge (rotation) and gliding (translation) movements, enabling opening, closing, protrusion, retrusion, and lateral excursions. This dual function categorizes it as a ginglymoarthrodial joint. Biomechanical studies demonstrate that the TMJ is exposed to complex multidirectional forces, including compression during mastication, shear during lateral movements, and tension from ligamentous attachments.[4]

The joint capsule and surrounding ligaments including the temporomandibular, sphenomandibular, and stylomandibular ligaments provide stability. Muscles of mastication (masseter, temporalis, medial pterygoid, and lateral pterygoid) generate the primary forces of movement. Accessory muscles, such as digastrics and suprahyoids, support mandibular depression and assist in function.

In designing prosthetic replacements, it is critical to replicate the biomechanical properties of the native TMJ. Failure to account for load distribution and articulation mechanics can result in accelerated wear, loosening, or failure of the prosthesis.

Indications and Patient Selection

TMJ TJR is indicated when conservative, minimally invasive, and autogenous grafting procedures cannot restore function or relieve pain. Common clinical scenarios include:

- Severe ankylosis, particularly recurrent ankylosis after failed gap or interpositional arthroplasty.
- Failed autogenous grafts such as costochondral grafts, which may overgrow, resorb, or re-ankylosis.[2]
- Post-traumatic defects leading to condylar loss or deformity.
- Extensive tumor resection involving the condyle or fossa.
- End-stage degenerative joint disease, including severe osteoarthritis or rheumatoid arthritis.
- Idiopathic condylar resorption, especially in young female patients.
- Congenital and developmental anomalies such as hemifacial microsomia or condylar aplasia.

Contraindications include uncontrolled systemic illnesses, local infection, poor oral hygiene, active malignancy, and patients with unrealistic expectations. Careful patient counseling is essential to ensure compliance with postoperative rehabilitation and to establish realistic outcomes. Psychological readiness is equally important, as postoperative adaptation to prosthetic function requires active participation in physiotherapy and diet modification.

Evolution Of TMJ Reconstruction

The history of TMJ reconstruction reflects a transition from biologic to alloplastic approaches. In the early 20th century, autogenous grafts such as costochondral grafts were widely used due to their growth potential in younger patients. However, long-term studies revealed unpredictable outcomes, with some grafts overgrowing and others resorbing completely.[3] Sternoclavicular and fibular grafts were explored but carried risks of donor site morbidity and functional limitations.

The introduction of alloplastic implants in the 1960s and 1970s marked a turning point. Silicone elastomers were initially popular, but these materials fragmented under functional loads, leading to foreign body reactions, lymphadenopathy, and bone resorption.[5] Similarly, Proplast-Teflon implants introduced in the 1980s caused severe inflammatory reactions and rapid failure, prompting FDA warnings and eventual recall.[6]

These failures underscored the importance of material science in TMJ prosthetics. Subsequent innovations drew from orthopedic hip and knee replacements, leading to the adoption of cobalt-chromium alloys, titanium, and ultra-high molecular weight polyethylene (UHMWPE). The development of CAD-CAM and virtual surgical planning further revolutionized the field, enabling precise customization of prostheses tailored to patient-specific anatomy. Modern prosthetic systems now demonstrate survival rates exceeding 90% over two decades.[7]

Current Prosthetic Systems

Current prosthetic systems fall into two main categories: stock and custom-made.

- **Stock Prostheses** are prefabricated in standardized sizes, allowing immediate availability and lower cost. However, they may not conform precisely to patient anatomy, potentially compromising function.
- **Custom-made Prostheses**, fabricated using CAD-CAM and virtual planning, provide superior anatomical fit and are especially useful in complex reconstructions. These prostheses are modeled on 3D CT scans, ensuring restoration of vertical dimension, occlusion, and facial symmetry.[8]

The materials employed include cobalt-chromium-molybdenum alloys for condylar components due to their strength and wear resistance, titanium alloys for fixation plates due to their lightweight and biocompatibility, and UHMWPE for fossa components to reduce wear. Advancements in surface coatings and fixation technology have further improved osseointegration and reduced micromotion.

Recent literature reports significantly improved functional outcomes, reduced pain, and high patient satisfaction with custom devices compared to stock systems.[8],[9] Long-term follow-up confirms prosthesis durability, with over 90% survival rates.

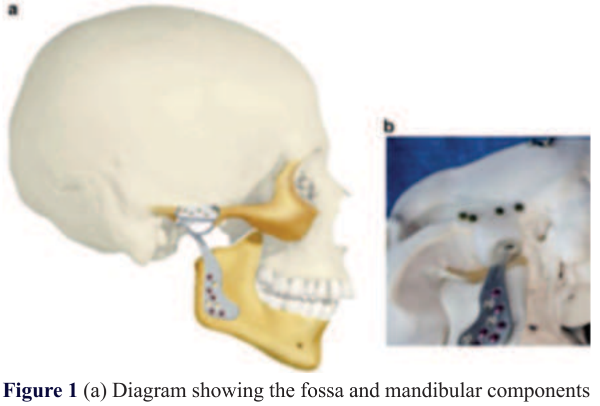

Figure 1 (a) Diagram showing the fossa and mandibular components placed. (b)Two screws for each component can be utilized and the mandible functioned to ensure proper component fit before the final screws are placed.[10]

Surgical Technique

Surgical success in TMJ TJR depends on meticulous preoperative planning, intraoperative precision, and comprehensive postoperative care. Preoperative work-up includes CT and MRI imaging, occlusal analysis, and virtual surgical planning. CAD-CAM models are used to simulate osteotomies and prosthesis placement, ensuring predictable outcomes.

The standard surgical approach is via a preauricular or endaural incision, with additional submandibular incisions when necessary. The diseased condyle and glenoid fossa are resected, followed by placement of the fossa component, secured with titanium screws. The condylar component is then fixed to the ramus. Intraoperative navigation may be employed to enhance accuracy.

Postoperatively, patients undergo intensive physiotherapy to restore mandibular mobility and prevent fibrosis. A progressive diet is recommended, starting with soft foods. Pain management, infection control, and long-term radiographic monitoring are integral to postoperative care.

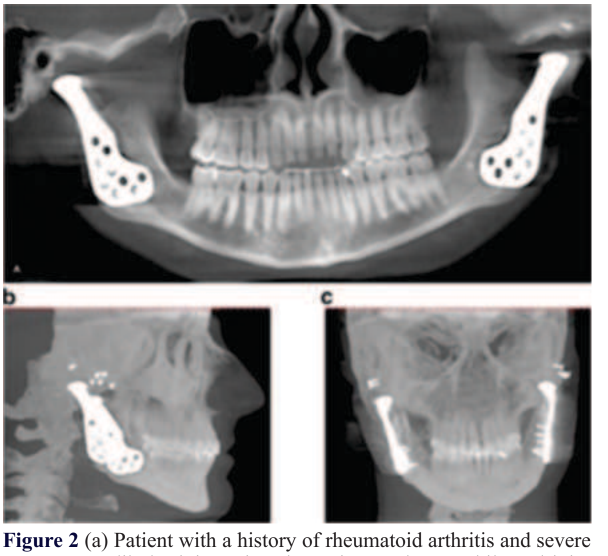

Figure 2 (a) Patient with a history of rheumatoid arthritis and severe temporomandibular joint pain. The patient underwent bilateral joint reconstruction and was able to achieve a pain-free opening of 40 mm. (b) Lateral view of the same patient showing good orientation of the prosthesis. (c) Anterior view showing well-adapted prosthesis with good bony interface.[10]

Clinical Outcomes and Complications

Clinical outcomes of TMJ TJR are overwhelmingly positive, with patients reporting significant improvements in pain, function, and quality of life. Maximum interincisal opening typically improves by 10–15 mm postoperatively, and most patients achieve a functional range exceeding 35 mm.[7]

Dietary function is restored, speech improves, and psychosocial well-being is enhanced. Pain scores decrease markedly, with many patients achieving complete pain relief. Prosthesis survival rates are excellent, with more than 90% functional at 10–20 years. Custom-made prostheses tend to outperform stock devices in terms of fit, functional outcomes, and longevity.[8],[9]

Despite these successes, complications remain. Early complications include surgical site infection, hematoma, transient facial nerve paresis, and malocclusion. Late complications include prosthesis loosening, hypersensitivity reactions to metal components, heterotopic ossification, and rare mechanical fractures. Revision surgery may be necessary in 5–10% of cases, most often due to infection, loosening, or mechanical wear. Younger patients present a unique challenge due to higher functional demands and the possibility of outliving the prosthesis lifespan, necessitating revision.[11]

Figure 3 (a) High inflammatory arthritis patient preoperative. (b)

Postoperative custom TMJ TJR. (c and e) Preoperative. (d and f) 16 years postoperative.[10]

Future Directions

The future of TMJ reconstruction lies in regenerative medicine, biomimetic materials, and digital surgical technologies. Tissue engineering using mesenchymal stem cells, scaffolds, and growth factors holds promise for regenerating condylar cartilage and discs.[12] Bioprinting and nanotechnology are being explored to create living prostheses capable of adapting to biomechanical stresses.

Robotic surgery and computer-assisted navigation may further enhance precision in prosthesis placement. Artificial intelligence could improve preoperative planning, predicting biomechanical outcomes and guiding prosthesis design. New biomaterials with superior wear resistance, osseointegration, and reduced inflammatory potential are under development.[13]

Ultimately, the integration of regenerative techniques with alloplastic designs may usher in a new era of hybrid reconstructions, combining durability with biological adaptation.

CONCLUSION

Total joint reconstruction of the TMJ has evolved into a highly reliable solution for patients with end-stage joint disease. From the early reliance on autogenous grafts to catastrophic failures with early alloplastic materials, and finally to the success of modern custom-made prostheses, the journey of TMJ TJR reflects the progress of surgical science and biomaterial engineering.

Today's prostheses demonstrate high survival rates, excellent functional outcomes, and improved quality of life for patients. Although complications such as infection, loosening, and heterotopic ossification persist, their incidence is relatively low. The future promises exciting advances in regenerative approaches, personalized prosthesis design, and surgical technology. Continued innovation, rigorous research, and multidisciplinary collaboration will further enhance outcomes and cement TMJ TJR as a standard of care.

REFERENCES

1. Scrivani SJ, Keith DA, Kaban LB. Temporomandibular disorders. N Engl J Med. 2008;359:2693–705.
2. Mercuri LG. Alloplastic temporomandibular joint replacement: rationale for custom devices. Int J Oral Maxillofac Surg. 2012;41:1033–40.
3. Driemel O, Braun S, Müller-Richter UD, Behr M, Reichert TE, Kunkel M, et al. Historical development of alloplastic TMJ replacement. Int J Oral Maxillofac Surg. 2009;38:909–20.
4. Hylander WL. Analysis of TMJ reaction force in macaques. Am J Phys Anthropol. 1979;51:433–56.
5. Wagner JD, Mosby EL. Complications of Proplast-Teflon TMJ implants. J Oral Maxillofac Surg. 1991;49:654–62.
6. Dutton M. The temporomandibular joint. In: Orthopaedic Examination, Evaluation, and Intervention. McGraw Hill; 2012.
7. Wolford LM, Mercuri LG, Schneiderman ED, et al. Twenty-year follow-up on TMJ Concepts prosthesis. J Oral Maxillofac Surg. 2015;73:952–60.
8. Giannakopoulos HE, Sinn DP, Quinn PD. Biomet Microfixation TMJ replacement: 3-year follow-up. J Oral Maxillofac Surg. 2012;70:787–94.
9. Wolford LM. Clinical indications for TMJ replacement. Oral Maxillofac Surg Clin North Am. 2006;18:345–56.
10. Mercuri LG. Temporomandibular joint total joint replacement—TMJ TJR. Switzerland: Springer Int Pub. 2016.
11. Navarro M, Michiardi A, Castaño O, Planell JA. Biomaterials in orthopaedics. J R Soc Interface. 2010;5:1137–58.
12. Wu Y, Gong Z, Li J, Meng Q, Fang W, Long X. Stem cell–based repair of TMJ disc perforation. Biomed Res Int. 2014:454021.
13. Sinno H, Tahiri Y, Gilardino M, Bobyn D. Engineering alloplastic TMJ replacements. McGill J Med. 2011;13:63–70.