Temporomandibular Joint Reconstruction

Louis G. Mercuri

Contents

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Key Points
1. Alloplastic TMJ replacement devices do not require a donor site.
2. Alloplastic TMJ replacement devices require less surgery time.
3. Custom alloplastic TMJ replacement devices can be designed and manufactured to conform to the anatomical situation.
4. Alloplastic TMJ replacement device components are not susceptible to prior failed foreign body particles, local, or systemic pathology.
5. Immediately after alloplastic TMJ replacement device implantation, a patient can begin physical therapy hastening regaining mandibular function.

34.1 Synopsis

Presently, there are two options for the reconstruction of the temporomandibular joint: autogenous bone grafting or alloplastic joint replacement. This chapter presents evidence-based advantages and disadvantages for each of these management options to assist both the surgeons and their obstructive sleep apnea patients in making that choice should this option be required to manage the case.

34.2 Introduction

Temporomandibular joint (TMJ) reconstruction (TJR) presents unique problems because of the integral role the TMJ plays in establishing and maintaining proper mandibular form and function. The TMJ not only acts as a secondary growth center for the mandible, but its integrity is vital to the functions of mastication, speech, and deglutition, as well as in obstructive sleep apnea (OSA) airway support [1].

TMJ TJR goals are (1) improvement of mandibular function and form, (2) reduction of further suffering and disability, (3) containment of excessive treatment and cost, and (4) prevention of further morbidity [2]. End-stage disease and/or pathology such as OSA, with accompanying anatomic form and physiologic function distortions dictate consideration for TMJ TJR.

The surgeon presented with an OSA patient requiring TMJ TJR has two options, either autogenous or alloplastic reconstruction. This chapter presents an evidence-based discussion of the advantages and disadvantages of autogenous and alloplastic TMJ TJR to assist both the surgeon and their patients in making that choice in the management of OSA.

34.3 Autogenous TMJ Replacement

Autogenous bone grafting has been reported to be "the gold standard" for reconstruction of developmental deformities, end-stage TMJ pathology, and ankylosis using either free or vascularized bone grafts from rib [3], calvarium [4], clavicle [5], iliac crest [6], or fibula [7].

In addition to the reported unpredictability of autogenous bone grafting [8–12], complications frequently occur. Complications associated with bone harvest have been reported up to 19% of cases and include chronic pain, skin sensitivity disorders, and complicated wound healing. This can lead to hypertrophic scarring or infection, fracture, and prolonged length of hospitalization, all associated with additional morbidity and medical costs [13, 14].

The costochondral graft has been the most frequently recommended autogenous bone graft for TMJ reconstruction due to its ease of adaptation to the recipient site, its gross anatomical similarity to the mandibular condyle, and its demonstrated growth potential in skeletally immature patients [3, 15–19].

Reitzik reported that in an analogous situation to autogenous costochondral grafting, cortex-to-cortex healing after vertical ramus osteotomy requires 20 weeks to consolidate in monkeys and 25 weeks in humans [20].

Maxillomandibular fixation is typically maintained for some period in patients after TMJ reconstruction with costochondral grafts. Despite rigid fixation, graft micromotion will invariably occur with early mandibular function. This results in shear stresses on the graft/host interface that potentially can lead to poor neovascularization, nonunion, or failure [21].

In a systematic review of the literature, Kumar et al. assessed the growth potential of costochondral graft for TMJ reconstruction. These authors concluded that there were no randomized clinical trials, and the only evidence is in the form of case series, considered the lowest level of evidence for any study. Therefore, no inference can be interpreted regarding growth potential of costochondral graft. Thus, based on available evidence, they concluded that use of costochondral graft for TMJ reconstruction for its growth potential lacks scientific evidence [22].

The advantages of an autogenous bone graft for TMJ reconstruction:
1. Availability – Part of the human skeletal system. No lead-time to purchase and acquire device components.
2. Biocompatibility – Autogenous tissue, therefore, little concern for issues of biocompatibility or hypersensitivity.

3. Adaptability – Autogenous bone can be shaped at surgery to adapt to the lateral surface of the mandible and glenoid fossa.
4. Less expensive – Alloplastic TMJ replacement components are expensive. No need to maintain an inventory of expensive alloplastic TMJ replacement components and specialized instruments or equipment.

The disadvantages of an autogenous bone graft for TMJ reconstruction:
1. Requires a second surgical donor site.
2. Longer surgery and anesthetic time – Simultaneous autogenous bone harvest and preparation of mandibular implantation sites are most often not technically feasible.
3. Potential morbidity associated with autogenous bone harvesting.
4. Requires neovascularization, bone turnover, and bone healing.
5. Delays physical therapy – Orthopedic surgeons understand that early physical therapy increases the range of motion of reconstructed joints [23]. Keeping a patient immobilized (maxillomandibular fixation) after any open joint surgery, particularly joint replacement, increases muscle atrophy, as well as periarticular fibrosis and the potential for the development of heterotopic ossification and ankylosis [24].
6. Bone is subject to foreign body reactions, local and systemic pathology – Henry and Wolford concluded that a foreign body reaction locally influenced the success of autologous tissue reconstruction [25]. This principle holds true in cases of high inflammatory arthritic diseases, OSA, and condylar resorption [26, 27].
7. Higher relapse potential when autogenous bone grafting to reconstruct the TMJ is combined with orthognathic surgery – Reconstruction of the loss of posterior vertical mandibular height and dental occlusion, as seen in end-stage arthritic disease, condylar resorption, and many cases of OSA, requires counterclockwise rotation of the mandible along with maxillary surgery [27]. This maneuver places great stress on the mandibular condyle. Relapse has been reported high when autogenous costochondral grafting has been used to reconstruct the condyle in such cases [28–30].

34.4 Alloplastic TMJ Replacement

With the potential morbidity associated with harvest of autogenous bone and the inability of these tissues to survive either the transplantation process or the functional demands applied to them, there arose the need for the development and use of alloplastic materials to replace them anatomically and functionally.

The practice of reconstructive orthopedic surgery would be unthinkable and impossible without the availability of alloplastic joint replacement devices. In the 1960s, posed with the problem that resection arthroplasty as an uncertain procedure with recurrent deformity and limited motion as common complications, Sir John Charnley developed a successful low-friction total alloplastic joint replacement device. Since that time, with the evolution of surgical techniques, implant materials and designs, excellent long-term function and quality of life improvement results have been reported along with device survival rates exceeding 90% after 10 years [31, 32].

Over the years, surgeons dealing with end-stage TMJ pathology unable to be managed predictably with autogenous bone grafting developed alloplastic total TMJ replacement systems [33, 34].

Presently, the two US FDA-approved total alloplastic TMJ replacement systems (TMJ Concepts, Ventura, CA and Zimmer Biomet, Jacksonville, FL) have demonstrated long-term successful outcomes in management of end-stage TMJ pathology (◘ Fig. 34.1).

The results of studies comparing the presently available FDA-approved alloplastic TMJ replacement support the surgical implantation of both stock and custom systems. Further, these studies demonstrate that alloplastic TMJ replacement is safe and effective, reduces pain, improves mandibular function, and patients' quality of life, with few complications. Therefore, alloplastic TMJ replacement represents a viable and stable long-term solution for cranio-mandibular reconstruction in patients with irreversible end-stage TMJ disease [35–51].

Lee et al. reviewed published research on TMJ total replacement that compared the outcomes of autogenous costochondral graft and alloplastic TMJ reconstruction. Using PubMed databases, including prospective, retrospective, case–control or longitudinal studies and significant statistical analysis, these authors divided outcomes into "Acceptable" or "Non-acceptable." These authors discovered seven articles that dealt with costochondral graft in 180 patients. Most patients had good outcomes (n = 109, 61%). They found six articles with 275 patients who had undergone alloplastic TMJ replacements. Those patients had excellent outcomes (n = 261, 95%). These authors concluded that alloplastic total joint reconstruction resulted in increased quality of life and fewer complications in comparison with autogenous costochondral grafting. Therefore, alloplastic TMJ replacement was deemed more effective for total joint replacement than costochondral grafting [52].

The advantages of alloplastic TMJ replacement:

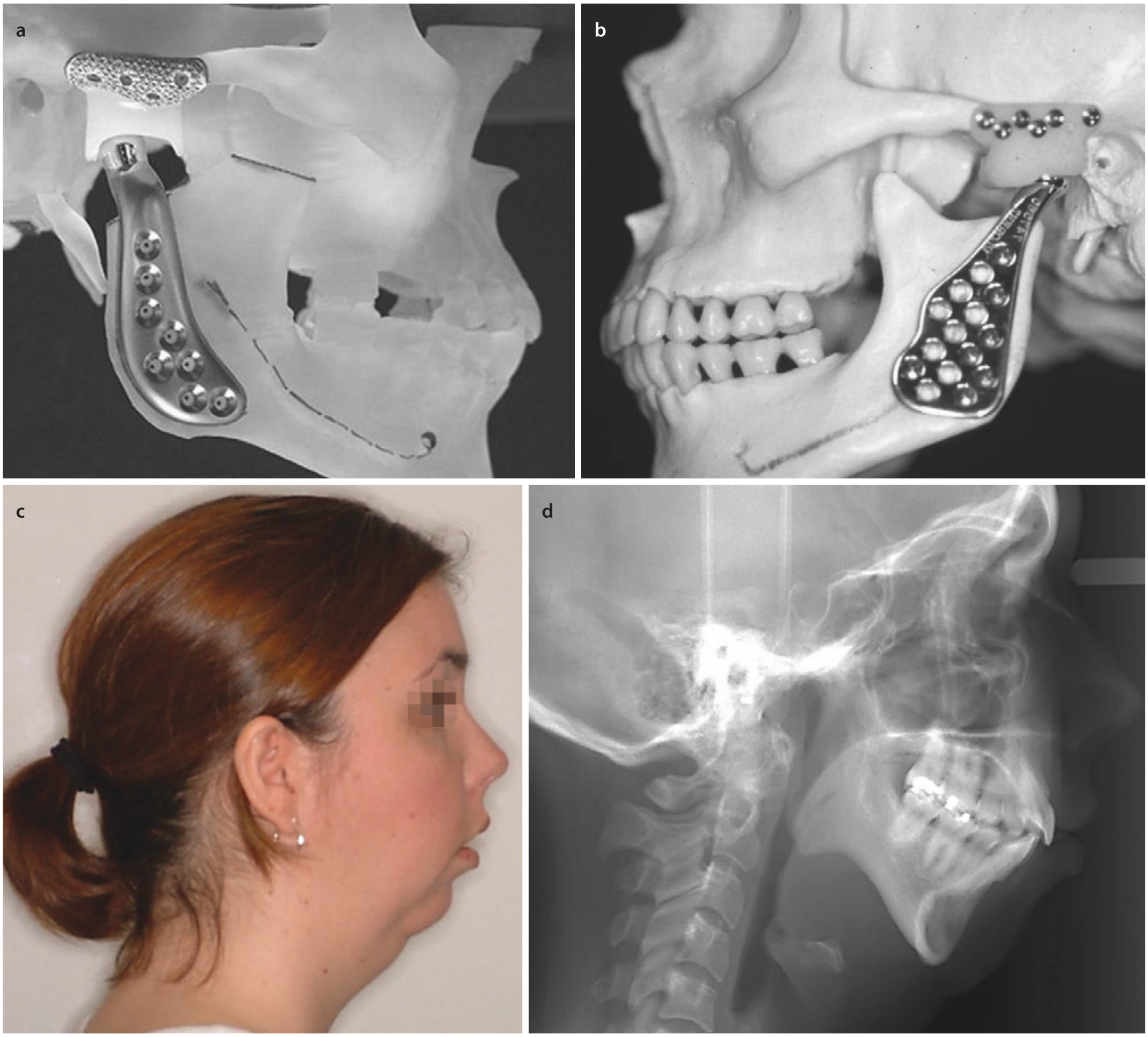

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Fig. 34.1 **a** TMJ Concepts (Ventura, CA) total TMJ replacement device consisting of a commercially pure titanium mesh backed ultrahigh molecular weight polyethylene fossa component and an alloyed titanium ramus component with a cobalt/chrome/molybdenum condyle. **b** Zimmer Biomet (Jacksonville, FL) total TMJ replacement device consisting of an all ultrahigh molecular weight polyethylene fossa component and an all cobalt/chrome ramus component

1. Availability – Stock systems can be inventoried for use as needed. Custom devices can be ordered in advance.
2. No donor site morbidity.
3. Decreased surgery time – No donor site.
4. Conforms to the anatomical situation – In the case of a stock system, the surgeon will alter the host bone to allow the components to fit. A custom system provides the surgeon with components that are designed and manufactured for the specific anatomical situation.
5. Components are not susceptible to prior failed foreign body particles, local, or systemic pathology.
6. Patient can begin physical therapy immediately as there is no concern for neovascularization and component mobility.

The disadvantages of an alloplastic TMJ replacement:

1. Expense – Since the operating room, anesthesia, and surgical time charges are much less than with autogenous costochondral graft harvest and implantation, the total cost of alloplastic TMJ replacement is less or at least comparable.
2. Longevity of the components. Studies indicate that alloplastic TMJ replacement devices have a lifespan of at least 10–20 years [37, 38, 41, 42].

Fig. 34.2 TC preoperative clinical and lateral cephalometric images. Note the restricted airway

3. Material hypersensitivity – Excessive reactivity to implant debris or hypersensitivity to implant debris is relatively rare, where it is estimated that only 1–3% of aseptic failures are due to hypersensitivity responses among traditional metal-on-polymer type total joint replacement hip and knee designs. The percentage of aseptic failures due to biomaterial hypersensitivity in alloplastic TMJ replacement is not known [53].
4. Only indicated for skeletally mature patients – It appears to be myopic to continue to reoperate in children with failed, overgrown, or ankylosed costochondral grafts, with autogenous TMJ replacements, using the same modalities that failed, when there may be an appropriate solution available. These patients would be benefit from undergoing alloplastic TMJ replacements knowing that, depending on functional growth, revision and/or replacement surgery may be required in the future, rather than incurring continued failures of autogenous grafting that will very likely also require future surgical intervention [54, 55].

34.5 Case

TC was a 27-year-old female who presented for consultation regarding maxillomandibular orthognathic surgery to manage her OSA. Polysomnography documented an apnea–hypopnea index (AHI) of 31.1/hour. She was prescribed and had been using continuous positive airway pressure therapy (CPAP), but this modality was becoming an issue between her and her spouse (Fig. 34.2).

Fig. 34.3 TC 5 years postoperative clinical and lateral cephalometric images. Note the enhanced airway

After clinical, radiographic examinations, TMJ, and orthognathic workups, TC and her spouse were presented with a treatment plan that included bilateral TMJ replacements with patient-fitted prostheses to increase her posterior vertical dimension and advance her mandible, LeFort I osteotomy to align her maxilla with the mandibular advancement, and an advancement genioplasty. Since she had a Class I, well interdigitated, and stable occlusion, orthodontics was not considered necessary (Fig. 34.3).

After the surgery, TC was able to discontinue the use of her CPAP and her AHI improved to <10/hour. She has maintained her occlusion and AHI for 5 years (Fig. 34.4).

Fig. 34.4 TC 5 years postoperative occlusion and maximum interincisal opening

34.6 Summary

The current literature supports isolated mandibular advancement as an efficacious treatment modality for adult OSA in select patients with mandibular insufficiency [56]. Therefore, based on the evidence cited, alloplastic TMJ replacement appears to provide the most predictable functional and esthetic outcomes for replacement of the TMJ in patients with end-stage disease and pathology resulting in symptoms of OSA.

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