Review Article

The role of alloplastic temporomandibular joint (TMJ) replacement in the management of condylar resorption—a narrative review of the literature

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Background and Objective: It has been hypothesized that condylar resorption is the result of maladaptive articular bone remodeling due to increased or constant temporomandibular joint (TMJ) functional overload surpassing the innate capacity of the local bone and cartilage to adapt to the situation. The literature has consistently demonstrated the successful utilization of alloplastic temporomandibular joint reconstruction devices (TMJR) in the management of end-stage TMJ disease. In light of the safety and efficacy demonstrated by TMJR in such cases over the years, this paper will discuss the rationale, advantages and disadvantages related to the use of TMJR devices for the management of mandibular condylar resorption.

Methods: A review of the pertinent English language orthopedic and TMJ literature on PubMed (pubmed.gov) between the years 1996 and 2021 was conducted using the terms "bone adaptive remodeling" and "TMJ condylar resorption".

Key Content and Findings: Based on the effects of increased or extreme joint overload resulting in a maladaptive remodeling of the TMJ condyle, potential comorbid factors, the severity and activity of the process, as well as patients' desires, the following management options were found and can be considered: no treatment, orthodontics, medical management with orthognathic surgery, disc repositioning with orthognathic surgery and alloplastic TMJ replacement. Based on the relevant literature reviewed, TMJR appears to be a safe and effective surgical option for the management of patients with end-stage condylar resorption.

Conclusions: Based on the literature reviewed for this paper, TMJR is a safe and effective surgical option for the management for both the skeletally mature and skeletally immature patient with end-stage condylar resorption. Therefore, it also appears appropriate for surgeons to consider a management option for condylar resorption such as TMJR that does not depend on a biomechanically compromised, degenerated condyle with documented biological maladaptive capacity under loading functions. Future studies with large condylar resorption subject cohorts should be pursued to further support this management option.

Keywords: Alloplastic temporomandibular joint (TMJ) replacement; temporomandibular joint reconstruction devices (TMJR); condylar resorption

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Introduction

Over 30 years, the literature has consistently demonstrated the successful utilization of alloplastic temporomandibular joint reconstruction devices (TMJR) in the management of end-stage temporomandibular joint (TMJ) disease in skeletally mature patients (1). This paper will discuss the rationale, advantages and disadvantages related to the use of TMJR devices for the management of mandibular condylar

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Table 1 Criteria used for narrative review

Items	Specification
Date of search	12/1/2021
Databases and other sources searched	PubMed.gov
Search terms used	"Bone adaptive remodeling", "TMJ condylar resorption"
Timeframe	1996 to 2021
Inclusion and exclusion criteria	All pertinent papers, English language
Selection process	The author

resorption. The author presents this article in accordance with the Narrative Review reporting checklist (available at https://fomm.amegroups.com/article/view/10.21037/fomm-22-3/rc).

Methods

A review included the pertinent English language orthopedic and TMJ literature between the years 1996 and 2021 cited in PubMed (pubmed.gov) using the terms "bone adaptive remodeling" and "TMJ condylar resorption" (*Table 1*).

Background

Arnett *et al.* stated condylar resorption is the result of maladaptive articular bone remodeling due to increased or constant TMJ functional overload surpassing the innate capacity of the local bone and cartilage to adapt to the situation (2,3).

From their ovariectomized rat studies, Nogami *et al.* and Yang *et al.* concluded that estrogen deficiency and mechanical overloading of the TMJ play a role in the morphologic changes in the mandibular condyle and changes in the osseous microstructure, which are more apparent in areas of poor bone quality (4,5). However, the exact role of estrogen deficiency in TMJ condylar resorption is still undetermined.

While the precise pathophysiology of condylar resorption is unknown, excessive mechanical loading beyond the adaptive capacity of the TMJ remains one of its most acknowledged risk factors. Masticatory functional loading forces subject the load bearing TMJ structures to high degree of mechanical stress (6). The condyle is reactive to loading which is exhibited by bone remodeling that occurs when the condyle is placed under continuous stress (6). This has been demonstrated to occur after orthognathic surgery (7). Higher occurrence of resorption of the subchondral bone was seen in animal studies when TMJ condyles were placed under excessive functional mechanical stress (8-10). Evidence suggests that pathological condylar resorption occurs when functional loading stress exceeds an adaptive remodeling threshold (11).

Frost's Utah Paradigm of Skeletal Physiology examined the adaptive capacity of joints to remodel as well as the outcomes of constant joint overload resulting in maladaptive remodeling (12). When functional loading exceed the adaptive modeling threshold, remodeling increases bone strength and mass (12-16). Where loading remains below that threshold, remodeling stops. This permits bones to become stronger than necessary when dealing with typical loads, this is termed the bone "strength safety factor" (17).

Therefore, when functional loading on a joint exceeds its ability to remodel and adapt the articular cartilage and underlying bone degenerate. This becomes manifested as pain and skeletal dysfunction. On TMJ imaging this process will be appreciated as loss of bony architecture. Clinically, the patient will demonstrate a loss of mandibular posterior vertical dimension, a Class II facial profile, with or without an anterior open bite.

Arnett *et al.* speculated on a number of factors capable of resulting in the decreased adaptive capacity of a TMJ that exhibits both the radiographic and clinical signs of condylar resorption.

These factors were the age of the patient, comorbid systemic illness, endocrine-and immune-related systemic disorders that might disturb bone growth, maturation, and maladaptive bone remodeling (2).

Results

Based on the literature reviewed for this presentation,

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the incidence of TMJ condylar resorption is uncertain ranging from 1–31% (18-20). In a survey of Midwest Angle Society orthodontists, Handelman reported the frequency of condylar resorption was found to be roughly 1 in 5,000 orthodontic patients. Of the cases in this survey, 62.5% had no history of orthognathic surgery, while 37.5% followed orthognathic surgery. While in the literature, the incidence of condylar resorption after orthognathic surgery was reported to be 2–5% (21).

Based on the effects of increased or extreme joint overload resulting in a maladaptive remodeling of the TMJ condyle, potential comorbid factors, the severity and activity of the process, as well as patients' desires, the following management options can be considered.

No treatment/occlusal appliance

If the condylar resorption is no longer is active, especially when the aesthetic affects are acceptable to the patient no treatment could be a possible option. With this option, a full coverage occlusal appliance should be used at night to circumvent excessive parafunctional forces on the TMJ (21,22).

Orthodontics

During the active phase of condylar resorption, concomitant orthodontics is contraindicated as it could hasten the maladaptive bony remodeling process. When in remission, orthodontic management without orthognathic surgery is possible in patients with moderate skeletal and occlusal discrepancies. However, in all condylar resorption cases that progress to necessitating orthognathic surgery, orthodontics is required to align the maxillary and mandibular dentition to achieve maximum dental occlusion following surgery (21).

Medical management with orthognathic surgery

The pharmacologic control of the condylar resorptive process both before and after orthognathic surgery has been proposed (23). The regimen consists of anti-inflammatory drugs such as the nonsteroidal anti-inflammatory drugs (NSAIDs), plus vitamin D and calcium supplementation, as well as an antioxidant diet to increase bone density. It is essential that a rheumatologist who understands condylar resorption prescribe and monitor any biologic medication that may be utilized as part of this regimen (21).

Combined orthognathic and TMJ disc repositioning surgery

Wolford and Gonçalves proposed a protocol for managing condylar resorption with a concomitant dentofacial deformity by repositioning salvageable articular discs to the condyle with an anchor and bimaxillary orthognathic surgery. However, this protocol should only be employed within 4 years of the onset of the signs and symptoms of condylar resorption, and only when there is an undamaged articular disc (24).

TMJ reconstruction

Condylar resorption results in biological, physiologic and biomechanically compromised host condylar bone due to the presence of osteoclastic over osteoblastic activity. So, expecting that compromised articular bone to be stable when utilizing autogenous reconstruction with a costochondral graft (25,26), orthognathic surgery alone (27,28), or distraction osteogenesis (29,30) is naïve to the situation.

Over 30 years, the literature has consistently demonstrated the successful utilization of alloplastic TMJR in the management of end-stage TMJ disease (1). Therefore, consideration should be giving to this surgical option which is not dependent on the compromised biological adaptive capacity of the articulation and the surrounding soft tissues. Understanding that TMJR is a biomechanical rather than biological solution to the management of anatomically distorted, maladaptive or dysfunctional joints resulting from end-stage disease (21,31-34).

Discussion

Condylar resorption management proved to be varied among the experienced TMJ surgeons Alsabban *et al.* (35) surveyed. In this study, 81 patients (81%) had already undergone 1 or more treatments that had failed. Of these, 52% had failed orthodontic treatment; 23% unsuccessful occlusal appliance therapy; 19% had relapsed orthognathic surgery; 9% failed occlusal equilibrations; 7% failed arthrocentesis; and 5% failed arthroscopic surgery.

The surgeon respondents reported managing 45% of these failed cases using a TMJR (39% with patient-fitted devices; 6% with stock devices), 32% with orthognathic

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surgery, 17% with disc repositioning, 14% with another course of orthodontics, 9% only with medications, 6% with arthrocentesis, 6% with discectomy, and 6% with arthroscopic surgery. Some of these patients underwent multiple procedures (e.g., TMJR with orthodontics and orthognathic surgery). The longest follow-up period reported with favorable outcomes was 120 months (40–54.6 months) for all surgeons (35).

Counterclockwise mandibular rotation is always a component of the surgical management of condylar resorption. Expecting the remnant of a compromised deteriorated condyloid process, an avascular costochondral bone graft, a degenerated condyle after orthognathic surgery, or distraction to tolerate this movement which increases Class III lever forces at the TMJ to survive lacks scientific logic (13). The literature demonstrates the long-term stability of TMJR in the management of condylar resorption cases (21,31-41).

The advantages of TMJR in the management of condylar resorption include (I) availability; (II) no autogenous donor site; (III) custom components conform to the given anatomy; (IV) the materials are not susceptible to systemic or local pathology; (V) physical therapy can start early preventing intra-articular adhesions and decreasing muscle pain (41).

The relative disadvantages of TMJR in the management of condylar resorption include (I) cost; (II) potential for material sensitivity, wear; (III) longevity; and (IV) cannot be used in skeletally immature patients (41). See the Tiwana paper in this series for a discussion of this last relative "disadvantage".

The major complications leading to revision and/or replacement reported for TMJR are infection, development of heterotopic bone around the articulation, material hypersensitivity, dislocation and persistent pain in the multiply operated patient (41,42).

Finally, in these cases when discussing device longevity, the issue of quality of life (QoL) must be discussed and considered. Stock TMJR devices have been reported to have a longevity of at least 10 years (43), custom TMJR devices at least 20 years (44), both with patient reported increased QoL. Is the increased QoL more important to the patient than the potential for revision and/or replacement? That is a question only the patient can answer.

Conclusions

Based on the literature reviewed for this paper, TMJR is a safe and effective surgical option for the management for both the skeletally mature and skeletally immature patient with end-stage condylar resorption. Therefore, it also appears appropriate for surgeons to consider a management option for condylar resorption such as TMJR that does not depend on a biomechanically compromised, degenerated condyle with documented biological maladaptive capacity under loading functions. Future studies with large condylar resorption subject cohorts should be pursued to further support this management option.

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Footnote

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