



Comparison of Costochondral Graft and Customized Total Joint Reconstruction for Treatments of Temporomandibular Joint Replacement

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Abstract

Purpose: We review published research on temporomandibular joint (TMJ) total replacement that compares costochondral graft and customized total joint reconstruction (especially TMJ concepts), focusing on effectiveness.

Methods: We searched PubMed databases, including prospective, retrospective, case-control or longitudinal studies and significant statistical analysis. In data analysis, we divided outcomes into 'Acceptable' or 'Non-acceptable'.

Results: There were seven articles found dealing with costochondral graft and 180 patients. The majority of patients had satisfactory treatment outcomes (n=109, 61%). There were six articles including 275 patients using the alloplastic material TMJ concepts. Almost all patients had satisfactory treatment outcomes (n=261, 95%).

Conclusion: Comparing customized total joint reconstruction with costochondral graft, use of TMJ concepts resulted in increased quality of life and fewer complications. In conclusion, we judged that alloplastic material such as TMJ concepts is more effective device in total joint replacement than costochondral graft.

Key words: Temporomandibular joint disorders, Joint prosthesis, Autograft

Introduction

End-stage temporomandibular joint (TMJ) pathology results in anatomic changes and restricted jaw function, requiring total joint replacement. The complexity of TMJ's functional relationship with the local anatomy and masticatory muscles and the technical requirements of implanting a replacement mean that it is incorrect to expect the replaced joint to return to its pre-morbid, fully functional condition[1].

The indications for TMJ replacement include joint ankylosis, rheumatoid arthritis, neoplastic disease, severe osteoarthritis, post-traumatic disorders and congenital disease or syndromes[2]. The purposes of the procedure include the restoration of mandibular function and form, decreased patient disability and the prevention of disease progression[3]. Reconstruction methods include a multitude of techniques, with both autogenous graft and alloplastic techniques as options[4].

The most widely accepted autogenous technique in-

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volves the costochondral graft, which offers biological compatibility, workability, functional adaptability, and minimal additional detriment to the patient. The growth potential of the costochondral graft makes it the ideal choice in children. Potential complications with the costochondral graft include fracture, further ankylosis, donor site morbidity, and the unpredictable growth tendency of the graft[5].

Customized alloplastic material has many advantages over costochondral graft. Of alloplastic materials, TMJ concepts (TMJ Concepts Inc., Ventura, CA, USA) has reliable and predictable results. Unlike costochondral grafts, TMJ concepts does not risk donor site morbidity. As the TMJ concepts can be manufactured individually, there is no need for bending or modification during surgery. Therefore, surgical time is reduced compared to costochondral graft. However, TMJ concepts does not have growth capability, so applications are limited in growing patients[6].

The costochondral graft and customized total joint reconstruction are the most useful techniques in TMJ replacement, but there is no research comparing them. We review published research on TMJ total replacement that compares costochondral graft and customized total joint reconstruction (especially, TMJ concepts), focusing on effectiveness.

Material and Methods

We searched PubMed, in English, for research published between 2000 and 2013, using the following keywords: TMJ replacement, costochondral graft, TMJ concepts. Article like editorials, letters to the editor, experimental studies with animals and short communications were excluded from this review. We included prospective, retrospective, case-control or longitudinal studies and significant statistical analysis. The inclusion criteria are TMJ ankylosis, condylar resorption, and articular changes resulting from previous surgical procedures or trauma. Studies that dealt with deformities and craniofacial syndromes or treatment by means of orthognathic surgery were excluded. Pre-prosthetic reconstruction cases were also excluded.

In data analysis, we divided outcomes into ‘Acceptable’ or ‘Non-acceptable’. ‘Acceptable’ is a satisfactory outcome in TMJ replacement technique. ‘Non-acceptable’ is a regrettable result in reconstruction technique. We dealt with the numbers of patients who underwent joint graft or

replacement. We judged the effectiveness of both costochondral graft and TMJ concepts statistically.

To compare both techniques, above all, we evaluated the quality of life (QOL). ‘Much better’ and ‘better’ were judged ‘Acceptable’ outcomes, and ‘no change’, ‘worse’ and ‘much worse’ were judged ‘Non-acceptable’ results. However, some articles did not mention the QOL. In those articles, we evaluated maximum mouth opening (MMO) or pain score. After total TMJ replacement procedure, an MMO increase to 35 mm was judged an acceptable outcome. Released pain score was also acceptable results. Recurrence in follow-up period and occurrence of any complications were designated ‘Non-acceptable’ outcome. Finally, we extracted the data of only costochondral graft and TMJ concepts, and compared results.

Results

1. Costochondral graft

We found seven articles dealing with costochondral graft according to the inclusion criteria. If the article dealt with other techniques (eg. gap arthroplasty, flap surgery), we included only costochondral graft data (Table 1)[4,7-12]. There were 180 patients meeting inclusion criteria. The majority of the patients had satisfactory treatment outcomes (n=109, 61%).

2. TMJ concepts

We found six articles dealing with TMJ concepts according to the inclusion criteria. If the article presented other materials (eg. Biomet System; Lorenz Microfixation, Jacksonville, FL, USA), we used only TMJ concepts data (Table 2)[13-18]. There were 275 patients meeting inclusion criteria. Almost all patients had satisfactory treatment outcomes (n=261, 95%).

The effectiveness of both techniques was evaluated by percentage score. The comparing results were summarized in Table 3.

Discussion

There are many techniques, developed over the years, for TMJ replacement with both autogenous and alloplastic

Table 1. Studies of costochondral graft

Citation	Study design	Population	Results
Saeed and Kent[4]	Retrospective	57 patients 76 grafts	There is no doubt that CCG reconstruction of the TMJ can produce excellent results.
Villanueva-Alcojol <i>et al.</i> [7]	Retrospective	13 patients 17 grafts	Use of CCG for the reconstruction of the mandibular condyle using the green-stick fracture technique provides optimal results in the surgical treatment of temporomandibular pathology.
Medra[8]	Retrospective	55 patients 85 grafts	Good remodeling in 50 (59%), reankylosis in 8 (9%), resorption of the graft in 21 (25%) and overgrowth of the graft in 3 (4%). Mouth opening was satisfactory (more than 25 mm) in 32 of the 55 patients (58%), unsatisfactory (between 5 and 25 mm) in 10 (18%), and the operation was a failure in 13 (24%).
Vasconcelos <i>et al.</i> [9]	Retrospective	3 patients 4 grafts (arthroplasty 10 patients Alloplastic recon 2 patients)	The articular reconstruction with alloplastic or autogenous grafts, or gap arthroplasty for the treatment of ankylosis is efficient in relation to the postoperative maximal incisal opening, recurrence and articular function.
El-Sayed[10]	Retrospective	12 patients 14 grafts	The author recommends routine use of modified approach for costochondral grafting in TMJ reconstruction.
Tanrikulu <i>et al.</i> [11]	Retrospective	7 patients 9 grafts (gap arthroplasty 8 patients, soft tissue interpositional arthroplasty 9 patient)	Effect of interpositional arthroplasty on postoperative maximal interincisal mouth opening was greater than that achieved using the other methods.
He <i>et al.</i> [12]	Retrospective	33 graft 20 CCG only, 11 CCG with TMF, 2 CCG with MMF	CCG with TMF has good results for ankylosis.

CCG, costochondral graft; TMF, temporalis myofascial flap; MMF: masseter muscle flap; TMJ, temporomandibular joint.

Table 2. Studies of TMJ concepts

Citation	Study design	Population	Results
Wolford <i>et al.</i> [13]	Retrospective	38 patients 69 joints	TMJ concepts/techmedica total joint prosthesis works well long-term.
Murdoch <i>et al.</i> [14]	Retrospective	42 patients 63 joints	It appears that the TMJ concepts patient-fitted system offers improved long-term results
Sidebottom and Gruber[15]	Prospective	74 patients 103 joints	This study provides further evidence for the efficacy and safety of total alloplastic TMJ reconstruction.
Mercuri <i>et al.</i> [16]	Retrospective	58 patients 97 joints	The CAD/CAM patient fitted total TMJ reconstruction system has proved to be a safe and effective long-term management modality in the patient population surveyed in this study.
Mercuri <i>et al.</i> [17]	Retrospective	61 patients 102 joints	The patient-fitted total TMJ reconstruction system continues to be a safe, effective, and reliable long-term management modality for the specific patient population surveyed in this study.
Jones[18]	Retrospective	2 patients 3 joints (Biomet 5 patients)	The alloplastic joint replacements were pleasing but long term review is required.

CAD/CAM, computer aided design/computer aided manufacturing; TMJ, temporomandibular joint.

Table 3. Comparing percentage of costochondral graft and TMJ concepts

	Acceptable	Non-acceptable	Total
Costochondral graft	109 (61)	71 (39)	180 (100)
TMJ concepts	261 (95)	14 (5)	275 (100)

TMJ, temporomandibular joint.

Values are presented as number (%).

materials, offering varying success. In particular, the costochondral graft has been used as an autogenous joint replacement for many years and many authors advocate its use[19]. Because of anatomical and biological character-

istics similar to the mandibular condyle, the costochondral graft has become the most versatile autogenous tissue to replace the TMJ. The costochondral graft consists of an autogenous material with an articular cartilage surface that can resemble the mandibular condyle, and it has the ability to adapt and remold in response to joint function[7].

The TMJ concepts system is custom-made and has the merit of appropriate fit in each patient. This allows maximum contact between the device and the patient's bone, which increases stability, reduces micromovement, and improves its long-term success. It is particularly applicable

for patients who demand replacement of the joint and whose anatomy is often distorted as a result of disease or previous operations. The TMJ concepts prosthesis was particularly designed for these patients[15,17].

Almost all studies cited in this review reported that costochondral graft in TMJ replacement has acceptable outcome and safety. El-Sayed[10] reported 14 costochondral grafts in 12 patients. The mean preoperative mouth opening was 6 mm, improving to a mean 40 mm by six months postoperatively. The author used a modified approach similar to conventional technique. There were no complications. However, other researchers note complications. Saeed and Kent[4] reported 76 costochondral grafts in 57 patients. In that study, there was improvement in both diet and pain, and the mean mouth opening improved. However, 33 grafts developed complications, mostly ankylosis. The authors concluded that costochondral graft reconstruction of the TMJ can produce excellent results, but there is a risk of pain and ankylosis for patients who have undergone multiple surgeries.

Another major concern with the costochondral graft is unpredictable growth, usually excessive[20]. Clinical and radiographic evaluation showed no growth in some cases and excessive growth in other cases. Medra[8] reported 85 costochondral grafts in 55 patients. In those patients, three (4%) grafts developed overgrowth. The risk appears small, but many cases of overgrowth after TMJ replacement by costochondral graft are reported. It is unclear whether the costochondral graft exhibits a primary growth potential or a secondary growth potential in response to a functional matrix[21]. To explain this phenomenon, more research is required.

Costochondral grafts entail risk of donor site morbidity. Villanueva-Alcojol *et al.*[7] noted one patient with right pneumothorax in a series of 13 patients. Costochondral graft has a low rate of complications at the donor site compared to other sites, but complications can always occur. Surgeons should consider precise anatomic structures and have skillful surgical techniques.

Research concludes that replacements via TMJ concepts offer acceptable outcomes and increase QOL of patients. Wolford *et al.*[13] reported 69 joint replacements in 38 patients. After joint replacement, patients' mouth opening increased, pain level decreased, and jaw function improved.

The study concluded that the TMJ concepts total joint prosthesis works well over long term, and is a viable technique for TMJ reconstruction. Sidebottom and Gruber[15] reported 103 joint replacements in 74 patients. In that study, all patients achieved excellent outcomes in pain, mouth opening and dietary score. Reaching the same conclusions, Mercuri *et al.*[16] found that patients who underwent TMJ replacement surgery via TMJ concepts developed improved jaw function and diet, and a diminished pain score. The study had a long follow-up period (range, 60 to 120 months), and showed symptoms improving over time. Murdoch *et al.*[14] reported 63 joint replacement in 42 patients via TMJ concepts in New Zealand. Nearly all patients (40 patients, 91%) reported improved QOL. The author concluded that TMJ concept system offers improved long-term results, and found total joint replacement using the TMJ concepts to be a reliable treatment option for management of end-stage TMJ disease.

However, TMJ concepts is not free from complications. These can include anatomic injury to blood vessels, nerves, or salivary glands. Therefore, surgeons should be very attentive during procedures and need knowledge of anatomic structure of TMJ area. Mercuri[1] noted that as the number of prior TMJ surgeries increases, the lower the subjective outcomes improvement measure. Pain can develop with worsening of TMJ symptoms. Another main complication is heterotopic bone formation. Sometimes, bone surrounding a joint replacement is discovered, leading to restricted jaw movement and pain. Heterotopic bone formation tends to recur and can grow excessively. This complication can be prevented by autogenous fat graft packing[6,22]. Infection is rare, and can be resolved by appropriate antibiotic and proper surgical management protocols. Dislocation can arise from time to time. Murdoch *et al.*[14] found coronoidectomy to be a risk factor for dislocation. The author noted at least two weeks delay for active postoperative physical therapy. Temporary pain and swelling can occur, although these are sequelae, not complications.

In this study, we evaluated the effectiveness of costochondral graft and TMJ concepts for joint replacement. Both techniques have proven efficacy, and are used in many diverse patient populations. Comparing TMJ concepts with costochondral graft, TMJ concepts offers increased QOL and fewer complications. In conclusion, we

judged that TMJ concepts is more effective in total joint replacement than costochondral graft. Although some articles noted complications of TMJ concepts in total joint replacement, outcomes are gratifying when accompanied skilled surgical technique and proper patient management.

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