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Review Article

Do costochondral grafts have any growth potential in temporomandibular joint surgery? A systematic review

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ABSTRACT

Purpose of the study: To assess the growth potential of costochondral graft in temporomandibular joint reconstruction in patients with temporomandibular ankylosis and hemifacial microsomia.

Method: Systematic review after inclusion of articles fulfilling the following criteria: (1) only human studies; (2) patients of temporomandibular joint ankylosis and hemifacial microsomia; and (3) studies with minimum of five cases and with a minimum follow-up for a period of 5 years. The primary outcome measure was the percentage of patients with optimum growth of costochondral graft. Secondary outcomes were any abnormal growth and restoration of function. Delphi's criteria were used for assessing the quality of the included studies.

Result: Only three studies satisfied all the inclusion criteria. A total of 96 costochondral grafts were placed in the included studies. Optimum growth was reported in 54 grafts, undergrowth in 1 graft, overgrowth in 7 grafts, lateral overgrowth in 1 graft and no growth in 1 graft. Graft resorption, reankylosis and sequestration were seen in 21, 8 and 3 cases, respectively. When the Delphi's criteria were applied to the case series for the assessment of quality, majority of the studies could be considered as satisfying at least 50% of the criteria.

Conclusion: There are no randomised clinical trials and the only evidence is in the form of case series that is considered as the lowest level of evidence for any study. No inference can be interpreted regarding growth potential of costochondral graft. Thus, on the basis of available evidence, it can be concluded that use of costochondral graft for temporomandibular joint reconstruction lacks scientific evidence.

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1. Introduction

Autogenous costochondral grafts (CCG) are being used extensively for many years in the temporomandibular joint (TMJ) reconstruction.¹ Although these are universally accepted as gold standard for autogenous reconstruction of TMJ, there is controversy regarding its growth potential.² A single school of thought is missing in the context of success of CCG as a growth centre of mandible. Overgrowth, undergrowth or no growth at all have been reported across the literature with no conclusive outcome.² The objective of the present systematic review was to check and review the existing literature for any uniform outcome regarding the indication of CCGs in TMJ reconstruction.

2. Materials and methods

2.1. Focussed question and study objective

The focussed research question was “Do CCGs have growth potential when used for TMJ reconstruction in patients with TMJ ankylosis and hemifacial microsomia?” The objective of this systemic review was to attempt to fill the void in the literature related to the long-term growth potential of CCGs. This knowledge will provide a basis on which the clinician can make decisions in treatment planning.

2.2. Development of a protocol

To investigate the growth potential of CCGs, an extensive search was done to identify longitudinal studies in humans, in

which follow-up of at least 5 years was conducted. The systemic review was carried out in accordance with the steps of practice based on scientific evidence, and the methodology was adapted to the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analysis).³

2.3. Search methodology

An electronic search was made of published studies using the PubMed, the Cochrane Central Register of Controlled Trials and Embase using specific Medical Subject Headings and keywords. In PubMed, the search was made using the following search terms: CCG, bone graft, rib graft, TMJ, ankylosis, temporomandibular ankylosis, hemifacial microsomia, facial asymmetry individually or in combination. The Embase search was similarly made using same search terms individually or in combination. In addition, the online databases of the “British Journal of Oral and Maxillofacial Surgery”, “Journal of Oral and Maxillofacial Surgery”, “International Journal of Oral and Maxillofacial Surgery”, “Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics” and “Plastic and Reconstructive Surgery” were searched for studies. Hand searches were also done from reference list of retrieved articles.

2.4. Inclusion criteria

Studies were included only if all the following eligibility criteria were met.

1. Only human studies to be included.
2. Studies that included patients of TMJ ankylosis and hemifacial microsomia.

Fig. 1 – Flow chart depicting systematic review of literature with exclusion and inclusion of relevant studies.

3. Studies with minimum of five cases and with a minimum follow-up for a period of 5 years.

2.5. Data extraction

Screening of relevant articles and data extraction was done at two levels by two authors independently (P.M. and S.R.) for the following aspects of the study: Type of study, number of participants/grfts included, duration of follow-up, outcome assessed and other relevant outcomes reported and results of the study. Disagreements were resolved by discussion. If disagreement persisted, the judgement of a third reviewer (V. R.) was decisive.

2.6. Outcome evaluated

The primary outcome measure was the percentage of patients with optimum growth of CCG. Optimum growth was defined as, when after surgery, the chin point remained in the facial midline, and occlusion remained normal, horizontal occlusal plane and labial fissure plane.

Secondary outcomes included were overgrowth, undergrowth, lateral growth, excellent function in terms of mouth opening, aesthetics (midline symmetry), arch coordination, range of mandibular movement, remodelling, restricted movement of the graft, sequestration, resorption of the graft, reankylosis and graft fracture following overload.

3. Results

After eliminating duplicate reports or those reporting previously published results, 988 eligible reports were identified for possible study inclusion (Fig. 1). The vast majority ($n = 918$) were excluded after reviewing abstracts or titles, as they were either reviews or growth of graft was not studied in them. After retrieving the full texts of the pertinent studies ($n = 70$), 58 were excluded due to one or more of the following reasons: mode of growth measurement not described or growth of CCG not studied ($n = 22$), inadequate follow-up ($n = 17$), inadequately done studies ($n = 15$), studies with other interventions like use of activator appliance or distraction appliance ($n = 7$) and review articles ($n = 3$). Out of the remaining 12 studies, 9 were excluded, as they were either single case reports or had less

than five cases.^{1,2,4–10} Only 3 studies satisfied all the inclusion criteria (Table 1). Delphi's criteria were used for assessing the quality of these 3 studies (Table 2).^{11–13}

A total of 96 CCG were placed in the included studies. Optimum growth was reported in 54 grafts (56.3%), undergrowth in 1 graft (1.04%), overgrowth in 7 grafts (7.3%), lateral overgrowth in 1 graft (1.04%) and no growth in 1 graft (1.04%). When the Delphi's criteria were applied to the case series for the assessment of quality, these studies could be considered as satisfying at least 50% of the criteria.¹⁴

4. Discussion

Gillies, in 1920, was the first to describe the use of CCGs for reconstruction of TMJs. Since then, metatarsal heads, fibula and sternoclavicular joints have been used, but CCG is favoured because of its biologic and anatomical similarities to the mandibular condyle. Complications at the donor site are rare and the ribs usually regenerate within a year. CCG is applicable to nearly all the abnormalities of the TMJ, both developmental and acquired.

When CCGs have been used in children, the subsequent growth of the graft has been unpredictable and usually excessive. Clinical and radiographic studies have shown no growth in some patients and excessive growth in others, and the results are unpredictable. However, encouraging functional and cosmetic results have been reported.

The purpose of the present study was to assess whether the CCG has growth potential when used for reconstruction of TMJ growth around 5 years; therefore, accordingly selection criteria for inclusion purpose were formulated. After a systematic review of the published data, only three reports met the criteria set by investigators giving details of fate of CCG. The analysis of these studies showed no promising results although there was optimum growth in more than 50% of the grafts placed. CCG has been studied extensively, but in a more anecdotal way. Most of the studies are either case reports or case series with irregular follow-up. Hence, a single school of thought was missing in context of success of CCG as a growth centre of mandible. The need of this systematic review was hence felt.

Medra et al. reported their results in context of 55 patients, whereas other two studies had 6 and 5 cases, respectively.^{11–13}

Table 1 – Study characteristics of included studies.

Reference of study	Type of study	No. of participants/graft	Duration of follow-up	Outcome assessed	Other relevant outcomes reported	Result	
						Primary outcome	Secondary outcome
Guyuron and Lasa (1992) ¹¹	Case series	6	>5 years	Growth	None	Optimum growth ($n = 0$)	Overgrowth ($n = 4$; 66.7%) Undergrowth ($n = 1$; 16.7%) No growth ($n = 1$; 16.7%)
Perrott et al. (1994) ¹²	Case series	5	>5 years	Linear growth changes	Facial symmetry Jaw motion Occlusion contour	Optimum growth ($n = 4$; 80%)	Lateral overgrowth ($n = 1$; 20%)
Medra (2005) ¹³	Case series	85	7–10 years	Growth	None	Optimum growth ($n = 50$; 58.8%)	Overgrowth ($n = 3$; 3.5%) Resorption ($n = 21$; 24.7%) Reankylosis ($n = 8$; 9.4%) Sequestration ($n = 3$; 3.5%)

Table 2 – Delphi's criteria to assess the quality of case series.

Criteria		Studies		
		Guyuron and Lasa (1992) ¹¹	Perrott et al. (1994) ¹²	Medra (2005) ¹³
1	Is the hypothesis/aim/objective of the study clearly stated in the abstract, introduction, or methods section?	Yes	Yes	Yes
2	Are the characteristics of the participants included in the study described?	Yes	Yes	Yes
3	Were the cases collected in more than one centre?	No	No	No
4	Are the eligibility criteria (inclusion and exclusion criteria) to entry the study explicit and appropriate?	Yes	Yes	Yes
5	Were participants recruited consecutively?	No	No	No
6	Did participants enter the study at a similar point in the disease?	No	No	No
7	Was the intervention clearly described in the study?	Yes	Yes	Yes
8	Were additional interventions (co-interventions) clearly reported in the study?	No	No	No
9	Are the outcome measures clearly defined in the introduction or methods section?	Yes	Yes	Yes
10	Were relevant outcomes appropriately measured with objective and/or subjective methods?	Yes	Yes	Yes
11	Were outcomes measured before and after intervention?	Yes	Yes	Yes
12	Were the statistical tests used to assess the relevant outcomes appropriate?	No	No	No
13	Was the length of follow-up reported?	Yes	Yes	Yes
14	Was the loss to follow-up reported?	No	No	No
15	Does the study provide estimates of the random variability in the data analysis of relevant outcomes?	No	No	No
16	Are adverse events reported?	Yes	Yes	Yes
17	Are the conclusions of the study supported by results?	Yes	Yes	Yes
18	Are both competing interest and source of support for the study reported?	No	No	No

Therefore, results here are influenced by the single study. Out of the 85 grafts placed in the study of Medra et al., overgrowth was reported in 3 cases, reankylosis occurred in 8 cases (9%) and resorption of the graft occurred in 21 cases (25%). The resorption was partial in 10 cases and complete in 11 cases. Partial resorption usually involved the portion of the graft that projected above the residual ramus. Complete resorption occurred mainly in patients with history of multiple recurrences of ankylosis. Reankylosis and resorption of the grafts were the two main causes of the failure. Graft fracture was also reported as a cause of failure of graft. Three patients reported graft fracture in which one was fractured during intermaxillary fixation and other two after release of fixation. The site of fracture was just above the contact point between the ramus and resulted from vigorous mouth opening exercise.

The cause of failure of CCG in Guyuron study was reankylosis in all three cases. Out of these three, two underwent release of ankylosis and alloplastic joint reconstruction, whereas in the study by Perrott et al., 4 out of 5 grafts showed optimum linear growth and 1 showed lateral overgrowth.

5. Conclusion

Out of the 70 relevant articles selected from various search engines, only three articles fulfilled the criteria for inclusion in the systematic review. This drastic reduction in number shows inadequacies of majority of studies in evaluating long-term

growth of CCG in mandibular reconstruction. There were no randomised clinical trials and the only evidence is from case series, which is considered as a low level of evidence for any study; hence, no inference can be interpreted regarding growth potential of CCG. Optimum growth of CCG was evident in more than half of the total grafts placed. The rest showed overgrowth, undergrowth, lateral overgrowth, graft resorption and fracture of the graft. Thus, on the basis of available evidence, it can be concluded that use of CCG for TMJ reconstruction lacks scientific evidence. Also, its unpredictable nature makes it a controversial reconstructing material with variable results.

Conflicts of interest

The authors have none to declare.

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