Fate of Costochondral Graft in Temporomandibular Joint Reconstruction: A Histological Study

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Abstract

Objective To assess the fate of the costochondral graft (CCG) used to stimulate mandibular growth in the management of Temporomandibular joint (TMJ) reconstruction in ankylosis—histologically.

Materials and Methods Ten patients who had undergone CCG grafting for TMJ ankylosis between 1994–2009 in the department of Oral & Maxillofacial Surgery, Tamil Nadu Govt Dental College and Hospital, Chennai and had come back with reankylosis, were surgically explored and the graft along with the ankylotic mass was excised and evaluated histologically. There is no documented human study and clinically it is not possible.

Results Histological evaluation revealed the presence of osseous tissue, fibrous tissue and osteocytes but no evidence of any chondroid tissue.

Conclusion Our study showing the absence of chondroid tissue raises the question on the rationale of CCG in TMJ reconstruction when other interpositional gap arthroplasty can achieve a disease free joint.

Keywords Costochondral graft (CCG) · Temporomandibular joint (TMJ) · Chondroid tissue · Ankylotic mass · Human study

Introduction

Temporomandibular joint reconstruction in the management of ankylosis is the most challenging task. The success of the reconstruction depends upon the satisfactory mouth opening, movement, maintenance of the form [1, 12] and the length of the mandible. In children continuance of the systematic growth of mandible [7] and surrounding tissue is important.

Gillies in 1920 was the pioneer in costochondral grafting (CCG) in temporomandibular Joint (TMJ) reconstruction. Since then different methods were advocated namely metatarsal head, fibula [17], sternoclavicular joint [3] and alloplastic materials [8]. CCG is most commonly used because of anatomic and biological similarity. Another major factor is its role as a growth centre. The donor site morbidity is less [9].

Even though CCG is preferred for their anatomical and adaptive nature there has been complications reported like fracture of graft [13], unpredictable growth [5], over growth or no growth mineralisation [4].

The evaluation of the CCG [12, 16] is done clinically by periodic assessment of the patient for mouth opening, movements and overall facial growth. Anne Raustia et al. [18] of Finland in 1996 evaluated CCG clinically and radiographically (computed tomography) and they found out varying results ranging from lateral over growth, no growth, resorption and graft mineralisation.

There are animal studies of CCG mainly in monkeys [3] and sheep [11] which showed cartilaginous elements on the surface even after 3 years. A study on 20 day old rats [14] showed the graft incompletely joined to the mandible. A British study [11] on sheep showed fibrous connective tissue, cartilage or both and proliferation of chondrocytes at the cartilage bone junction. There are not many human [15]

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histological evaluation of CCG in world literature (Figs. 1, 2, 3).

We, at the Department of Oral and Maxillofacial Surgery, Tamil Nadu Government Dental College and Hospital, Chennai had two patients who presented with reankylosis after undergoing CCG in our institution. We analysed the possible causes for reankylosis despite following Kabans [6] Protocol. We wanted to study the graft along with the ankylosed mass. Histologically we studied 10 cases between 1994 and 2009 who had undergone CCG in our institute and returned with reankylosis.

By this study we tried to assess the fate of CCG histologically.

Fig. 1 Reankylosis after CCG

Fig. 2 OPG showing reankylosis of CCG

Fig. 3 Surgically joint exposed to excise the CCG

Aim of the Study

The main aim of our study was to evaluate the ankylotic mass along with the Costo Chondral Graft histologically and assess the nature of the tissue present. We analysed the graft to evaluate any chondral tissue that was still present or mineralisation that had taken place.

Materials and Method

Period of Study

The 15 years study was carried out in Department of Oral and Maxillofacial Surgery, Tamil Nadu Government Dental College and Hospital, Chennai between 1994 and 2009.

Criteria for selection

We selected only unilateral CCG done in our institution who had come back over a period with reankylosis.

Number of cases

Male	4
Female	6

Age groups

Cases	<8 years	Between 8 and 12 years	Above 12 years
Male	2	2	0
Female	2	3	1

Time gap between CCG and ankylosis

<2 years	Between 2 and 5 years	Above 5 years
5	3	2

Surgical Technique*Costochondral Graft*

1. All cases were approached by Alkayat Bramley incision. The ankylotic mass was excised and glenoid fossa was freshly fashioned using rose head burs with adequate irrigation. In 3 cases the displaced disc was repositioned; we did not go for temporalis myofacial flap in growing children. The surface of the recipient site was decorticated for better bone contact (Figs. 4, 5, 6, 7).
2. By horizontal incision in the submammary region we harvested rib graft from 5th or 6th. Only right rib was taken. The length of the rib ranged from 3 to 5 cm with 0.5 cm of the cartilage. Care was taken to preserve the periosteum and perichondrium. The graft was carried to simulate the condylar head.
3. By submandibular incision the graft was inserted and then oriented on the lateral surface. We tried to maintain adequate distance between the graft and glenoid fossa. The graft was fixed with ligature wire (26 gauge SS). In 3 cases we used screws.
4. Post operatively the patients were on antibiotics for 1 week and they were placed on IMF for 4–6 weeks. Followed up with active and passive exercise.

Fig. 4 Excised CCG with ankylotic mass **Fig. 5** Lamellar bone with empty lacunae and marrow tissue **Fig. 6** Woven bone and fibrous tissue **Fig. 7** Lamellar bone

Excision of Ankylotic Mass with Graft

In all the cases we approached the joint via the preauricular incision. Adequate precautions were taken to avoid any nerve injury. The Graft along with the ankylotic mass was excised.

The space was decalcified with 9 % hydrochloric acid and 1 % sodium acetate over saturated EDTA. The space was divided into three blocks (lateral, central, and medial segments).

Tissue was histologically prepared and stained with Hematoxin and Eosin and was assessed macroscopically and microscopically.

Result

Histological section showed hyalinised eosinophilic areas resembling woven bone with absence of osteocytes. Bone marrow composed of fibrous tissue and vessels were seen. Mostly lamellar bone with numerous empty lacunae and marrow tissue were seen (Figs. 8, 9, 10). In all the cases there was no chondral tissue seen.

Discussion

The rationale for CCG in TMJ ankylosis in a growing child is the anticipated role played by the cartilage to stimulate [[2, 9], 19]] the growth of mandible and surrounding tissue by acting as a growth centre. It is believed that transplanted CCG has germinative cells for cartilaginous growth [15].

Bone is unique because it heals by callous regeneration [2, 15] and production of mineral matrix rather than by just collagen deposit known as scar. A bone graft heals by osseous induction and osseo conduction [2, 9]. The basis of graft uptake between bone and cartilage is different.

Fig. 8 Lamellar bone with empty lacunae and marrow tissue

Fig. 9 Lamellar bone with empty lacunae and marrow space

Fig. 10 Bone with numerous empty lacunae and fibrous tissue

Cartilage grows by interstitial and appositional growth which depends upon adequate nutritional and hormonal background [2, 3]. In a grafted scenario an early neovascularisation is very important. It has been reported that in mammals the ability to regenerate a mass of cartilage is low [11]. The viability of a graft depends upon the recipient bed, preservation of the periosteum and the perichondrium [2, 9].

Multiple other elements such as bone matrix, cytokines, hormones and generated nutrients play a major role. Some believe in blood borne supply of pluripotent cells, osteoblasts and osteocytes to make up volume of the bone graft to ensure its survival [10]. To date no definite system can enhance the natural healing process.

The long term evaluation of CCG is done mainly by radiographic and clinical parameters [4, 18]. Radiographic evaluation of cartilaginous part is very difficult because of its translucent nature and lack of bone mass in paediatric rib which adds to its difficulty [18]. Recent advances in

radioimaging technique have shown encouraging result. But histological evaluation is clinically not possible in humans. Animal studies have shown presence of activity [3, 11].

Our histological study of the ankylotic mass along with CCG excision from patients who had come back with reankylosis is an attempt to understand the nature of chondral activity in humans. All the 10 cases which we studied over a period of time showed hyalinised eosinophilic areas resembling immature woven bone with absence of osteocytes, bone marrow composed of fibrous tissue, and some areas showed mature bundle bone with osteocytes inside the lacunae. But no evidence of any chondral tissue was seen.

Absence of any chondroid tissue in the excised mass raised the question of viability of the chondroid tissue in TMJ region. The vascular bed on which the CCG was activity which is evident in the form of new callus formation while not much chondral activity is seen.

Our study has raised the question of viability of the CCG in TMJ ankylosis when other forms of interpositional gap arthroplasty would achieve a satisfactory result and a disease free joint.

Conclusion

Our study is an attempt to evaluate histologically the chondral activity of CCG in TMJ ankylosis while most other studies are radiological and clinical in nature. Opinions may differ regarding the surgical skill, recipient bed environment, post-operative care, nature of fixation, duration of immobilization and the number of cases taken for study.

Absence of chondral activity has raised the rationale of CCG in TMJ reconstruction when other form of interpositional gap arthroplasty can achieve a disease free joint.

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