Overgrowth of Costochondral Graft in Temporomandibular Joint Ankylosis Reconstruction: A Retrospective Study

Abstract

**Background:** Temporomandibular joint (TMJ) ankylosis is a situation in which the mandibular condyle is fused to the glenoid fossa by bone or fibrous tissue. The management of TMJ ankylosis has a complicated chore, and it is challenging for the maxillofacial surgeon because of technical hitches and high rate of reankylosis. Costochondral graft (CCG) is a common treatment modality for TMJ ankylosis. One of disadvantages of CCG is unpredictability of growth pattern and risk of overgrowth. This report illustrates the fate of CCG used in the TMJ reconstruction and also the management of patients with CCG overgrowth. **Materials and Methods:** A retrospective evaluation of 14 patients presented with unilateral TMJ ankylosis reconstructed using CCG in our hospital from 2000 to 2013 was done. Only patients with unilateral ankylosis treated by CCG with at least 2-year follow-up and complete case records with clinical and radiographic details were included in the study. Patients with bilateral ankylosis, reankylosis, missing details, and the patients with <2-year follow-up were excluded from the study. The patients were selected based on the specified inclusion/exclusion criteria. All the patients were analyzed clinically and radiographically. Facial appearance, jaw motion, occlusion, contour, and linear growth changes were documented preoperatively, immediately postoperatively, and long term (>2 years). **Results:** Totally 14 unilateral temporomandibular ankylosis cases were reconstructed using CCG from the period of 2000–2013. The mean age of the patients is 5.2 years with the standard deviation of 1.48 ranging from 3 to 9 years. Follow-up of the patients ranges from 2 to 6 years with mean follow-up of 3 years. Out of 14 patients, 2 patients had normal growth of CCG after the mean follow-up of 3 years, whereas 5 patients presented with moderate growth, 4 patients with CCG overgrowth, and 3 patients presented with no growth of CCG following surgery. Overgrown CCG was treated with condylar shaving, and orthodontic elastic was maintained to stabilize the occlusion. Moderately grown and nongrowing CCG was treated by internal distractor for the management of facial symmetry. Facial asymmetry and malocclusion were successfully corrected in all patients with altered growth pattern. **Conclusion:** The growth pattern of the CCG is extremely unpredictable, which can be in the form of no growth at all or excessive growth, and mandibular overgrowth on the grafted site can actually be more troublesome than the lack of growth. Care should also be taken to ensure proper postoperative functional therapy and to examine the role of cartilage thickness on future growth in young patients.

**Keywords:** Costochondral graft, costochondral graft overgrowth, reankylosis, temporomandibular joint

Introduction

Temporomandibular joint (TMJ) ankylosis is defined as the bony or fibrotic fusion between anatomic components of the TMJ. Trauma affecting the TMJ often results in hematoma formation, which undergoes reorganization and remodeling, eventually resulting in ossification of the joint.[1] Treatment requires excision of the affected structures and consideration for immediate replacement. Costochondral grafts (CCGs) are used to replace the mandibular condyle in cases of TMJ ankylosis and are generally viewed as a gold standard for autogenous reconstruction of the mandibular condyle.[2] Reconstruction of the mandibular condyle with CCGs in children may result in overgrowth at the reconstructed side of the mandible. The growth pattern of the CCG is extremely unpredictable, and mandibular overgrowth on the grafted site can actually be more troublesome than the lack of growth. Some authors have postulated a direct correlation between the rates of overgrowth with reconstruction at an earlier age or an excessive amount of cartilaginous cap harvesting during procurement although there is no proof for the same.
Literature has varying rate of growth response with CCG in TMJ ankylosis. Such reports stem from reports from a single center with several surgeons and some with single surgeons experience over long period of time. There have been several explanations provided in the literature for this phenomenon. However, till date, no single isolated cause has been delineated and proven. The tendency of variation of the growth of CCG in cases treated for TMJ ankylosis has been poorly documented in this part of the world. The aim of this manuscript is to present the experience of a single center with a single operating surgeon in CCG in TMJ ankylosis cases over a period of 13 years.

Materials and Methods
A retrospective evaluation of 14 patients presented with unilateral TMJ ankylosis reconstructed using CCG treated in our hospital from 2000 to 2013 was done. Only patients with unilateral ankylosis treated by CCG with at least 2-year follow-up and complete case records with clinical and radiographic details were included in the study. Patients with bilateral ankylosis, reankylosis, missing details, and the patients with <2-year follow-up were excluded from the study. The patients were selected based on the specified inclusion/exclusion criteria. All the patients were analyzed clinically and radiographically. Facial appearance, jaw motion, occlusion, contour, and linear growth changes were documented preoperatively, immediately postoperatively, and long term (>2 years). All relevant data were collected from case records. Demographics of patients are presented. Only descriptive statistics was used for the present study.

Surgical procedure
Stage 1
Under general anesthesia, standard surgical preparations were done. The right condylar joint was exposed through a submandibular incision. The ankylosic mass along with the elongated ipsilateral coronoid process was excised creating a 1 cm gap. If the intraoperative maximal interincisal distance with no force was measured as 38 cm, then the need for contralateral coronoidectomy was obviated. From the sixth rib (right side), a CCG was harvested with a cartilage cap leaving the overlying periosteum/perichondrium in the area intact which aids in lining the joint and aids in the retention of the cartilage cap to the rib. Approximately 2–5 mm of cartilage was maintained on the graft to act as the growth center. The harvested graft was interpositioned in the gap created and then fixed to the ramus with the help of two bicortical screws. The intraoperative mouth opening of 38 mm achieved which was maintained postoperatively by physiotherapy.

The patients were maintained on regular follow-up for every 6 months to assess the mandibular growth and mouth opening. Every visit, the clinical image and radiographic analysis was done.

Stage 2 – Overgrowth
Condylar shaving was done in the right CCG, thus correcting the facial asymmetry. Orthodontic elastic was maintained to stabilize the occlusion [Figures 1-7].

Results
Totally 14 unilateral temporomandibular ankylosis cases were reconstructed using CCG from the period of 2000–2013. The mean age of the patients is 5.2 years with the standard deviation of 1.48 ranging from 3 to 9 years. The male and female ratio ranges from 10:4, right side is affected more than left in the ration of 9:5. Follow-up of the patients ranges from 2 to 6 years with mean follow-up of 3 years. Out of 14 patients, 2 patients had normal growth of CCG after the mean follow-up of 3 years, whereas 5 patients presented with moderate growth, 4 patients with CCG overgrowth, and 3 patients presented with no growth of CCG following surgery. The two patients who had stable growth with facial symmetry after the mean follow-up of 3 years necessitated no further treatment. Overgrown CCG was treated with condylar shaving, and orthodontic elastic was maintained to stabilize the occlusion. Moderately grown and nongrowing CCG was treated by internal distractor for the management of facial symmetry. Facial asymmetry and malocclusion were successfully corrected in all patients with altered growth pattern [Tables 1 and 2].

Discussion
Management of TMJ ankylosis in children is dictated by requiring further growth to reduce the risk of further intervention. To achieve this, autogenous graft is often used, of which the gold standard is a CCG. CCG is the...
The most common treatment of TMJ ankylosis in children due to several advantages. The disadvantages of this method are morbidity at the donor site, poor quality, and flexibility of bone which is prone to fracture, possibility of infection, and the most importantly unpredictability of growth.

The CCG is always taken from the chest opposite to the side of the reconstruction so that the best convexity to the graft is obtained to produce the maximum facial width. Unlike other graft, the rib growth continues through adolescence. The cartilaginous growth of rib is nearly linear, with some acceleration during puberty.

In most children, the grafted side grows more than the unaffected side until the two sides become equal, and afterward, the two condyles grow at the same rate; however, overgrowth of the CCG may occur in some cases as in our case, both patients reported with condylar overgrowth.

| Age | Sex | Side involved | Fate of CCG | Clinical picture | Follow-up (years) | Management       |
|-----|-----|---------------|-------------|------------------|-------------------|------------------|
| 5   | Male| Right         | Good        | Facial symmetry  | 2                 | -                |
| 3   | Male| Right         | Moderate growth | Deviation to right side | 3 | Internal distraction |
| 4   | Female| Left         | Moderate growth | Deviation to left side | 4 | Internal distraction |
| 6   | Male| Right         | No growth    | Deviation to right side | 6 | Internal distraction |
| 5   | Male| Right         | Good         | Facial symmetry  | 2                 | -                |
| 5   | Female| Left        | Overgrowth   | Deviation to left side | 2 | CCG shaving          |
| 4   | Male| Right         | Overgrowth   | Deviation to left side | 3 | CCG shaving          |
| 9   | Male| Right         | Overgrowth   | Deviation to left side | 4 | CCG shaving          |
| 5   | Male| Left          | Moderate growth | Deviation to left side | 2 | Internal distraction |
| 6   | Female| Right       | No growth    | Deviated to right side | 2 | Internal distraction |
| 7   | Female| Left         | Overgrowth   | Deviated to right side | 3 | CCG shaving          |
| 5   | Male| Right         | Moderate growth | Deviated to right side | 4 | Internal distraction |
| 5   | Male| Right         | Moderate growth | Deviated to right side | 2 | Internal distraction |
| 4   | Male| Left          | No growth    | Deviation to left side | 3 | Internal distraction |

CCG=Costochondral graft

There are two types of overgrowth reported in the literature: lateral contour or tumor-like overgrowth and linear overgrowth. The type of overgrowth in the presented first patient and also the most commonly reported type in the literature is lateral contour overgrowth diagnosed by a tumor-like mass on the condyle region that can push the chin toward the unaffected side causing esthetic problems and limitations in mandibular movements.

Figure 2: (a) Harvesting of the costochondral graft from the left fifth rib. (b) Marking for submandibular incision approach to the right temporomandibular joint. Costochondral graft (c). Secured to the mandibular angle with titanium screws. (d) 6-month postoperative view showing adequate mouth opening

Figure 3: (a) Post-CCG view at the age of 5 years. (b) Post-CCG view at 10 years follow up showing marked deviation towards left side. (c) Computed tomography showing elongated ramal length and condylar portion indicative of condylar overgrowth. (d and e) Condylar reshaping with excision of overgrown head and excised specimen
Experimental findings of Akbay and Aydogan supported the use of smaller cartilage size as the linear overgrowth supports the role of larger grafts in linear overgrowth.\[^{[11]}\]

During early childhood to age 10, rib 6 grows at a rate of approximately 1.52 mm annually. As puberty approaches, the growth rate accelerates to approximately 2.58 mm per year. By age 17, the growth of rib 6 is 94.9% of its adult size. When considering common ages for Brent and Nagata reconstructions, rib 6 is 71.9% and 78.6% of its adult size at ages 6 and 10, respectively.\[^{[12]}\] This could probably
explain the reason for overgrowth of the reconstructed CCG in our cases, despite there remains a paucity of data regarding cartilaginous growth of the ribs.

In our series, all cases were of unilateral involvement and all showed marked improvement in the functional and esthetic appearance immediately after correction. Only 12 out of 14 patients have developed abnormal growth. One of the main disputes in using CCG is the lack of predictable growth. Eight out of 14 patients had growth deficiency either moderate or complete which could be attributed to poor quality of medullary and cortical bone, the possibility of resorption or infection, bone flexibility, elasticity that may cause the graft to be deformed and to produce occlusal changes with time, and the possible separation of the cartilage from the bone.

When CCG overgrowth is diagnosed, condylar shaving can prevent further unbalanced growth. Possible treatment modalities for cases with facial asymmetry due to CCG overgrowth depend on severity of deviation and its impact on the occlusal plane. When the patient exhibits occlusal cant due to maxillary or mandibular deviation, bimaxillary surgery that includes Le Fort I and/or ramus osteotomy is indicated. In situations with lower severity without skeletal canting, genioplasty with or without adjunctive esthetic surgeries such as fat injection and alloplastic esthetic facial augmentation can be done. After surgery, intermaxillary fixation is not used, but light elastics are applied to control the occlusion, minimize edema in the joint, and provide support to the muscles of mastication. The elastics may be used for 1–2 weeks or longer as required for occlusal control as in our cases. Occlusal harmony was also achieved. Neither the patient had any sign of recurrence or limitation of mandibular movements. Irrespective of the technique chosen by the surgeon, aggressive resection of the bony or fibrous ankylosis segment is crucial to avoid recurrence.

Nongrowing and moderately grown CCG can be treated by distraction osteogenesis using internal distractor which is distracted at the rate of 0.5–1 mm per day, thereby achieving facial symmetry and occlusion.

Corrective surgeries after overgrowth should be postponed until completion of growth to prevent further reankylosis or overgrowth.

**Conclusion**

Management of overgrowth by resection of the condylar cartilaginous head (the presumed growth center) was done to counterbalance any further continued growth. This correction would also lead to increased risk of reankylosis and restricted condylar function. Predicting growth in these cases can be challenging, and it is difficult to decide the area and amount of resection. Care should also be taken to ensure proper postoperative functional therapy and to examine the role of cartilage thickness on future growth in young patients.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

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