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COMPARATIVE STUDY

Sternoclavicular Graft Versus Costochondral Graft In Reconstruction of Ankylosed Temporomandibular Joint

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Abstract

Introduction The temporo-mandibular joint (TMJ) is a complex anatomical structure that is concerned with mastication, deglutition, and speech. Ankylosis of the TMJ occurs when the condyle gets fused to glenoid fossa by bony or fibrous tissue. It is an incapacitating problem, commonly occurring in children and is usually associated with trauma or infection.

Materials and Methods A total of ten patients with written informed consent having TMJ ankylosis (unilateral/bilateral) fulfilling the inclusion criteria were selected for the study and were operated under general anaesthesia with arthrectomy followed by reconstruction of ramal condylar unit with SCG (Group I) or CCG (Group II). Pre-operative and post-operative evaluation assessments were done at regular intervals for maximum mouth opening, range of mandibular movements, and height of ramus.

Results Statistical analysis shows that the increase in maximum mouth opening was found 1.1% higher in Group II (75.9%) as compared to Group I (74.9%). The increase in lateral excursion at affected side was found 1.3% higher in Group I (84.6%) as compared to Group II (83.3%). The increase in lateral excursion at non-affected side was found 10.3% higher in Group I (76.9%) as compared to Group II (66.7%). The increase in protrusive movement was found 17.5% higher in Group II (88.9%) as compared to Group I (71.4%). Six months post-operative height of ramus was found 10.5% higher in Group II as compared to Group I.

Conclusion The present study concludes the superiority of costochondral graft over sternoclavicular graft in terms of growth and function. Continued deliberation between the two grafts with larger sample size and a longer follow-up with multicentric consensus will be required to draw definitive indications of the two grafts.

Keywords Temporomandibular joint ankylosis · Sternoclavicular graft · Costochondral graft

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Introduction

The temporo-mandibular joint (TMJ) is a complex anatomical structure that is concerned with mastication, deglutition, and speech. Ankylosis of the TMJ occurs when the condyle gets fused to glenoid fossa by bony or fibrous tissue. It is an incapacitating problem, commonly occurring in children and is usually associated with trauma or infection [1].

TMJ ankylosis leads to impairment of oro-facial function which may include restricted mouth opening, limited

chewing ability, impairment of speech, compromised oral hygiene, restricted airway problem, and psychological stress disrupting family life; and surgery is the only effective method of correction to restore and maintain normal function [1].

The surgical treatment essentially consists of arthrectomy with or without reconstruction. A successfully reconstructed TMJ should reproduce normal joint structure, provide functional articulation, and permit adaptive growth and remodelling [1].

Sternoclavicular graft (SCG) and TMJ are similar anatomically and physiologically. The head of the clavicle contains layers of cartilage that are similar to the mandibular condyle. The SCJ articulation has a growth centre and an interarticular fibrocartilage articular disc that simulates the meniscus of the TMJ. When a whole joint is used, the two adjacent synovial compartments and the strong fibrous capsule resemble those in the TMJ [2].

Costochondral graft is biologically compatible like any autogenous graft, easily workable, especially when contouring the cartilaginous part to fit into the glenoid fossa. Costochondral graft also has the capability for remoulding into an adaptive mandibular condyle, and there is always a potential at the donor site to grow and regenerate [3].

The present study is an attempt to compare sternoclavicular graft with costochondral graft in reconstruction of temporomandibular joint and their efficacy in terms of function and growth in the management of ankylosed temporomandibular joint.

Materials and Methods

The present single-centre prospective study included ten patients diagnosed with TMJ ankylosis (unilateral/bilateral) fulfilling the inclusion criteria; and those ten patients were divided into two groups of five patients each.

Group I—Reconstruction with SCG
Group II—Reconstruction with CCG

Pre-operative assessment included a thorough history and physical examination to determine the cause of ankylosis, measurement of maximal incisor opening (MIO), photographs, occlusion, and facial asymmetry. Clinical parameters assessed were: mouth opening, lateral excursion, and protrusive movements at day 7, day 30, day 90, and day 180 follow-up. Radiographic analysis included panoramic, cephalograms, posteroanterior (PA) view of chest. CT scan was done in all cases pre-operative and 6 months post-operative to assess the adaptation and growth potential of the graft material. PA chest radiograph was done to assess the thickness of the clavicle or rib, and any abnormality if present (Figs. 1, 2).

Operative Procedure

All the patients were operated under general anaesthesia following strict asepsis.

Alkayat–Bramley incision was used to expose the affected temporomandibular joint. Arthrectomy was performed creating a gap of 1.5 cm, and immediate reconstruction was done as per the group they belong to (Figs. 3, 4).

Reconstruction was done with graft approximately 5 mm shorter than the length of resected segment to maintain the gap between the superior part of the graft (condylar head) and the glenoid fossa (D. H. Perrott et al. Int. J. Oral Maxillofac. Surg. 1994) [4]; in Group I patients, SCG was harvested from the ipsilateral side by using supraclavicular incision, 1–2 cm above the clavicle, and in Group II patients CCG was harvested from the contralateral side by making submammary incision at the fifth or sixth rib, starting approximately 4 cm from the midline.

The grafts were fixed on the lateral aspect of the ramus using at least two 10-mm titanium screws in both the groups.

Temporalis fascia was interposed in the gap and fixed with 3-0 vicryl suture to prevent reankylosis. Layered closure was done.

The muscle layer was closed, and a suction drain was placed and secured with suture. Skin was sutured by giving interrupted sutures using 3-0 black silk. Pressure dressing was given and changed after 12 h for 4–5 days post-operatively.

Post-Operative Assessment

The complications of graft harvest site in both the groups were assessed.

Post-operative radiographs were taken to assess the functional adaptation of the graft at ramus of reconstruction site and gap created between the glenoid fossa and superior part (condylar head) of the graft (Figs. 5, 6).

Aggressive mouth opening physiotherapy was started after the third post-operative day and continued till the patients learnt the exercise and continued it by themselves. Patients were checked on regular follow-ups for at least for 6 months.

Result

In this study, total ten patients with ankylosed temporomandibular joint were recruited and randomized equally into two groups and treated with either sternoclavicular graft (Group I) or costochondral graft (Group II). The outcome measures of the study were maximum mouth

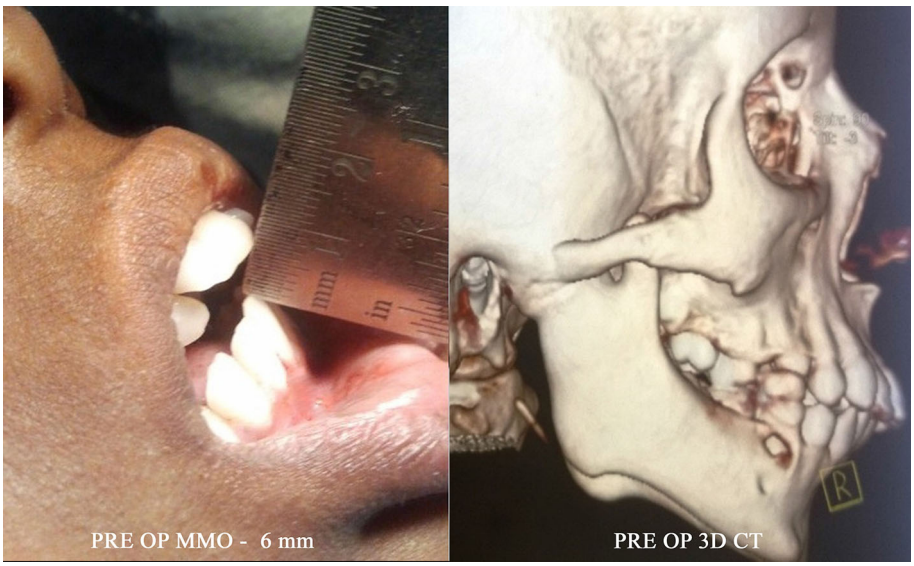

Fig. 1 Maximum mouth opening and 3D CT (before surgery)

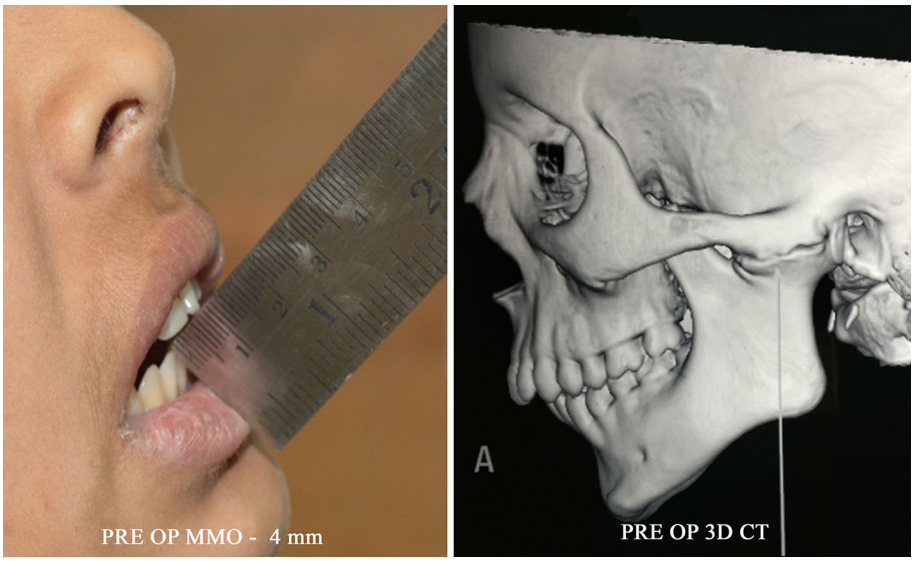

Fig. 2 Maximum mouth opening and 3D CT (before surgery)

opening, lateral excursion affected side and non-affected side, protrusive movement, and height of ramus. The outcome measures were assessed at pre-op and post-treatment (1 week, 1, 3, and 6 months), while the height of ramus was assessed at pre-op and 6 month post-treatment. The objective of the study was to compare the outcome measures between the two groups over the time (Tables 1, 2, 3, 4, 5).

Discussion

Temporomandibular joint is a ginglymoarthrodial joint. This has the capability of translational as well as rotational movements.

Salins described the ankylotic mass as being an abnormal bone that replaces the TMJ and results in restriction of mandibular movement [5].

The impairment of oro-facial function may include restricted mouth opening, limited chewing ability, impairment of speech, compromised oral hygiene, restricted airway problem, and psychological stress disrupting family life [6–8].

The treatment of TMJ ankylosis is surgical, either gap arthroplasty, interpositional arthroplasty, and/or joint reconstruction using autogenous grafts or alloplastic material [9–11].

In the present study, out of ten subjects five (50.00%) were male and five were female (50.0%). Male to female ratio was 1:1.

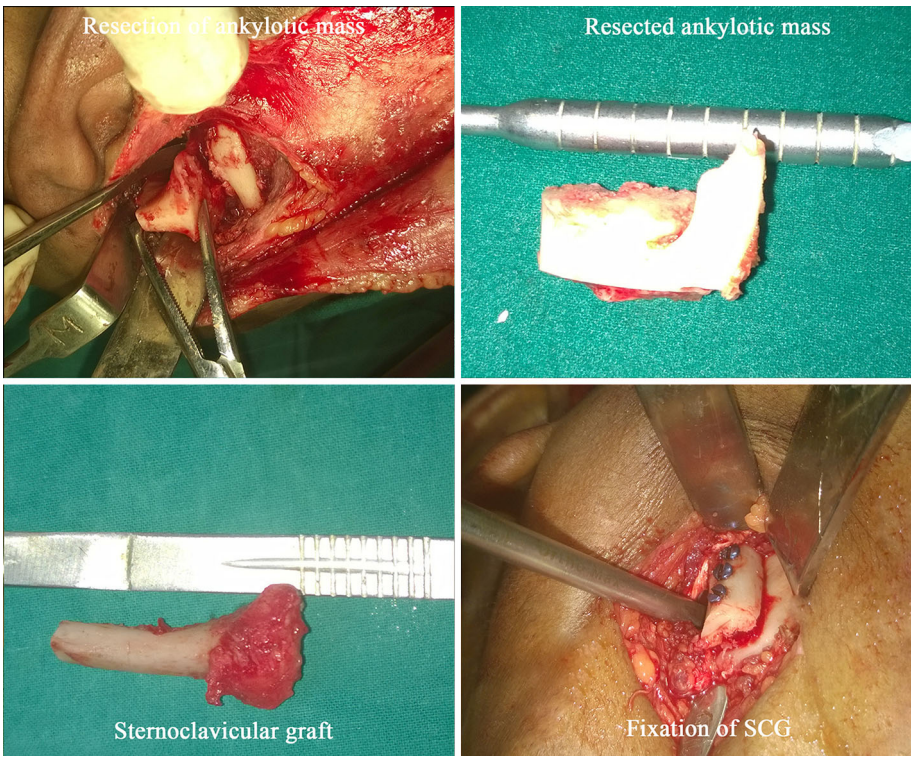

Fig. 3 Resection of ankylotic mass and sternoclavicular graft and fixation of SCG

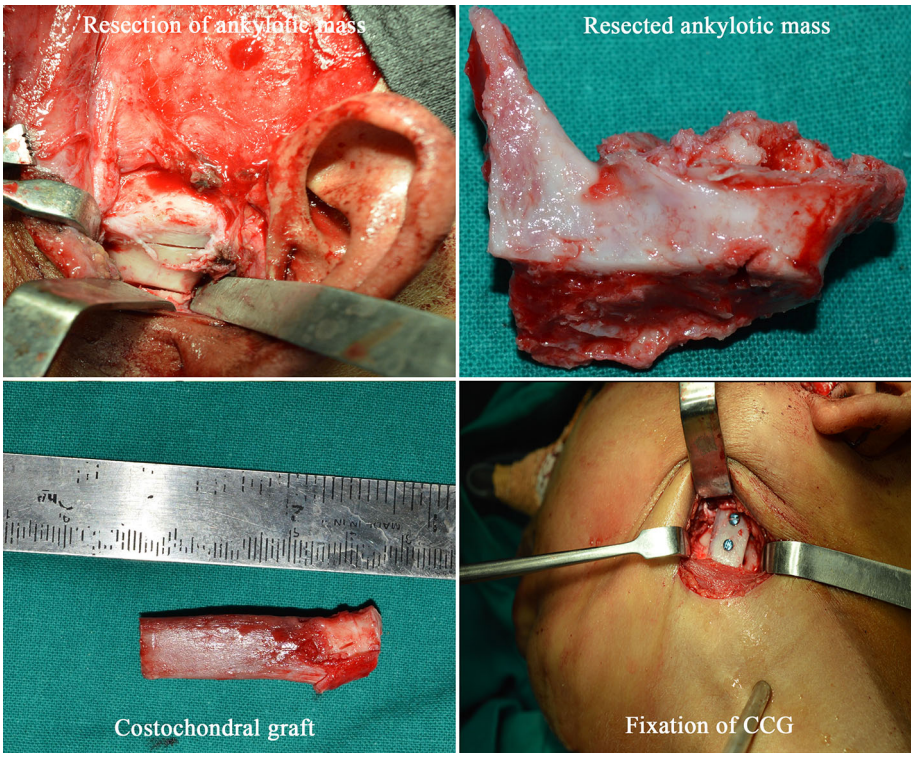

Fig. 4 Resection of ankylotic mass and costochondral graft and fixation of CCG

Age of patients of Group I ranged from 8 to 17 years, with median age of 12 years, while that of Group II ranged from 7 to 15 years with median age of 13 years. Mean age of Group I (13.00 ± 3.61 years) was found to be higher than that of Group II (12.40 ± 1.47) in accordance with study of Güven and Keskin [12].

Left joint was more affected than the right joint, though our sample size did not derive any significant result, but it

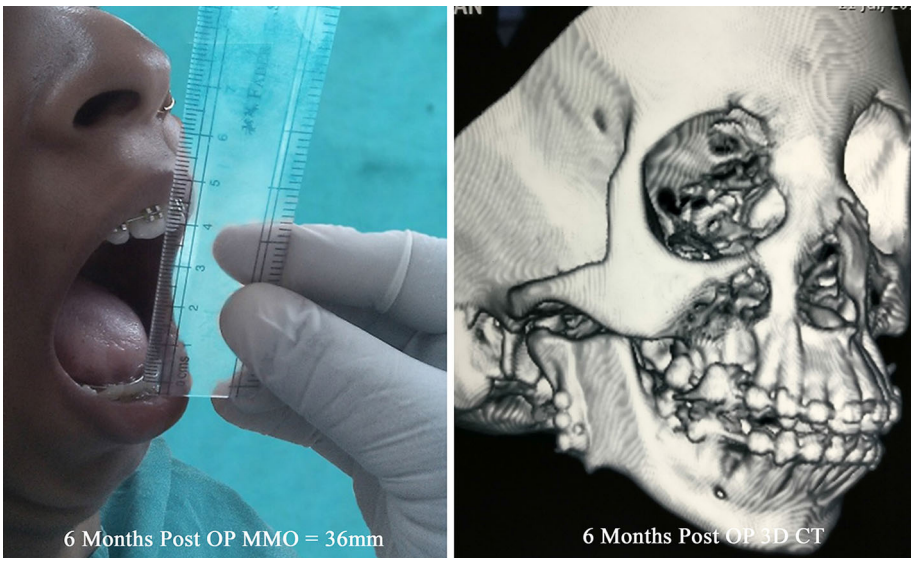

Fig. 5 Maximum mouth opening and 3D CT (6 months after surgery)

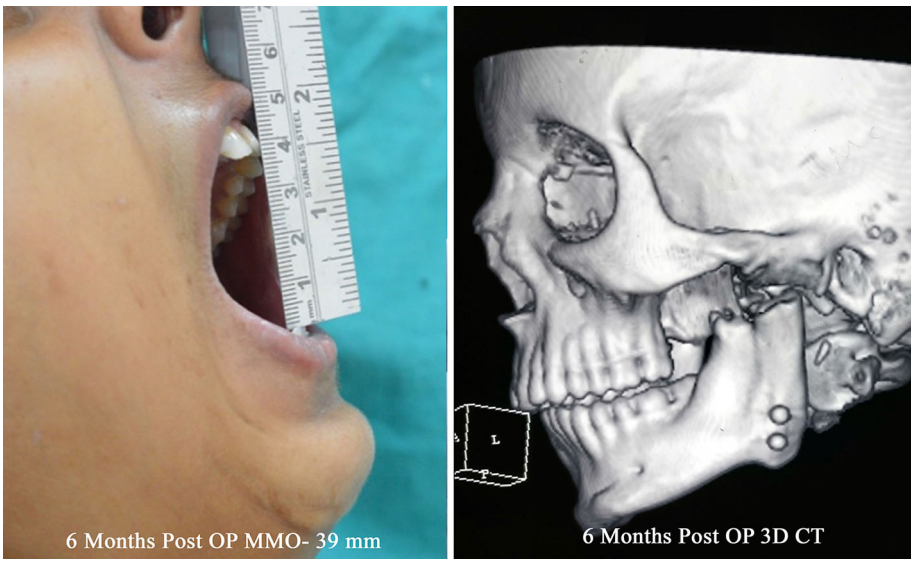

Fig. 6 Maximum mouth opening and 3D CT (before surgery)

Table 1 Pre- and post-maximum mouth opening (mean ± SE, $n = 5$) of two groups over a period of 6 months

Period	Group I	Group II	Mean diff	p value
Pre-op	8.40 ± 1.69	9.20 ± 2.24	0.80	1.000
1 week	23.40 ± 4.07	35.40 ± 0.40	12.00	0.001
1 month	31.20 ± 2.08	36.80 ± 0.73	5.60	0.462
3 months	33.20 ± 0.58	37.00 ± 0.84	3.80	0.882
6 months	33.40 ± 0.75	38.20 ± 0.86	4.80	0.668

Table 2 Pre- and post-lateral excursion at the affected side (mean ± SE, $n = 5$) of two the groups over a period of 6 months

Period	Group I	Group II	Mean diff	p value
Pre-op	0.60 ± 0.60	0.80 ± 0.58	0.20	1.000
1 week	2.60 ± 0.60	2.60 ± 0.40	0.00	1.000
1 month	2.80 ± 0.58	3.20 ± 0.49	0.40	1.000
3 months	3.80 ± 0.72	4.40 ± 0.24	0.60	0.998
6 months	3.90 ± 0.68	4.80 ± 0.37	0.90	0.966

could be due to reflex mechanisms as majority of the population is right handed. Whenever we fall, our body tries to land on our right side, thereby having contrecoup injury to TMJ, which is well supported by Kavin et al. [13].

At all subsequent follow-ups, there was increase in mouth opening in both the groups, although statistically insignificant increase in mouth opening was always greater in Group II as compared to Group I (Fig. 7).

Table 3 Pre- and post-lateral excursion at the non-affected side (mean ± SE, $n = 5$) of the two groups over a period of 6 months

Period	Group I	Group II	Mean diff	*p* value
Pre-op	0.60 ± 0.40	0.60 ± 0.24	0.00	1.000
1 week	1.75 ± 0.63	1.00 ± 0.45	0.75	0.994
1 month	2.40 ± 0.60	1.20 ± 0.58	1.20	0.954
3 months	2.60 ± 0.68	1.40 ± 0.68	1.20	0.941
6 months	2.60 ± 0.68	1.80 ± 0.49	0.80	0.997

Table 4 Pre- and post-protrusive movement (mean ± SE, $n = 5$) of the two groups over a period of 6 months

Period	Group I	Group II	Mean diff	*p* value
Pre-op	0.40 ± 0.24	0.20 ± 0.20	0.20	1.000
1 week	0.60 ± 0.40	0.60 ± 0.24	0.00	1.000
1 month	0.60 ± 0.40	0.80 ± 0.20	0.20	1.000
3 months	0.80 ± 0.49	1.40 ± 0.40	0.60	0.967
6 months	1.40 ± 0.40	1.80 ± 0.49	0.40	0.998

Table 5 Pre- and post-height of ramus (mean ± SE, $n = 5$) of the two groups over a period of 6 months

Period	Group I	Group II	Mean diff	*p* value
Pre-op	45.00 ± 1.76	43.20 ± 1.32	1.80	0.784
6 months	38.00 ± 1.14	41.00 ± 1.10	3.00	0.424
Mean diff	7.00	2.20	–	–
p value	0.022	0.650	–	–

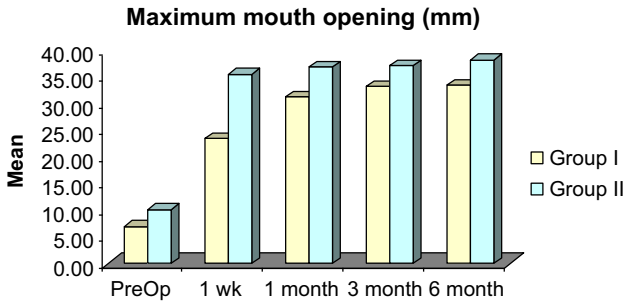

Fig. 7 Pre-operative and post-operative maximum mouth opening

At the final evaluation (i.e. mean change from pre-op to 6 month), the increase in lateral excursion at affected side was found to be 1.3% higher in Group I (84.6%) as compared to Group II (83.3%) (Fig. 8). This finding can be attributed to the fact that the muscles are in a developing state and can respond well to any favourable change in RCU to a better level. Therefore, from the result of this study, it can be assumed that reconstruction of the RCU

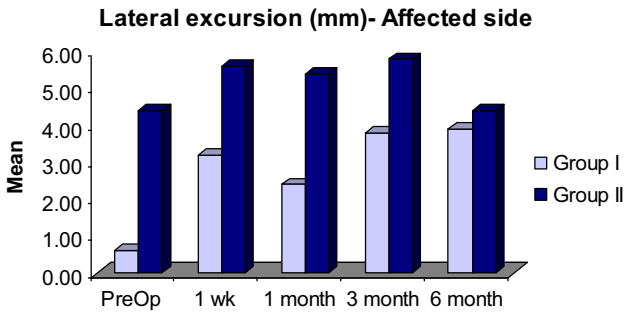

Fig. 8 Pre-operative and post-operative lateral excursion at the affected side

post-arthrectomy avails more favourable results. This can also be attributed to the release of ankylotic mass and, thereby, free translatory movement of mandible on the affected side.

At the final evaluation (i.e. mean change from pre-op to 6 month), the increase in lateral excursion towards the non-affected side was found to be 10.3% higher in Group I (76.9%) as compared to Group II (66.7%) (Fig. 9). This can be due to anatomic resemblance of SCG to the mandibular condyle and probably lateral pterygoid function being regained on the reconstructed RCU.

However, Wolford et al. [14] stated that even with the reconstruction of RCU by total joint replacement, patients can expect a decrease in pain and increase in incisal opening but no significant improvement in lateral excursive movements. The reason for this difference could be the use of autogenous graft for reconstruction, which favours reattachment of lateral pterygoid to improve lateral excursion.

Singh et al. [7] reported that when RCU reconstruction performed using interpositional arthroplasty with SCG, laterotrusive movement was 4.1 ± 1.98 mm towards the affected side and 2.4 ± 0.99 mm towards the normal side.

In our study difference in pre-operative heights of ramus in Group I and Group II was 45.00 ± 1.76 mm and 43.20 ± 1.32 mm respectively. At the 6 month, heights of ramus in

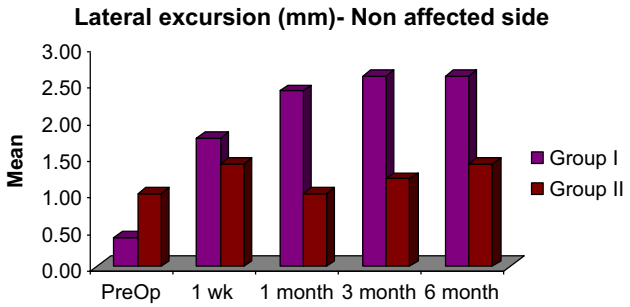

Fig. 9 Pre-operative and post-operative lateral excursion at the non-affected side

Group I (38.00 + 1.14 mm) were found to be lesser than those of Group II (41.00 ± 1.10 mm)..

Elgazzar et al. [11] reported that marked improvement in mouth opening was documented when the ramus-joint complex was reconstructed using distraction osteogenesis (34.7 mm), costochondral graft (34.4 mm) and Surgibone (34.6 mm). Gap arthroplasty showed least satisfactory mouth opening compared with other techniques.

At the final evaluation (i.e. mean change from pre-op to 6 month), the increase in protrusive movement was found to be 17.5% higher in Group II (88.9%) as compared to Group I (71.4%) (Fig. 10).This can be attributed to the fact that CCG has more growth potential as compared to SCG, since the height of the of the ramus achieved was more in CCG group as compared to the SCG group.

On comparing the mean height of ramus of mandible between both the groups, statistically no significant difference was found. However, the height of ramus was found to be 10.5% higher in Group II as compared to Group I (Fig. 11), which may be due to bone-cartilage junction which provides a centre with growth potential.

In this study, none of the cases in either group showed infection, nerve damage, or recurrence post-operatively till 6 months. In the present study, all the cases using the SCG and CCG showed complete regeneration of the clavicle and rib, respectively, during the follow-up.

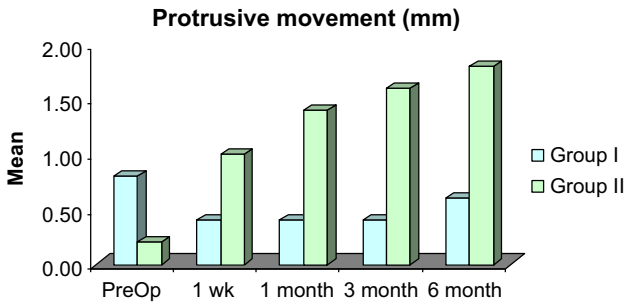

Fig. 10 Pre-operative and post-operative protrusive movement

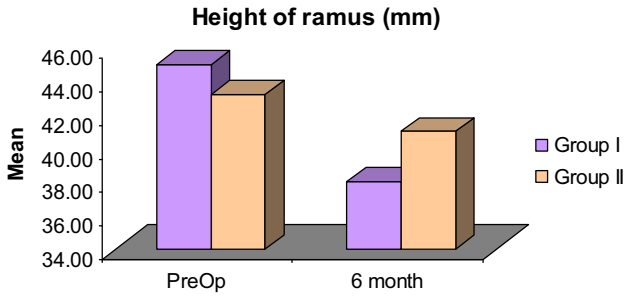

Fig. 11 Pre-operative and post-operative height of ramus

Clinical Implication

In the treatment of TMJ ankylosis, this study favours reconstruction of the RCU for better joint function. Although the procedure is time taking and prone to complications most of which are self-resolving, the results attained with reconstruction of the RCU are more satisfactory and beneficial for the patient.

Conclusion

The assessments of effectiveness of two surgical techniques in interpositional arthroplasty for treating TMJ ankylosis were made on the basis of ease of surgical techniques and post-operative observations. There is an increase in protrusive movement and post-operative mouth opening in patients who underwent interpositional arthroplasty and reconstruction with CCG, while in SCG group lateral excursive movement was greater and adaptive changes could be assessed easily in terms of functional and radiographic outcomes. Increase in height of ramus at 6 month was higher in patients who underwent interpositional arthroplasty and reconstruction with CCG. Thus, CCG is better for younger patients as they require more growth; additionally patients with larger deficiencies in the mandible on the affected side should be candidates for CCG, owing to its higher growth potential.

SCG is an excellent graft where compensation for existing deficiency is not much required. The study also demonstrates increased value of lateral excursion towards non-affected side when using SCG. Although this study suggests superiority of CCG over SCG in terms of growth but lack in adaptability and range of functional movement as compared to SCG, continued deliberation between the two grafts with larger sample size and a longer follow-up with multicentric consensus will be required to draw definitive indications of the two grafts.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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