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***Research Paper***


# Advances in temporomandibular joint reconstruction in TMJ ankylosis : Our experiences and literature review

**Deepak Passi [1]*, Geeta Singh [2], Satyavrat Singh [2] , Gagan Mehta [2] , Shubharanjan Dutta [3] , Sarang Sharma [4]**

[1] *Departmant of Oral & Maxillofacial Surgery, E.S.I.C Dental College and Hospital, Rohini , Delhi, India*
[2] *Departmant of Oral & Maxillofacial Surgery, Faculty of Dental Sciences, King Georges Medical University, Lucknow ,U.P, India*
[3] *Departmant of Oral & Maxillofacial Surgery, Vyas Dental College and Hospital, Jodhpur , Rajasthan , India.*
[4] *Departmant of Conservative Dentistry and Endodontics, E.S.I.C Dental College and Hospital, Rohini , Delhi, India*
**Corresponding author E-mail: drdeepakpassi@gmail.com*

**Abstract**

The treatment of temporomandibular joint ankylosis poses a significant challenge because of the high incidence of recurrence .The only treatment option for TMJ ankylosis is surgical with or without condylar reconstruction. Various grafts are available for condylar reconstruction after removing the ankylotic mass such as costochondral, sternoclavicular, posterior border of mandibular ramus, fibular, coronoid process, and metatarsophalangeal, alloplastic graft like hydroxyappatite collagen and recently condylar distraction osteogenesis. To date, there is no ideal autogenous graft for condylar reconstruction that satisfies the complex anatomy and the myriad of functions of a missing condyle. This study was conducted to determine the efficacy of using the various autogeneous and alloplastic graft and condylar distraction osteogenesis for reconstruction of mandibular condyle.

***Keywords***: *TMJ (Temporomandibular Joint); CCG (Costochondral Graft); SCG (Sternoclavicular Graft); DO (Distraction Osteogenesis).*

## 1. Introduction

Temporomandibular joint (TMJ) ankylosis is characterized by difficulty or inability to open the mouth due to fusion of the temporal (glinoid fossa) and the mandible (condyle), resulting in facial asymmetry/deformity, malocclusion and dental problems. It a disabling condition of the masticatory system leading to growth abnormalities due to the loss of function, especially when it occurs in childhood. Failure to alleviate the ankylosis can result in difficulty in mastication, speech impairment, poor oral hygiene and decrease facial and mandibular growth in childrens and more severly to upper airway obstruction or sleep apnoea.The treatment of TMJ ankylosis possess a significant challenge to maxillofacial surgeons because of its high incidence of recurrence. Treatment of temporomandibular joint ankylosis should meet the following requirements (Politis *et al.* 1987). Restore the vertical and protrusive movements and the laterality of movements of the mandible and an adequate opening of the mouth. Restore and maintain the facial vertical dimension to obtain an adequate dental occlusion. To obtain facial symmetry when at rest and during movements; during and after the period of development of the patient. To avoid the post-surgical re-ankylosis. A 7-step protocol (Kaban *et al.* 1990) has been developed for the treatment of TMJ ankylosis: (1) aggressive resection of the ankylotic segment, (2) ipsilateral coronoidectomy, (3) contralateral coronoidectomy when necessary, (4) lining of the joint with temporalis fascia or cartilage, (5) reconstruction of the ramus with a CCG, (6) rigid fixation of the graft and (7) early mobilization and aggressive physiotherapy.
The treatment of TMJ ankylosis is always surgical .i.e surgical resection of ankylotic bone with creation of 1- 1.5 cm of gap , followed by physiotherapy. To avoid post ankylotic deformity, deviation and considering normal growth, reconstruction should be done. Various grafts are available for condylar reconstruction after removing the ankylotic mass such as costochondral, sternoclavicular, posterior border of mandibular ramus, fibular, coronoid, and metatarsophalangeal, alloplastic graft like hydroxyappatite collagen and recently condylar distraction osteogenesis. The main contribution of condylar reconstruction is to decrease lateral deviation and improve stability.

## 2. Case series

This study was conducted in selected healthy male and female subjects of TMJ ankylosis who visited the outpatient department of Oral and Maxillofacial Surgery, King George's Medical University, Lucknow, India , irrespective of their cast, creed, sex and socio-economic status, between age group 14 to 21 year, were included in the study. Pre informed consent was taken from all the subjects undergoing in the study. All were thoroughly examined clinically and routine haematological investigations. Our operative protocol included excision of bony mass through alkayat-bramley incision followed by immediate reconstruction. All the patients' underwents interpostional gap arthoplasty followed by reconstruction using planned graft under G.A

**Group 1:** (8 Cases) Reconstruction using Sternoclavicular graft (S.C.G).

**Fig. 1:** Harvested Sternoclavicular Graft

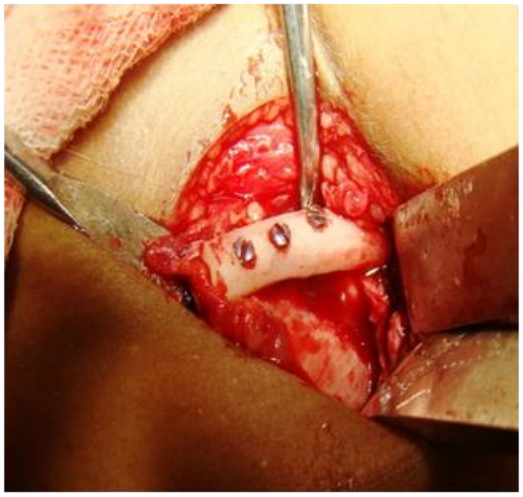

**Fig. 2:** Graft Shaped and Fixed to Posterior Border of Mandible.

For SCG grafting, surgical exposure was usually by combined alkayat-bramley and submandibular incisions. After complete removal of ankylotic mass, gap of about 1.5 cm was created. The SCG was harvested, shaped and fixed to the lateral border of the ramus by 3-4 screws (Fig. 1 and 2). Temporalis fascia was used as a soft tissue interpositional material between the glenoid fossa and the SCG.

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**Group II:** (10 cases) Reconstruction using autogenoue coronoid process.

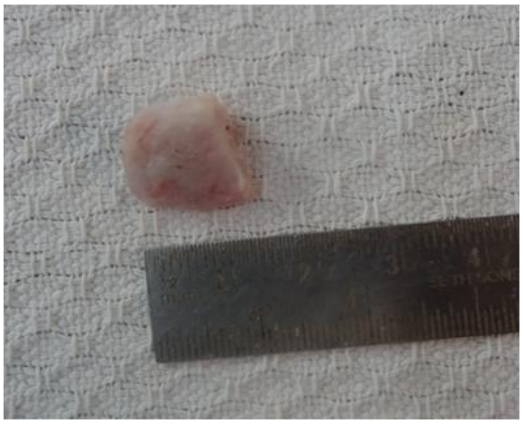

**Fig. 3:** Harvested and Shaped Coronoid Process

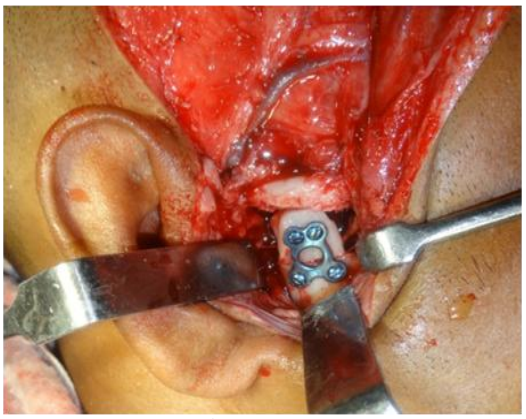

**Fig. 4:** Coronoid process Graft Fixed with Condylar Trapezoidal Plate.

After creating gap of 1.5 cm using alkayat-bramley incision, the coronoid process was removed from the same surgical field and used for condylar reconstruction. Coronoid process was detached using straight fissure bur through postage stamping technique. The length of the graft was trimmed according to the original height of the ramus .Coronoid graft was shaped like a condyle of required and measured size. The final position of the coronoid process in the glenoid fossa was determined by the position of the ramus when the teeth were placed into occlusion. Then it was fixed to superior part of ramus using condylar trapezoidal plate.(Fig. 3 and 4). Temporalis muscle is reflected and rotated to interpose between graft and glenoid fossa. The elongated coronoid process thus is expedient to restore the height of the mandible ramus.

**Group III:** (10 cases) - Reconstruction using Preshaped Hydroxyapatite collagen block .

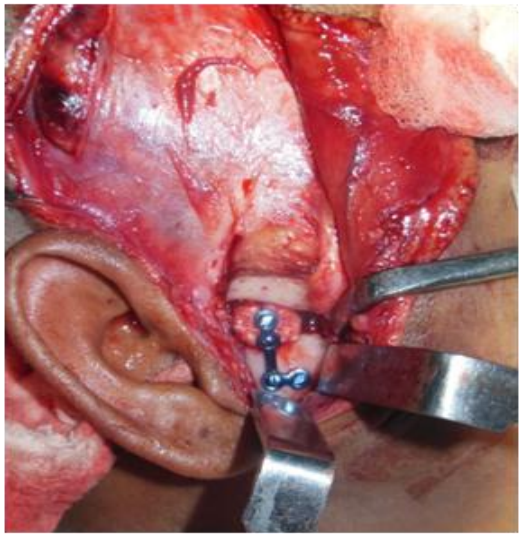

**Fig. 5:** Hydroxyapatite Collagen Block Shaped and Fixed with L Plate.

After gap arthroplasty, a sufficient amount of gap was created. Hydroxyapatite collagen block which was preshaped simulating condyle with platelet-rich plasma was fixed to ramus with titanium 4 hole L plate and temporalis fascia was placed in between block and glenoid fossa (Fig.5). Preshaped hydroxyapatite/collagen condyles as carriers for platelet-rich plasma providing scaffold for bone/neocondyle formation.

**Group IV:** (8 cases) Reconstruction using Condylar transport distraction osteogenesis

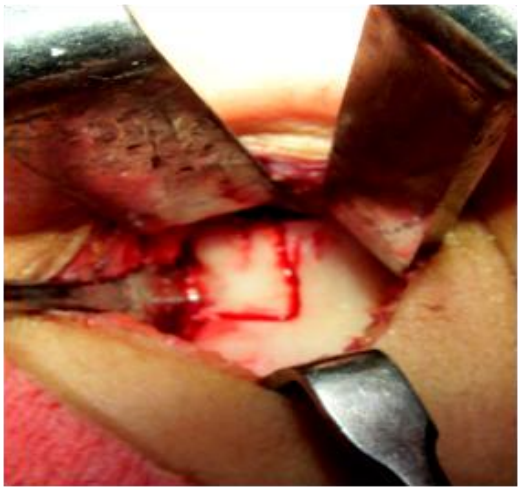

**Fig. 6:** Inverted L Shape Osteotomy

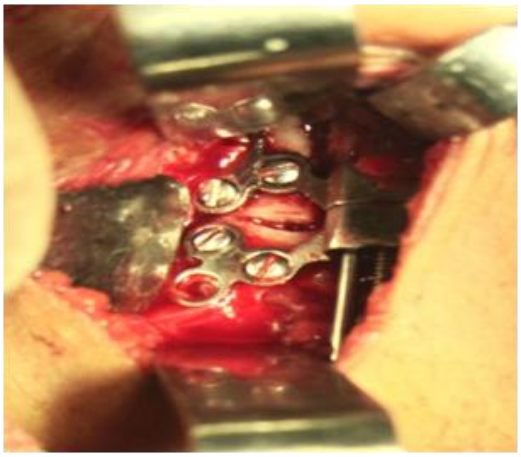

**Fig. 7:** Distractor Fixed on Both Ramus and Transport Disc.

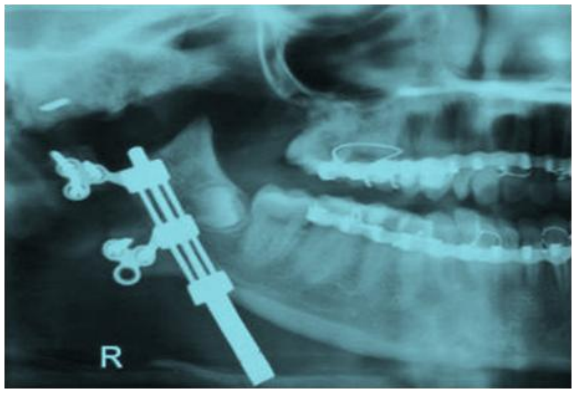


**Fig. 8 :** X-ray OPG after Distraction.

The technique involves creating a transport disc of bone from the ramus of the mandible with an L-shaped osteotomy whilst preserving the medial periosteum and muscle attachments to ensure an intact blood supply. The transport disc, after a latency period of 7 days, is advanced 1.0 mm/day (0.5 mm twice daily) until contact is made with the glenoid fossa and proper ramus height is established. The distraction device is then held in place for 5 weeks until there is radiographic evidence of mineralisation at the trailing edge of the transport disc resulting in bridging of the defect without the need for bone grafting. The leading edge of the transport disc tends to remodel and become rounded to form a neocondyle (Fig. 6,7,8).

## 3. Discussion

The treatment of temporomandibular joint ankylosis poses a significant challenge because of the high incidence of recurrence. TMJ reconstruction remains one of the most challenging tasks faced by maxillofacial surgeons, with a variety of autogenous and alloplastic techniques available.Various autogenous grafts are available for condylar reconstruction after removing the ankylotic mass such as costochondral, sternoclavicular, fibular, coronoid, and metatarsophalangeal.Autogenous costochondral and Sternoclavicular graft have been used as a gold standard in reconstruction of TMJ ankylosis for many years. Their bony part used to replace the condylar neck or ramus and to affix graft to mandible while cartilagenous portion rest in existing or newly created glenoid fossa. Autogenous grafts has a significance influence on mandibular growth and have specific characterstic of growth capacity. Direct exposure of medulary bone of the graft to adjacent soft tissues may facilitate integration of the graft to systemic growth stimulating or inhibiting process mediated via blood vessel, growth prediction of non-vascularised graft cannot be predicted.

The Sternoclavicular joint and TMJ are similar anatomically and physiologically. The head of the clavicle contains layers of cartilage that are similar to the mandibular condyle. The Sternoclavicular joint articulation has a growth centre and an inter articular 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. Its absence is also of no great anatomical, functional, or aesthetic consequence. Complete regeneration of the clavicle at the donor site has also been reported, significantly reducing patient morbidity postoperatively (Daniels et al. 1987).

SCG is morphologically and histologically is very similar to condyle throughout the growth process but many authors consider that there are no significant differences in the potential for mandibular growth between reconstructions with sternoclavicular and with costochondral grafts. This graft in addition to thier potential has some disadvantage specialy related to abnormal growth pattern and relapse (Divya et al. 2011).

Costochondral graft is preferred by surgeons for reconstruction of the mandible for growing patients, defending that growth capacity is compatible with the ascending branch of the mandible. Their bony part is used to replace the condylar neck and ramus and to affix the graft to mandible while the cartilaginous portion occupy newly constructed glenoid fossa. The bone cartilage junction provides a centre with growth potential.

Autogenous grafts have been tested over time and are the most commonly used grafts for condylar reconstruction. The most significant attribute of autogenous tissues is that they are not intrinsically harmful. They enjoy almost universal host acceptance with low rates of rejection, resorption and infection, and are easily workable at the operating table. Either hard or soft, they are adaptable to their host sites, and once in place generally adapt and remodel appropriately to the stresses put upon them. Their harvest entails discomfort at the donor sites, but seldom leaves patients significantly compromised.

Immediate Autogenous coronoid process graft is another option for condylar reconstruction , using Temporal muscle myofascial flaps or native articular disc was as an interpositional tissue and showed to be suitable bone resource for graft (Zhu *et al*. 2008). Recently coronoid process as free autogenous bone graft for repairing defects in the TMJ ankylosis has been extensively applied owing to its fitting dimension and thickness. Also surgical management of excision of the ankylosed joint alone is usually insufficient to provide a satisfactory improvement in mouth opening; because longstanding ankylosis predisposes to fibrosis of the masticatory muscles, additional coronoidectomy is necessary in most patients. If the coronoid process is not involved, then it can be used as a graft, because of its easy accessibility, the good shape and thickness of the graft and its corticocancellous nature. Added

advantage is no donar side morbidity and both surgery and graft harvestment can be done through same incision.
As these are free, non-pedicled grafts, there is eventual resorption with subsequent decrease in height of the ramus, facial asymmetry and deviated mouth opening. Autogenous coronoid process pedicled on temporal muscle grafts used as reconstruction and showed apparent improved joint function, less bony resorption and better long-term clinical outcomes (Liu et al. 2010). Another option is use of total and partial sliding vertical osteotomy on the posterior border of the mandibular ramus for reconstruction of the mandible condyle as a pedicled graft for the correction of temporomandibular joint (TMJ) ankylosis and showed apparent improved joint function with no cases of re-ankylosis (Liu et al 2011).
The role of alloplastic materials for TMJ reconstruction needs to be reassessed in light of recent literature showing excellent long-term functional outcomes, which reflect advances in prosthetic materials and surgical technique. Hydroxyapatite block used for reconstruction after gap arthroplasty. A preshaped hydroxyapatite collagen condyle with platelet-rich plasma fixed to the ramus with a titanium miniplate, and temporal fascia was placed in between . Results shows improves both aesthetics and function (Divya et al. 2012). Radiographic evaluation at 3 months showed a less opaque condyle, but the opacity at 18 months was more defined, suggesting a newly formed condyle. The potential disadvantages of alloplastic reconstruction relate mainly to wear or failure of the material. Wear particles can generate a giant cell foreign body reaction with potential loosening of the implant, resulting in occlusal change or displacement or fracture. Other problems relate to long-term stability, cost, dystrophic bone formation, and lack of growth which precludes the use of such joints in children (Kent et al. 1994, Mercuri et al. 2000).
Custom-made total joint prostheses for TMJ reconstruction , custom-made prosthesis, made with orthopaedically proven structural materials, in combination with autogenous peri-implant fat grafting significantly improved the predictability and success rates of treatment for the rehabilitation of complex TMJ patients with inflammatory diseases, connective tissue/autoimmune diseases, ankylosis, tumors, or absence of TMJ structures (Larry et al. 2000 ) (Fig. 5).
Total alloplastic TMJ reconstruction prosthesis definitely have a place in the armamentarium of the experienced TMJ surgeon. They have been in the past, and will continue to be in the future important modalities in the management of the severely degenerated, anatomically mutilated, functionless TMJs. The increase in the quality of life these patients gain post implantation is akin to that found in the orthopedic population with peripheral joint implants. With continued research and development, these devices will become more functionally stable, providing patients with long term success.

**Fig. 9:** Custom-Made Total Joint Prostheses

Condylar transport distraction osteogenesis has been applied to reconstruction of the ramus-condyle unit with promising early results suggesting it may ultimately become the standard of care in selected patients providing a cost-effective approach with low morbidity and excellent functional outcomes (Divya et al. 2012)
McCormick was the first to report the use of DO for the reestablishment of the condyle in two cases in 1997. It was demonstrated that the condylar process is reconstructed by the L shaped transported segment prepared at the posterior ramus, and asserted that the articular disk is re-established with fibrocartilagenous tissue, surrounding this transported segment during the distraction process (Stucki McCormick et al. 1997) .Recently, clinical and experimental studies about the reconstruction of the structure and the function of the TMJ with DO have been reported. Experimental studies also revealed the remodeling of the transported disk to the neocondyle. Histologically, the pseudodisk formed by fibrocartilagenous tissue is shown. However, it is stated that the thickness of this fibrocartilagenous tissue is 1/10 of a normal disk.
TMJ Stem cell biology and tissue engineering is another budding field which has shown promising results in animal studies but has not been applied to humans. Recently, stem/progenitor cells have been identified in TMJ disc and condyle, with potential origin from neural crest cells in development. With the recent advances in the understanding of stem cell biology and biomaterials, it is more and more promising to construct a bioengineered TMJ replacement that is bio-compatible and capable of withstanding the physiologic loads required of this joint using three critical elements i.e stem cells, scaffold and bioactive molecules. Jaw Bone (Condyle) has been Grown from Adult Stem Cells. Tissue engineering and the burgeoning field of biomimetics, replacement of tissues and organs with biologically engineered tissues, organs and other body parts including joints, certainly have the potential for altering the way surgeons will deal with joint reconstruction in the future. Although there is definitely a future for engineered grafts, their routine clinical application is a long way off (Katja Mäenpää et al. 2010).

## 4. Conclusion

The myriad of available TMJ reconstructive options reflect the fact that it remains an evolving field. Although no gold standard currently exists, the various techniques each have their own proponents and potential advantages and drawbacks. Although with the the inherent property of growth potential, autogenous CCG and SCG, biological behaviour of these graft that can cause problems including overgrowth, resorption, and particularly recurrent ankylosis. Alloplast can mimic normal anatomy and restore vertical dimension.There is no donor site morbidity and immediate physiotherapy can be given although they have no growth potential. Ultimately, the reconstructive surgeon must consider the ablative defect and underlying pathology, the needs of the individual patient, the resources of the providing institution and the capabilities of the surgical team.

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