Ramus Condyle Unit Reconstruction Using Vertical Ramus Osteotomy in Temporomandibular Joint Ankylosis

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Abstract

Introduction Treatment of bony Temporomandibular Joint (TMJ) Ankylosis includes release of the ankylosis and creation of a gap with or without insertion of interposing material and complete reconstruction of the joint using e.g. costochondral, autogenous coronoid/ankylosed mass, sternoclavicular, clavicular bone grafts etc. As these are non-pedicled grafts, there is eventual resorption with subsequent decrease in height of the ramus, facial asymmetry, deviated mouth opening and reankylosis. The authors have applied the method of *vertical ramus osteotomy* (VRO) on the posterior border of the mandibular ramus for reconstruction of the ramus condyle unit (RCU) as a pedicled graft along with *Myofascial Temporalis Interposition* for the correction of TMJ Ankylosis.

Materials and methods Ten patients of TMJ Ankylosis were included in this study. All ten patients were treated using VRO for the RCU reconstruction with posterior border of mandibular ramus after Gap Arthroplasty. Temporalis myofascial flap was used as an interpositional material in all patients. Patients were followed from 20 to 30 months (mean 24 months).

Results As a result of successful procedure the post-operative maximal mouth opening of 32–45 mm (mean 37 mm) was achieved. No patient experienced pain and infection at surgical site. None of the patients had graft rejection and reankylosis at follow-up.

Conclusion The results showed that VRO on the posterior border of the mandibular ramus seems to be an alternative and promising method for RCU reconstruction in patients with TMJ Ankylosis.

Keywords Temporomandibular Joint Ankylosis · Posterior border of ramus · Vertical ramus osteotomy · Myofascial temporalis · Reconstruction

Introduction

The term “*Ankylosis*” is of Greek origin and means “stiff joint”. Temporomandibular Joint (TMJ) Ankylosis is bony or fibrous adhesion of the anatomical joint components characterized by formation of an osseous, fibrous or fibro-osseous mass fused to the base of the skull with ensuing loss of function and partial to almost complete inability to open the jaws and is primarily caused by trauma, infection or failed surgery [1, 2]. When this occurs during development, it results in an alteration of the normal potential growth which leads to mandibular micrognathia, facial asymmetry and reduction of the normal functional spurs necessary for the development of the whole maxillofacial complex [2].

Treatment options for TMJ Ankylosis aim at restoring joint function, restoration of proper mandibular length and form, improving the patient’s aesthetics and quality of life, preventing re-ankylosis and achieving normal growth and occlusion in the child [1, 3]. Preservation of this joint or construction of an artificial one that functions properly is of prime importance [3, 4]. Several methods have been used for the treatment of TMJ Ankylosis including release of the ankylosis and creation of a gap with or without insertion of interposing material and complete reconstruction of the

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joint and correction of jaw deformities. Several *autologous bone grafts* are used to reconstruct the ramus-condyle unit (RCU) including metatarsal head, costochondral, sterno-clavicular, iliac crest, clavicular bone grafts etc. [3–5]. Resected elongated coronoid process and excised ankylotic mass have also been tried [6]. As these are *non-pedicled grafts*, in the long term they may lead to resorption with subsequent decrease in height of the ramus, facial asymmetry, deviated mouth opening and reankylosis. Furthermore, these procedures suffer from several drawbacks repeatedly stated in the literature, such as the need for second surgical sites, growth unpredictability and donor site morbidity [7]. Joints reconstructed with *alloplastic materials* have experienced infection and wear and/or failure of the material, particles generating a giant cell foreign body reaction with potential loosening of the implant resulting in occlusal change, displacement or fracture, high cost, dystrophic bone formation, and lack of growth, which precludes the use of such joints [8].

Posterior border of the mandibular ramus has been used as a pedicled graft for condylar reconstruction in maxillofacial surgery for a long time. The posterior mandibular border as a free bone graft for condylar reconstruction was reported by Colburn and Epker [9] in a patient with myxoma of the mandibular condyle. Loftus et al., Akiyuki et al. and Gonzalez-Otero et al. [10–12] reconstructed the condyle by superior repositioning of the pedicled stump of the proximal condylar segment into the condylar fossa as a local osseous pedicled graft based on the internal pterygoid muscle in cases of osteochondroma.

Vertical ramus osteotomy (VRO) for reconstruction of the RCU in TMJ Ankylosis corrects the function, morphology of the orofacial structure, is safe, effective and less invasive [13, 14]. Thus exploration of two surgical sites, donor site morbidity and graft resorption are readily avoided [12] Taking these advantages into consideration a study was carried out in the Oral and Maxillofacial Surgery

Department of our institution on ten patients with TMJ Ankylosis with the aim to evaluate the feasibility of VRO on the posterior border of the mandibular ramus for reconstruction of the RCU.

Materials and Methods

In the present study, ten cases were selected amongst the patients of *bony* TMJ Ankylosis with *prominent antegonial notch* attending the Department of Oral and Maxillofacial Surgery at our institution. This study was approved by our Institutional Ethical Committee and Review Board.

Pre-operative preparation of the patient included detailed history, complete clinical examination; radiological examination including orthopantomogram (OPG), CT scan, frontal and lateral photographs with maximal mouth opening (MMO) were done.

Alkayat and Bramley (Fig. 1a) approach along with *submandibular approach* was used for resection and reconstruction in all patients with identification and preservation of facial nerve and its branches. Ankylosed mass was exposed (Fig. 1b) and two (lower and upper) bony cuts oblique and parallel made with the help of drills, chisel and mallet, saw (Fig. 1c, d) such as to create a gap of approx. 1–1.5 cm (Fig. 2a) safeguarding the internal maxillary artery, inferior alveolar artery and preventing damage to middle cranial fossa. Any sharp margins of main ramal stump were smoothened. The glenoid fossa was prepared for reception of graft. The elongated coronoid process of the affected side was excised if needed. Mandible was mobilized to visualize and ascertain its free and smooth movement without resistance and minimum intraoperative mouth opening of 3.5 cm was achieved (minimum). MMO was <35 mm in two cases for which contralateral coronoidectomy was performed.

Fig. 1 a Alkayat–Bramley incision placed. b Exposed ankylotic bony mass. c Lower cut placed. d Upper cut placed

Fig. 2 **a** Gap of approx. 1–1.5 cm created. **b** Total vertical ramus osteotomy cut placed parallel to posterior border of ramus through sub-mandibular approach. **c** Sliding reconstruction of RCU with posterior border of mandibular ramus

Vertical Ramus Osteotomy

Anterior and posterior borders of ramus of mandible are anatomical landmarks for placement of osteotomy. The initial osteotomy point was determined by an individual point determined based on each patient's radiograph, as it is more consistent. The *antilingula* is a lateral prominence of the mid ramus that generally corresponds to the entrance of the inferior alveolar nerve into medial surface of ramus which can be taken as a guide. Vertical ramus osteotomy was performed on the entire mandibular ramus parallel to posterior border of the ramus which would *eliminate the antegonial notch* and create a smooth angle. Surgical burs were used for making initial osteotomy cut and then deepened to medial cortex. The osteotomy line preserved the integrity of inferior alveolar nerve. Once the initial osteotomy cut has been made, osteotomy can be extended safely in either direction, while maintaining an adequate *sling of medial pterygoid* (on the medial side) or masseter muscle along the posterior border to prevent avascular necrosis of inferior tip of the proximal segment (Fig. 2b, c).

Temporalis Myofascial Pedicle Flap

After ascertaining the free movement of the released mandible, the inferior pedicle composite (fascia, muscle and periosteum) temporalis muscle was developed which was finger shaped and about 5 cm × 2 cm in dimension. The incision on the fascia, muscle and pericranium was placed and the raised flap was rotated below the zygomatic arch and sutured medially and posteriorly such that the pericranium faced the glenoid fossa enhancing the healing process and preserving the integrity of the fossa (Fig. 3a).

Contouring and Fixation of Graft

The final position of the neocondyle in the glenoid fossa was determined by placing the teeth in occlusion and its

Fig. 3 **a** Finger shaped Temporalis Myofascial flap taken as interpositional material. **b** Contouring and fixation of graft with X-shaped titanium plate

correct position was ascertained by taking care that 5 mm of space remained between the interpositional material and neocondyle during opening and closing movements of

mandible. The osteotomized segment with an adequate sling of medial pterygoid and masseter muscle along the posterior border slides upwards without losing contact at any level and was placed in glenoid fossa in contact with interpositional material. The upper end of the cut ramus was then remodeled to simulate a neocondyle with a functional shape for proper positioning and the sharp edges at the lower border were smoothened to achieve a flowing margin. After establishing that the new position did not interfere with mandibular movement, the osteotomized segment was secured to the mandible by 2.0 mm 'X' shaped titanium plate (Fig. 3b). Patient was maintained in maxillomandibular fixation (MMF) for 2–3 weeks after surgery. The function of the joint as well as the occlusion was verified after releasing the MMF. During the first few days, mouth opening was limited, and no condylar translation movements were recommended. After 10 days, more movements were encouraged. Elastic traction was used after that for next 3–4 weeks to guide the occlusion.

Results

Table 1 shows the results of patient before and after surgery. All patients were of bony ankylosis. There were four male patients and six female patients. Mean duration of ankylosis was 4 years and mean age of patients was 14.5 years in this study.

Trauma is considered a major cause of TMJ Ankylosis. Eight of the cases gave a history of trauma, one case gave a history of infection and one case was of reankylosis. No patient gave history of congenital or any other causes. Out of the ten patients, eight cases were of unilateral ankylosis

and two cases of bilateral ankylosis. Among unilateral, there were four cases of right TMJ Ankylosis and four cases of left TMJ Ankylosis. Preoperative mouth opening ranged from 0 to 10 mm with mean being 3.8 mm. As a result of successful procedure, the immediate post-operative mouth opening increase ranged from 22 to 26 mm (mean 24.2 mm). Follow up of patients at the third month and twelfth month showed good results with increase in mouth opening from a range of 28–39 mm (mean 32.2 mm) to 32–45 mm (mean 36.57 mm) (Fig. 4a, b). Post-operative CT scans and OPG showed good remodeling of the RCU.

One patient had temporary paresis of facial nerve postoperatively which resolved completely in 3 months. No patient experienced pain and infection at surgical site. None of the patients had graft rejection and reankylosis.

Discussion

Temporomandibular Joint Ankylosis occurs primarily in the first and second decades of life (35–92 %) and is commonly associated with trauma (13–100 %), local or systemic infection (0–53 %), systemic diseases such as ankylosing spondylitis, rheumatoid arthritis, psoriasis and previous TMJ Ankylosis surgery [1]. In this study also ankylosis was mostly found in second decade with age ranging from 10–19 years with mean age being 14 years which is in concordance with other studies [1, 15]. Roychoudhury et al. [16] retrospectively studied 50 cases of TMJ Ankylosis and showed that trauma was documented as a major etiologic factor in 86 % of all cases. This was documented in 8 (80 %) cases in the present study, which is also comparable with the figures in other studies [1, 15, 16].

Table 1 Results of patients with TMJ Ankylosis before and after surgery

Sr. no.	Age (years)/gender	Joint involved	Type of ankylosis	Etiology	Follow-up (months) (mm)	Pre-operative MMO (mm)	Post-operative MMO (12 month) (mm)	Post-operative complications
1	14/F	R.S. U/L	Osseous	Trauma	29	Nil	36	None
2	14/F	B/L	Osseous/ Fibro-osseous	Trauma	28	Nil	33	None
3	14/F	R.S. U/L	Osseous	Trauma	30	6	45	Temporary facial nerve palsy
4	9/M	L.S. U/L	Osseous	Trauma	24	5	32	None
5	19/F	L.S. U/L	Osseous	Infection	24	7	38	None
6	18/M	L.S. U/L	Osseous	Trauma	22	Nil	36	None
7	15/F	R.S. U/L	Osseous	Trauma	22	6	36	None
8	8/M	B/L	Osseous	Trauma	21	Nil	35	None
9	14/M	L.S. U/L	Osseous	Trauma	21	3	37	None
10	19/F	R.S. U/L	Osseous	Reankylosis	20	4	38	None

F female, M male, R.S. right side, L.S. left side, U/L unilateral, B/L bilateral with no signs of resorption of the graft

Fig. 4 **a** Pre-operative frontal view showing limited MMO of 7 mm. **b** Post-operative frontal view after 6 months showing MMO of 38 mm. **c** Pre-operative 3D CT Scan showing fusion of right condyle with base of skull. **d** Post-operative 3D CT Scan at 6 months follow-up showing good remodeling of the reconstructed RCU with no resorption of graft. **e** Pre-operative panoramic radiograph showing radiopaque mass with obliteration of right temporomandibular joint space. **f** Immediate Post-operative panoramic radiograph showing right side reconstructed RCU with TVSRO fixed with X shaped titanium miniplate. **g** Post-operative panoramic radiograph at 6 months follow-up showing remodeling of the RCU with no signs of resorption of the graft

Many methods using autogenous (temporalis, auricular cartilage, fascia lata, skin-dermis, native disc, buccal fat pad, Human Amniotic Membrane, costochondral, sternoclavicular, coronoid process, fibula, metatarsal, clavicle, iliac crest and cranial bone) and alloplastic (acrylic, synthetic, ulnar head prosthesis, compressible silicone rubber and total joint systems) materials have been reported for interposition arthroplasty and reconstruction of the mandible condyle [1, 3–8, 17, 18]. Interpositional arthroplasty has less risk of re-ankylosis and facilitates reconstruction of the diseased joint. Temporalis muscle and fascia has been used widely as interposition material in TMJ Ankylosis [19, 20]. Kaban et al. [3, 21] in their protocol suggested lining of the TMJ with temporalis myofascial graft. In the present study, temporalis myofascial pedicle flap was used as an interpositional material in all patients. The flap best simulates the articular disc in reconstruction of the ankylosed TM Joint. Use of the composite temporalis muscle flap with its associated fascia and pericranium is predicated on the fundamental concept of providing a soft tissue interpositional lining within the TMJ to prevent fibrous or bony union, as well as supplying an easily displaceable material which exhibits low degree of friction that aids in joint unloading and good stability at host site. Their principal advantages are their autogenous nature, absence of donor-site morbidity, resilience; adequate blood supply and proximity to the joint, allowing for a pedicled transfer of vascularized tissue into the joint area makes it a preferred choice over other TM Joint lining materials [3, 20, 21].

Among the autogenous tissue, the most common method for treating TMJ Ankylosis, particularly in children, is arthroplasty and reconstruction of the RCU with autogenous costochondral grafts mainly because of their biological similarities and their capacity to regenerate and grow [3, 22, 23]. Potential problems with the costochondral graft include fracture, further ankylosis and donor site morbidity. Sternoclavicular grafts have seen a revival recently because they have similar properties to CCG, but they produce a prominent scar which can be a disadvantage [4]. This disadvantage has led us to search for another solution for treatment of TMJ Ankylosis.

Vertical ramus osteotomy has been previously used in animal and human studies as a good alternative to reconstruct a neocondyle as a pedicle graft with satisfactory TMJ function [10–14]. Vertical ramus osteotomy is indicated for the correction of mandibular prognathism, mandibular asymmetry, distraction osteogenesis of the mandible and post-traumatic reconstruction. In this study, VRO, an extra oral technique has been used for condylar reconstruction using posterior border of ramus as pedicled graft in ten patients of osseous/fibro osseous ankylosis. Paula Cristina [2] described that through this technique, the reconstruction

of the TMJ is performed using the block of osteotomized mandible itself without need of a new surgical approach to obtain the graft, significantly decreasing the morbidity of the surgical procedure and avoiding complications associated with the donor site.

In contrast to free grafts (e.g. costochondral, clavicular) the use of the posterior border of the mandible as a pedicled graft can be performed safely and easily [13]. The posterior ramus border is attached to the medial pterygoid muscle, which can supply enough blood to prevent bone resorption/necrosis. In this study, the osteotomized segment with an adequate sling of pterygoid and masseter muscle along the posterior border slides upwards and no bone resorption was observed in the radiographs during the follow up period. The vertical osteotomy provides bone with a size and shape that is adequate for reconstruction of the new condyle and similar histological characteristics. In all patients of this study, there was noticeably significant adaptation and remodeling of the top of the raised ramus, which gave the impression of being the real condyle when observed on panoramic radiography. When postoperative CT scan was done at 12 months follow-up, there was well-maintained intra-articular space and the graft had taken the shape of the condyle. Martinez-Lage [13] pointed out in their study that mild to moderate displacement of the bone fragments permit enough bone in contact to stimulate the formation of a fracture callus and to restore continuity by forming a new ramus that is able to resist mastication forces. In the present study, complete bony union occurred between the grafts and the ramus in all the patients. At 6 and 12 months follow-up all the patients were able to perform excursive movements and had resumed a normal diet. Likewise, patients with evident antegonial notch or angle at the lower border were smoothened to achieve a flowing margin. In all patients, there was good remodeling of the inferior osteotomy step with pleasing aesthetic results, despite diminution of the angle. The small external scars and the alterations of the mandibular angle were not of concern to the patients. In all patients, despite preoperative concerns about ‘stretch’ of medial pedicle, the superior movement was accomplished without difficulty. The establishment of a passive opening of 30 mm is considered successful. In this study, as a result of successful procedure, preoperative MMO ranging from 0–10 mm (mean 3.8 mm) increased to 32–45 mm (mean 36.8 mm) at follow up of 12 months. All patients were given MMF for 2–3 weeks postoperatively to provide stability to the graft. This delay allows early phase healing of the surrounding tissues. The potential problem with early mobilization is that it may provoke bleeding and create a large hematoma with delayed healing and an increased likelihood of wound breakdown, disorganization and ossification. The results of the some previous studies highlight the importance of immediate postoperative

exercise and appropriate physiotherapy as a key element in the success of TMJ Ankylosis management. Reconstruction may be negated by poor postoperative physiotherapy or patient compliance. However, all our patients maintained regular physiotherapy and showed improvement in mouth opening at regular follow-up. None of the patients had infection at surgical site. No cases of reankylosis and graft rejection were noted at follow up.

Conclusion

In the present study, fairly good results were obtained in terms of postoperative mouth opening and acceptance of graft along with RCU reconstruction. Early postoperative exercises of mouth opening and appropriate physiotherapy played an important role in the prevention of recurrence. However, to analyze the proper adaptability and function of the graft, growth of mandible, improvement in aesthetics and recurrence of ankylosis, a study with more functional parameters and a longer follow up is required.

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