Neocondyle Distraction Osteogenesis in the Management of Temporomandibular Joint Ankylosis: Report of Five Cases with Review of Literature

Abstract

Introduction and Objectives: Management of temporomandibular joint (TMJ) ankylosis is a challenging and rather daunting task owing to complex abnormal anatomy and its sequel to craniofacial structures. Various autogenous grafts and alloplastic materials have been tried with variable success for creation of a near-normal joint. In recent years, neocondyle distraction has added a new dimension to the management of TMJ ankylosis. The aim of this paper is to describe the role of neocondyle distraction in TMJ ankylosis.

Materials and Methods: Neocondyle distraction was carried out in five patients with TMJ ankylosis following gap arthroplasty. Computed tomogram scans were taken before surgery and 1-year postdistraction for surgical planning and postoperative assessment, respectively. The intraoral distractors (KLS Martin, Jacksonville, FL, USA) were used in this study. Results: All five patients reported with adequate mouth opening and functional jaw movements. The procedure was well tolerated by all the patients. None of the patients underwent reankylosis following neocondyle distraction. Conclusion: With proper surgical planning and distraction protocol, neocondyle distraction is an effective and safe technique for TMJ reconstruction and preventing reankylosis.

Keywords: Distraction osteogenesis, neocondyle distraction, temporomandibular joint ankylosis, temporomandibular joint reconstruction

Introduction

Ankylosis of temporomandibular joint (TMJ) is a relatively debilitating condition resulting in restricted mouth opening, limited functional movements, and severe facial asymmetry during the growth phase leading to difficulty in mastication, swallowing, speech, airway obstruction, and poor oral hygiene. Surgical treatment should aim at restoring the normal joint function, correction of facial asymmetry, and preventing reankylosis.

Reconstruction of TMJ after ankylosis release is rather a challenging task due to its unique anatomy and physiology. Autogenous costochondral graft is the method of choice for TMJ reconstruction. However, it involves exploration of the second surgical site, and possible complications include surgical site infection, chances of graft failure, and unpredictable growth of the graft.[1] Even with a cartilage or bone graft, the necessity for a dynamic material to act like meniscus is mandatory for better functional rehabilitation of the joint.

Alloplastic materials have been used in the reconstruction of ramus-condyle unit with limited advantages, higher complications, and failure rates.[2] Vertical sliding ramus osteotomies[3] and reconstruction with resected ankylotic mass[4] have been tried, but no single method has produced uniformly successful and satisfactory results with long-term evaluation.

In the recent years, distraction osteogenesis (DO) has been successfully applied in the reconstruction of the TMJ. This technique involves gradual advancement of surgically created transport segment from the ramus toward the articulating surface of the temporal bone. The gap created after distraction is gradually filled with bone, while the leading edge is covered with fibrocartilaginous cap acting as an articular disc of the joint.[5-7]

How to cite this article: Sharma R, Manikandhan R, Sneha P, Parameswaran A, Kumar JN, Sailer HF. Neocondyle distraction osteogenesis in the management of temporomandibular joint ankylosis: Report of five cases with review of literature. Indian J Dent Res 2017;28:269-74.
Materials and Methods

The objective of this prospective cohort study was to determine the role of DO in TMJ reconstruction. Of all the patients who reported to our center with TMJ ankylosis, five patients (four males and one female in the age range of 19–23 years, mean age 21.2) were enrolled in this study. All patients underwent gap arthroplasty with ipsilateral as well as contralateral coronoidectomy to achieve good mouth opening intraoperatively.

Once adequate mouth opening was persistent for the follow-up period of 1 year, the patients were reevaluated for neocondyle regeneration. Patients with maximal interincisal opening (MIO) of >30 mm, no signs of reankylosis clinically and radiographically, and patients with adequate ramus size and shape as determined in computed tomogram scan and three-dimensional (3D) reconstruction to allow proper placement and fixation of distractor device were included in the study. Exclusion criteria included potentially uncooperative patients who cannot comply with the distraction protocol and patients with systemic conditions which can significantly affect the bone physiology and outcome of DO. Informed consent was obtained before surgical intervention and for enrollment in the clinical study.

Orthopantomogram and lateral cephalogram were obtained preoperatively and at periodic intervals of every 3 months postoperatively for a follow-up period of 2 years. Computed tomogram scans with 3D reconstruction (Siemens, Germany) were taken before surgery and 1-year postdistraction for surgical planning and postoperative assessment, respectively. The follow-up period ranged from 14 months to 30 months (mean follow-up 20.8 months). The intraoral distractors (KLS Martin, Jacksonville, FL, USA) were used in this study.

Surgical procedure

The surgical procedure is performed under general anesthesia with nasoendotracheal intubation. A small incision is placed in the submandibular region, 2 cm below the lower border of the mandible. The dissection is carried out, and lateral surface of ramus and angle of the mandible were exposed reflecting the periosteum over the bone. No periosteal stripping should be attempted on the medial side, thereby maintaining an adequate amount of soft tissue attachment and blood supply to the distraction site over the medial surface.

Once the dissection is complete and superior border of ramus is visible, the markings are placed for a reverse L-shape osteotomy extending from the sigmoid notch to approximately 1 cm above the inferior border of the mandible, preserving the angle region. The vertical cut should be planned parallel to the vector, so it can direct the transport disc toward glenoid fossa. The transport disc is created from the ramus by making osteotomy cuts over the markings. The superior surface of the disc is rounded to simulate the condylar surface.

The distractor device is then oriented parallel to the vertical cut. The holes for device fixation are placed without changing the position of the device. The distractor is then fixed with the screws of appropriate size. Once the distractor device is fixed, the osteotomy can be carried out, mobilizing the transport segment completely. The distractor is activated for 1–2 mm intraoperatively to confirm the unrestricted movement of the transport disc in planned direction. The activation arm can be brought out from separate stab incision if needed [Figure 1]. The incision is then closed in layers. Routine intravenous antibiotics and analgescics are administered postoperatively for 3 days followed by oral administration for next 4 days.

After 5 days of latency period, the distraction is initiated 1 mm daily (0.5 mm in the morning and 0.5 mm in the evening) till the transport disc achieves close contact with the articular surface of temporal bone [Figure 2a and b]. The distractor is left in the neutral position for a consolidation period of 6–8 weeks. Once the mature bone formation is evident radiographically, the distractor can be removed under general anesthesia. During the entire treatment phase, patients should be motivated for aggressive physiotherapy and active mouth opening exercises.

Results

The technique was well tolerated by all the patients. All five cases reported with satisfactory MIO ranging from 30 to 35 mm (mean ± 3 mm ± 2 mm) [Figure 3 and Table 1]. None of our patients reported with chronic pain or surgical site infection during and after the distraction phase.

The occlusion in all the patients remained stable throughout the process; however, in two cases, mild posterior open bite developed on the affected side during distraction.
period which was corrected during the consolidation phase. Mandibular movements determined postoperatively revealed near-normal functional movements emphasizing the successful outcome of the technique.

Radiographic examination confirmed effective movement of the transport disc toward glenoid fossa. During consolidation period, bone formation was seen in the regenerate chamber. Physiological remodeling of the leading edge was also evident on subsequent radiographs [Figures 4 and 5].

After removal of the distractor device, no significant changes were observed at distraction site. Patient reported with good mouth opening and improved functional movements during subsequent visits. On computed tomography scan examination, mature bone was evident in the distraction gap, and the articulating surface of the neocondyle exhibited more smooth and convex shape, without any signs of reankylosis [Figure 6a and b].

**Discussion**

In the recent years, management of TMJ ankylosis has advanced tremendously. Kaban et al. in 1990 proposed a protocol for systematic approach for the management of TMJ ankylosis.[8] In 2009, this protocol was modified, and DO was added as an alternative modality to costochondral graft for condylar reconstruction.[9] The main objective in the management of TMJ ankylosis is not only to achieve normal mouth opening but also to restore the missing joint anatomy and functions along with prevention of reankylosis in long term. Various techniques for the treatment of TMJ ankylosis and reconstruction of condyle-ramus unit with autogenous grafts, alloplastic materials, and bovine bone grafts have been described in literature.[10]

Gillies in 1920 first reported the use of costochondral grafts in the reconstruction of TMJs. Various autogenous grafts
Animal studies have demonstrated that biomechanical properties of neocondyle under functional loading are equivalent to the physiologic condyle. Histologic analysis has revealed distraction gap filled with collagen fibrous tissue in early stages which is gradually replaced by mature bone almost indistinguishable from the surrounding normal bone approximately after 24-week postdistraction.\cite{21}

The main advantage of this technique is distraction histogenesis which refers to simultaneous elongation of soft tissues adjacent to distraction site along with hard tissue correction. The newly formed advancing front of the distraction fibrocartilaginous cap over the leading surface of transport segment can act as a pseudo disc, thereby facilitating movement of neocondyle over glenoid surface as well as preventing reankylosis.\cite{10}

Proper osteotomy cuts and distractor orientation are the key in success of neocondyle distraction and are often a difficult task due to the absence of well-defined glenoid fossa and the amount of bone left after gap arthroplasty. The distraction vector should be aimed more posteriorly, and maximum movement of the disc should be carried out superiorly toward glenoid surface without compressing the interposition material if present, to achieve maximum TMJ anatomy and vertical correction of the ramal deficiency.

The neocondyle distraction has obvious advantages over autogenous grafts. The neocondyle is formed through the process of DO, thereby obviating the need for graft and elimination of second surgical site. There is no need for intermaxillary fixation, and hence functional movements can be started immediately after surgery which can be encouraging to the patient. This also reduces the chance of reankylosis. One can restore the normal ramus height along with the correction of soft tissue deficiency making this technique more preferable over other conventional methods of reconstructing ramus-condyle unit. Further, animal studies suggest that neocondyle reconstructed by means of transport distraction has the potential to grow under functional stimuli of the TMJ comparable to condyle ramus growth of the contralateral normal side.\cite{22} Therefore, this technique can be a viable option for TMJ reconstruction in growing children where facial symmetry after growth phase is one of the major concerns.
However, there are few drawbacks to this technique. The duration of the treatment is prolonged; the device needs to be activated on a daily basis at the recommended rate and rhythm followed by the consolidation period for several weeks. Hence, patient compliance is imminent. Cost factor is also a concern in distraction procedure as it requires two surgeries; distractor devices and its components are expensive. Device failure, vector loss, loosening of the hardware, premature consolidation, and nonunion of the transport segment are possible complications associated with this technique.\(^{[18]}\)

A latency period of 5–7 days after surgery is necessary to allow time for initial callus formation and healing of the soft tissues. Consolidation and quality of bone formation in the regenerate chamber are largely determined by the rate and rhythm of the distraction. Faster distraction rates in enchondral bone might result in local ischemia in the distraction gap and delayed ossification or pseudarthrosis, whereas slower distraction rates might lead to premature ossification and consolidation.\(^{[23]}\) In our study, gradual distraction rate of 1 mm per day has been found to yield adequate movement of the transport disc as well as timely consolidation of the regenerate chamber. The activation port site should be cleaned daily, and antibiotic dressing should be placed to keep the site infection free. The patient should be encouraged for active mouth opening exercises immediately after surgery to initiate remodeling of the condylar surface under functional load and prevent reankylosis. The distractor removal is often more difficult than its placement due to superior positioning of the upper plate, and sometimes, bone or fibrous tissue covering the screws, one may find it difficult to remove with indirect access through existing submandibular scar. To overcome this problem, the distractor devices are available with the detachable plate system (KLS Martin, Jacksonville, FL, USA), in which the plates and fixation screws can be left behind after removing the body of the distractor [Figure 7].

Recently, it has been suggested that the height of the reconstructed condyle is not stable, and the mandible tends to be asymmetrical with age, mainly owing to compromised blood supply to the transport segment.\(^{[17]}\) Hence, further evaluation and long-term follow-up of this technique are warranted.

In our cases, efforts have been made to create transport segment of adequate size and avoiding periostral stripping on the medial side, thereby preserving maximal blood supply to the transport disc. None of our patients reported back with a reduction in mouth opening or signs of reankylosis. Functional movements have been satisfactory in all the patients after neocondyle distraction. No significant resorption or loss of vertical height of distracted segment has been observed in any case radiographically so far. The residual facial asymmetry can be corrected at later stage with multiplanar distraction or bone grafting depending on the magnitude of correction required and growth of the mandible.

Further, we have performed neocondyle reconstruction approximately 1 year after resection of ankylosic mass, interposition with costochondral graft with or without contralateral coronoidectomy. This protocol has helped us to achieve good mouth opening and to assess patient compliance before distraction and better evaluation of functional movements in patients before and after condylar reconstruction. However, one can perform ankylosis release and neocondyle distraction simultaneously to avoid multiple surgeries and reduce overall treatment time period, cost, and morbidity. Future studies should focus on the long-term assessment of this technique, role of osteoconductive materials in early consolidation, use of multivector distractor devices in neocondyle regeneration, and correction of facial asymmetry simultaneously.

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.

Conclusion

Neocondyle distraction is a novel approach for reconstruction of ramus-condyle unit, thereby restoring physiological TMJ function, simultaneously correcting hard and soft tissue deficiency, and preventing reankylosis. With proper technique and patient compliance, it is safe, predictable, and effective procedure for TMJ reconstruction.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.
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