Total Alloplastic Temporomandibular Joint Reconstruction for Management of TMJ Ankylosis

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Abstract

Introduction Temporomandibular joint (TMJ) ankylosis involves the fusion of the mandibular condyle to the glenoid fossa, the skull base. The dilemma with regards to treatment planning whether distraction is done before gap arthroplasty or as a simultaneous procedure or after gap arthroplasty is still a controversy. In an attempt to carry out both the procedures simultaneously there is loss of vector control of the distal segment and the risk of pseudoarthrosis at the osteotomy site. This combined problem could be overcome by the use of total alloplastic joint prosthesis which offers a firm posterior stop for the proximal segment and negates aggressive physiotherapy.

Material and methods The reference literatures were retrieved from Pub Med and Science Direct database. Three case reports of bilateral recurrent TMJ ankylosis successfully treated with custom made total TMJ by the authors are illustrated.

Conclusion The purpose of this article is to review the world literature on various alloplastic joints available for TMJ reconstruction and to introduce our indigenous total joint prosthesis in the management of recurrent ankylosis.

Keywords TMJ re-ankylosis · Total alloplastic TMJ replacement · Simultaneous distraction

Introduction

Temporomandibular joint (TMJ) ankylosis involves the fusion of the mandibular condyle to the glenoid fossa, the skull base. It is a serious and disabling condition that may cause problems in mastication, digestion, speech, appearance and hygiene. It can also cause disturbance of facial and mandibular growth associated with acute airway compromise. The treatment for ankylosis poses a significant challenge because of the high incidence of recurrence. The first sign of the condition may be a progressive limited mouth opening with minimal facial asymmetry becoming obvious as growth advances. Pain is uncommon. Early diagnosis and intervention are critical to prevent the worst sequelae of this condition. Conventionally complete bony TMJ ankylosis so far had been managed by performing gap arthroplasty with or without costo-chondral autogenous tissue grafting. Often the autogenous grafting techniques causes delayed mandibular function [1] as early physiotherapy often leads to graft mobility during healing period which compromises its incorporation with the host environment or its blood supply leading to graft-host interface failure [2]. The various biological donor sites for reconstruction reported in the literatures so far had been either non vascularised namely from costo-chondral, metatarsal, free grafts of iliac bone, clavicle and sterno-clavicular joint or vascularised namely metarso-phalangeal joint with dismal success rates [2–4]. Saeed and Kent reported a high incidence of re-ankylosis in patients who underwent initial autogenous costo-chondral temporomandibular reconstruction and advised caution in using this technique in this group of patients [5]. Hence for patients who report with re-ankylosis, placing autogenous tissue such as bone into an area where reactive or heterotopic bone is forming is not logical [2]. Orthopaedic surgeons typically choose total

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alloplastic joint reconstruction in similar situations involving other joints. In view of the biologic considerations and orthopaedic surgeon's experience on major joints, a total alloplastic reconstruction should be considered for patients with severe anatomical discrepancies involving the TMJ and patients with recurrent ankylosis [2, 6]. The purpose of this article is to review the world literature on various alloplastic joints available for reconstruction to introduce our indigenous total joint prosthesis in the management of extensive primary and recurrent TMJ ankylosis and to stress the possibility of combined joint release and mandibular corpus lengthening with distraction osteogenesis without encountering any of the known associated complications.

Materials and Methods

The reference literatures were retrieved from Pub Med and Science Direct database. The search words used were alloplastic TMJ reconstruction, total alloplastic temporomandibular joint prosthesis, TMJ replacement for recurrent ankylosis and custom made alloplastic TMJ prosthesis. Further articles were retrieved using cross references in these literatures. Three case reports of bilateral recurrent TMJ ankylosis successfully treated with custom made total TMJ by the author are illustrated.

Historical Considerations

According to the literature, Christensen in 1965 designed the first total temporomandibular prosthesis. His device consisted of cast vitallium ramus component with a polymethylmethacrylate condylar head to his vitallium fossa-eminence device [7, 8]. In 1965 he abandoned the use of polymethylmethacrylate due to particulation under function [9–11]. Morgan upgraded his articular-eminence prosthesis to create a total TMJ replacement [12, 13]. In 1997, Christensen developed a metal-on-metal all cast vitallium custom prosthesis which was designed using stereolithographic model (CAD/CAM) [14, 15]. In 1998 his prosthesis was CE-certified as a medical device in the European Union and in 2001 was approved by the US Food and Drug Administration (FDA). Later Kiehn combined the principles of Christensen's fossa-eminence prosthesis and Hahn's ramus mesh prosthesis which was fixed using polymethylmethacrylate cement [16]. Kent introduced the total TMJ prosthesis. Between 1981 and 1990 several thousand patients were implanted with what then became known as the Vitek–Kent prosthesis [17]. In the early 1980s, Sonnenburg developed a total TMJ replacement in Eastern Germany. The glenoid fossa was

created from high-pressure polymerized polyethylene providing effective shock absorption due to its low module of elasticity and the condylar head consisted of titanium/palladium alloy that could be plastically moulded secondarily [18]. In 1989 the 'TMJ concepts prosthesis' designed the fossa component with pure titanium mesh backing that contains the ultra-high molecular weight polyethylene (UHMWPE) articulating surface which is screw fixed to the zygomatic arch. The ramus component has a titanium alloy shaft including a chromium-cobalt-molybdenum condylar articular head. The prosthesis is said to provide maximum host-prosthesis contact despite difficult anatomical form. It was approved by the FDA in 1999 [19–22]. In 1992 titanium/titanium nitride TMJ (TTN-TMJ) prosthesis lined the fossa and the condylar component with titanium nitrate to decrease the wear properties. The Biomet-Lorenz total TMJ prosthesis of 1995 combines a prosthetic shaft with a sphere-shaped head of Co-Cr or titanium and ultra-high molecular weight polyethylene (UHMWPE) fossa component with 12 different dimensions [23].

Though the above said total TMJ prosthesis is all available with western literature, no such work has been so far reported by Indian authors who restrict to autogenous reconstruction in spite of encountering a high incidence of unpredictable growth or re-ankylosis.

Case Report

Case 1

A 19 year adult male was referred to the department for management of bilateral recurrent TMJ ankylosis without any features of secondary deformity and with the history of trauma treated conservatively in 2008. Later in 2010 he developed restricted mouth opening for which he was subjected to a joint surgery as evidenced by a surgical scar bilaterally. The patient gradually developed re-ankylosis with 2 mm mouth opening on reporting to our center in 2012. Clinical examination revealed all the features of an untreated displaced bilateral condylar fracture with re-ankylosis namely anticlockwise rotation of the mandible with dental class III molar relationship and dental anterior open bite due to tongue thrusting while eating (Fig. 1). Radiological features showed evidence of bilateral bony ankylosis, bilateral antero-medially displaced condyle and shortened ramal height without pronounced antigonial notching (Fig. 2). Considering the total distorted anatomy of the joint space, shortened ramal height, restricted mouth opening without any features of secondary deformity on an adult patient, a bilateral total joint replacement surgery alone was planned (Figs. 3, 4).

Fig. 1 Case 1 pre-operative picture showing the open bite

Case 2

An 18 year adult female was referred to the department with clinical features of bilateral TMJ ankylosis and obstructive sleep apnoea with history of birth injury, un-operated so far (Fig. 5). Radiological examination represented Sawhney's class IV bilateral ankylosis with shortened corpus, pronounced antgonial notch with compromised airway. Considering the clinical features a bilateral total joint replacement surgery was contemplated simultaneously with distraction of the mandibular corpus (Figs. 6, 7, 8).

Case 3

A 14 year old female was referred to the department with clinical features of bilateral TMJ ankylosis with a mouth opening of 4 mm and history of trauma in childhood, un-operated so far. Radiological examination represented Sawhney's class IV bilateral ankylosis with shortened ramus and corpus with pronounced antgonial notch and compromised airway. As the clinical features demanded

Fig. 2 Case 1 pre-operative ophthopantomograph

Fig. 3 Case 1 TMJ prosthesis insitu

lengthening of both ramus and corpus with joint release, a bilateral joint replacement surgery was contemplated to restore the required vertical height of the ramus combined with distraction osteogenesis to lengthen the corpus (Fig. 9).

Fabrication of the TMJ Prosthesis

The prosthesis was customised for each patient. It is a two piece unit comprising of the fossa-eminence component

Fig. 4 Case 1 post-operative ophthopantomograph

Fig. 5 Case 2 pre-operative profile picture showing bird's face appearance

and the condylar component. The height of the total joint prosthesis is fabricated in such a way that the vertical height of the ramus was restored to its normal height. The height of the fossa-eminence component of the prosthesis was fabricated according to the dimension of the gap arthroplasty planned (25 mm). The fossa-eminence component is made up of ultra-high-molecular-weight polyethylene on a surgical grade stainless steel frame transfixed to the underlying bone with a 2 mm × 5 hole plate. The condylar component is made up of surgical grade stainless steel with dimensions of 5 mm antero-posteriorly and

8 mm medio-laterally providing a stable articulation with the fossa-eminence component transfixed inferiorly with a 2 mm × 2 hole plate (Fig. 10). The prosthesis provides only rotational movement during mouth opening. The fossa component being made up of high density porous polyethylene requires sterilization with ethylene oxide. As the prevalence of the condition is more among the lower socio-economic group, an indigenous total TMJ prosthesis is designed to keep the cost to a bare minimum of Rs. 2,500.

Surgical Technique

In all three patients as mouth opening was restricted, a fiber-optic guided endotracheal tube intubation was carried out. A combination of AL Kayat and Bramley along with Risdon approach was made to access the ankylotic mass and the ramus to perform gap arthroplasty and fixation of the condylar component respectively. After performing gap arthroplasty (25 mm) on either side, inter-maxillary fixation was done to have a proper flare of the ramus in relation to the skull base. The fossa-eminence prosthesis was fixed to the zygomatic arch and the condylar component was fixed to the ramus of the mandible keeping them in unison (Fig. 3). Following this, inter-maxillary fixation was released to check the occlusion, mouth opening and articular excursion on either side. In addition to the above mentioned procedure, in cases 2 and 3, a vertical osteotomy was made in the predetermined position in the corpus through the same Risdon approach and monofocal distractors were transfixed on either side parallel to the inferior border of the mandible with a motive to increase the lower anterior facial height. The distractors were activated on the 4th postoperative day until the predetermined the length of the corpus was achieved. The devices were dismantled after 3 months of consolidation. The wound was closed in layers with active drains placed bilaterally. The patient was followed-up for a period of 6 months without any sign of rejection or discomfort.

Fig. 6 Case 2 post-operative ophthopantomograph

Fig. 7 Case 2 post-operative profile picture after total TMJ replacement with distraction of the corpus

Discussion

The holistic approach for the management of TMJ ankylosis involves not only adequate mouth opening but also correcting the associated facial deformity. Leonard Kaban proposed a biological protocol for the management of TMJ ankylosis.

He stated an aggressive excision of fibrous and/or bony mass followed by ipsilateral/contralateral coronoidectomy based on the achieved mouth opening. This was followed by reconstruction of the ramus condyle unit with either distraction osteogenesis or costo-chondral graft, with early mobilization of the jaw in the former and inter maxillary fixation with a maximum period of 10 days in the later [24].

Guyuron and Lasa in 1992 observed that the growth potential with costo-chondral graft is highly unpredictable, overgrowth being more difficult to correct than lack of growth. He also observed that the incidence of re-ankylosis is much higher with costo-chondral reconstruction [25]. Obeid et al. also observed that an additional corrective osteotomy is required subsequent to growth completion there by increasing the morbidity [26].

The concept of neo condyle distraction osteogenesis by Zhu in 2006 has an advantage over costo-chondral grafting which eliminates secondary donor site morbidity and allows immediate mobilization and also re-establishment with fibro-cartilagenous tissue over the advancing segment which mimics the articular disc. However the major disadvantages are the unpredictable vector, long treatment period and patient's compliance [27].

Now the dilemma is, whether distraction is to be done before gap arthroplasty or as a simultaneous procedure or after gap arthroplasty. With regard to the timing of distraction for correction of secondary deformity, various authors have suggested different period of intervention. Lopez et al. in 2006 suggested a two phase procedure suggesting gap arthroplasty first with aggressive physiotherapy followed by distraction, keeping in mind the restoration of the mouth opening which was also the patient's primary complaint. Though some authors like McCormick, Cascone and Alonso prefer to perform gap arthroplasty and

Fig. 8 Pre-operative and immediate post-operative mouth opening

Fig. 9 Case 3 pre-operative picture showing bird's face appearance and post-operative picture after total TMJ replacement with distraction of the corpus

distraction simultaneously, Lopez et al. report the increased risk of pseudoarthrosis at the osteotomy site due to strong physiotherapy. Furthermore, the external forces may change the initial vector direction. But if the patient at the first clinical examination complains of obstructive sleep apnea then mandibular distraction is done first to solve the airway compromise followed by gap arthroplasty at the time of removal of the device [28].

Dimitroulis observed that placement of autogenous tissue such as bone into an area where reactive or heterotopic bone is forming leads to further ankylosis. They suggest the use of total TMJ prosthesis in re-ankylosis cases [29].

Although the long term outcome of our indigenous TMJ prosthesis in our setup is yet to be ascertained, our clinical experience over the past 20 years shows that the use of costo-chondral graft for the reconstruction of ramus-

Fig. 10 Total alloplastic TMJ prosthesis

condyle unit has a significant rate of unpredictable growth and re-ankylosis as even observed by other Indian authors. The problem that we encountered with neo condylar distraction was with vector control and patient's compliance. The observation made by Wolford et al. in 1994 on 100 reconstructed TMJs in 56 patients using the TMJ Concept (Techmedica) total joint prosthesis, with an average follow-up of 2 1/2 years was good outcome in 63 % of the patients, fair outcome in 26 % of patients and poor outcome in 16 % of patients [15].

Though the incidence of TMJ ankylosis has considerably reduced due to better socio-economic and health care in rural population, the holistic approach of joint release and secondary deformity correction among contemporary surgeons has lead to great dilemma with regards to treatment planning. In an attempt to carry out both the procedures simultaneously there is loss of vector control of the distal segment and the risk of pseudoarthrosis at the osteotomy site. This combined problem could be overcome by the use total alloplastic joint prosthesis which offers a firm posterior stop for the proximal segment and negates aggressive physiotherapy.

There are few literatures which highlight the post operative complications of total TMJ prosthesis such as implant loosening, particulate wear debris during functional loading, infection, rejection, breakage of the prosthesis, peri-prosthetic bone fracture. We did not encounter any such complications. Further long term follow up is required to determine its success [9–11].

Conclusion

The Indian subcontinent has been the capital of TMJ ankylosis. Though the priority was in achieving adequate mouth opening by the yesteryear surgeons and the patients,

only in the past two decades with better understanding of the jaw deformity and the availability of surgical armamentarium there is an acceptance for the concomitant secondary deformity correction. The yesteryear surgeons were concentrating more on arthroplasty protocols to prevent re-ankylosis. Their role on secondary deformity problem was more on prevention than correction by way of reconstructing the joint with costo-chondral graft. Though the costo-chondral graft was the work horse of reconstruction among the Indian surgeons and still is, in spite of its unpredictable behaviour no other modality of reconstruction had been so far thought off. With the predictable results of distraction osteogenesis in achieving the predetermined length and vector of new bone regenerate and our indigenous total TMJ prosthesis, the primary pathology of ankylosis and secondary deformity can be corrected simultaneously.

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