Available online at www.sciencedirect.com

ScienceDirect

British Journal of Oral and Maxillofacial Surgery 57 (2019) 1113–1118

BRITISH Journal of Oral and Maxillofacial Surgery

www.bjoms.com

Protocol for the management of ankylosis of the temporomandibular joint

J.N. Khanna, Radhika Ramaswami *

Saifee Hospital, Mumbai, Maharashtra, India

Accepted 8 October 2019
Available online 13 November 2019

Abstract

Ankylosis of the temporomandibular joint (TMJ) is a severely deforming, disabling condition as a result of craniomandibular fusion caused mainly by condylar fractures with displacement of the meniscus. Ankylosis may be fibrous, fibro-osseous, or bony, and unilateral or bilateral. The severity of the deformity is based on the onset, duration, and type of ankylosis. Various surgical techniques have been described for treatment, but no single treatment is recommended because of inconsistent results and the high rate of failure. While our total experience extends to 300 cases, we have developed a protocol using the most recent 193 patients to address our earlier high failure rate. The onset was during childhood in 168 patients, and 25 were adults. We describe the protocol that we developed for these two groups. Our management included gap arthroplasty, costochondral grafting, temporalis flaps, ramus osteotomies, and transport distraction.
© 2019 The British Association of Oral and Maxillofacial Surgeons. Published by Elsevier Ltd. All rights reserved.

Keywords: temporomandibular joint; ankylosis

Introduction

The word "ankylosis" is of Greek origin and means a stiff joint. It may be classified as fibrous, fibro-osseous, or osseous union of the components of the joint. Trauma is the major cause, others being rheumatoid arthritis, degenerative arthritis, infectious spondylitis, and psoriasis.[1,2]

Ankylosis of the temporomandibular joint (TMJ) may be unilateral or bilateral, and facial deformity is governed by the type of ankylosis, and its onset and duration. During the growth phase the deformity is severe, and affects nutrition, speech, growth, oral hygiene, eruption of teeth, malocclusion and (in severe cases) micrognathia that causes obstructive sleep apnoea. After the growth phase ankylosis leads only to functional loss, while aesthetic deformity is minimal.

Various lines of treatment have been described.[3] We have tried several of them, weighed our successes and failures, and devised a management plan according to the patient's age at the occurrence of ankylosis of the TMJ.

We have divided our patients in two groups: the first whose ankylosis started during the growth phase and the second in whom it developed after the growth phase was complete. If the ankylosis developed during the growth phase but did not present until adulthood, the patient was considered in group 1.

The aim of this paper was to suggest a protocol for the management of ankylosis of the TMJ, with correction of the deformity, based on the age when it presented.

* Corresponding author at: Flat 2, Sarovar CHS, Plot 36, Sector 9A, Vashi, Navi Mumbai 400703, Maharashtra, India. Tel.: +91 9821717110.
E-mail address: radhika.ramaswami@gmail.com (R. Ramaswami).

https://doi.org/10.1016/j.bjoms.2019.10.298
0266-4356/© 2019 The British Association of Oral and Maxillofacial Surgeons. Published by Elsevier Ltd. All rights reserved.

Patients and methods

We grouped our patients into those with ankylosis that developed during the growth phase (group 1) and adult patients in whom it developed after the growth phase (group 2).

Examination included detailed history, clinical examination, and laboratory and radiographic investigations. The patients were given a general anaesthetic by blind nasoendotracheal intubation (railroad method), and fibreoptic intubation. Tracheostomy was not attempted in any patient. Only those with minimum of two years follow up were included in the study.

Ankylosis that started during the growth phase (group 1)

Stage I : access was gained to the TMJ through a standard modified preauricular (Al-Kayat Bramley) incision. The posterior glenoid tubercle was identified. From here the periosteum was incised and subperiosteal dissection done on the zygomatic arch anteriorly for a distance of 3–4 cm (to prevent damage to the zygomaticofrontal branch of the facial nerve), and then inferiorly to expose the TMJ. The ankylotic mass was resected to create a gap of 6 mm, followed by bilateral coronoidectomy. Free movements of the ramus were checked and incisal opening of over 40 mm was achieved.

The temporalis myofascial flap was raised and rotated down under the zygomatic arch after creating space using a rose head burr on the posteromedial side of the arch. The fascia, muscle, and pericranium were sewn together and interposed with the fascia to face the costochondral graft. The pericranium was placed superiorly towards the cranial side and 4/0 polypropylene (Prolene®, Johnson & Johnson) was used to fix the flap.

The costochondral graft was harvested with cartilage (4 mm) and bone (15–18 mm). It was contoured and the graft fixed with a minimum of two screws; we used a one-hole plate that acted like a washer, or a two-hole plate (Fig. 1).

Nasoendotracheal intubation was maintained until the next morning in cases of severe micrognathia. Oral feeding was started after extubation with a high protein liquid diet followed by a soft diet for three weeks.

No active physiotherapy was used postoperatively except for normal tolerable excursions while using the jaw. Dental rehabilitation was started after 12 weeks, to allow the new joint to settle.

Stage II: after six months we started distraction osteogenesis. An oblique osteotomy was made through a submandibular approach at the angle of the mandible. The osteotomy cut was made at the angle of the mandible, running superoanteriorly, and ending 5 mm distal to the last tooth present, maintaining the mucoperiosteum. Any tooth bud in the area meant that the angulation of the osteotomy cut had to be changed (Figs. 2 and 3). The inferior alveolar nerve was protected and a monoplanar or multiplanar distractor was fixed (Fig. 4). After a latency period of five days we started distraction at the rate of 1 mm/day until the desired distraction was achieved. In children below the age of 6, distraction started after a latency period of three days at the rate of 1.5 mm/day. Distractors were removed after 8–16 weeks, when consolidation had been confirmed radiographically.

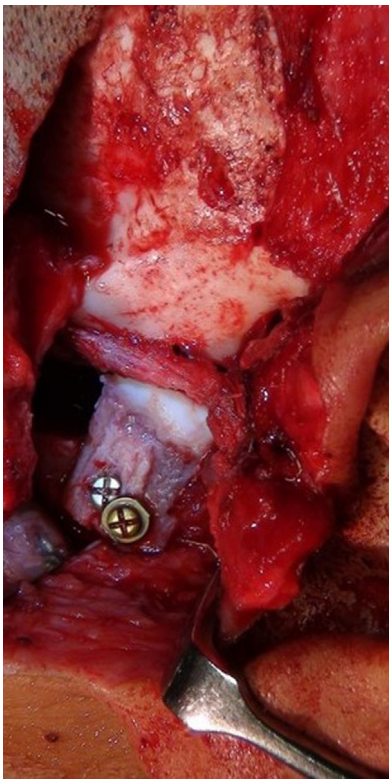

Fig. 1. Temporalis myofascial flap in position, and costochondral graft fixed with two screws.

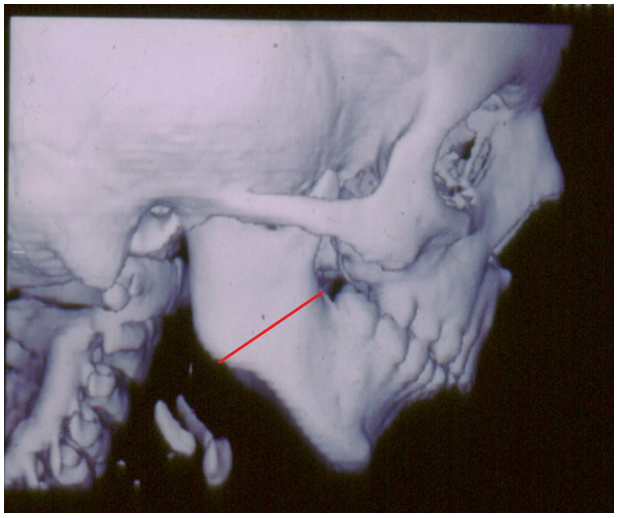

Fig. 2. Line drawing showing osteotomy cut for distraction osteogenesis in patients in group 1.

Orthodontic treatment was continued until the occlusion was corrected. For any residual deformity, the necessary orthognathic procedure was done after 18 years of age.

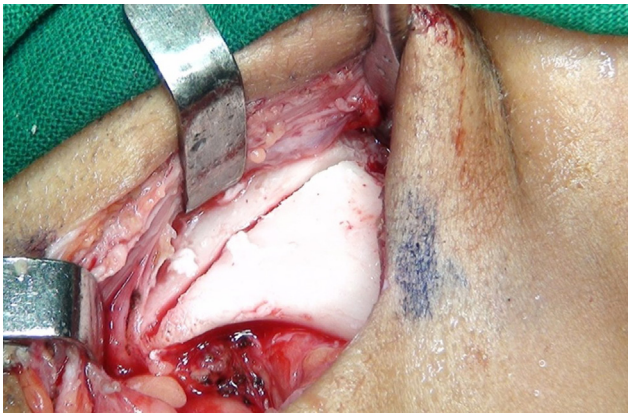

Fig. 3. Osteotomy cut for distraction osteogenesis (stage II in patients in group 1).

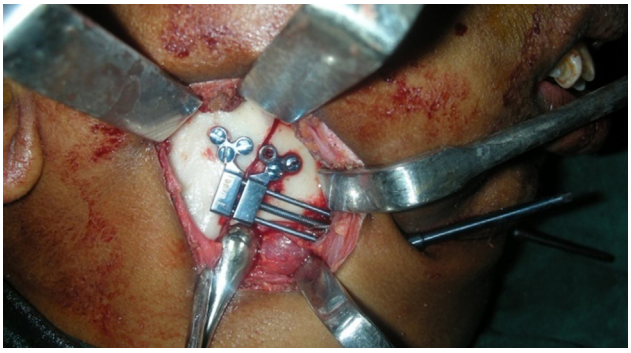

Fig. 4. Distractor in position (stage II in patients in group 1).

Ankylosis that started after growth had finished (group 2)

Stage I : only the temporalis myofascial flap was used, as described in group 1. A bite block was placed in the posterior molar area and elastics anteriorly to prevent superior displacement of the ramus that would have resulted in open bite in patients with bilateral ankylosis.

Stage II: after three months, the procedure used depended on the available height of the mandibular ramus. If the height was sufficient (around 3.5 cm), a sliding osteotomy of the posterior border was done through a transparotid approach using a reverse-L osteotomy, posterior to the mandibular foramen and the inferior alveolar canal (Fig. 5). We then slid it superiorly towards the cranial base against the temporalis myofascial flap. Care was taken not to strip the attachment of the medial pterygoid muscle from the cut segments. The segment was immobilised with a minimum of two bony plates. The defect created by the sliding osteotomy was grafted using coronoid process if available, or a bone graft.

If the height of the ramus was inadequate (less than 3.5 cm), as seen in cases of reankylosis, we did a transport distraction using a reverse-L osteotomy cut, posterior to the mandibular foramen and inferior alveolar canal, to ensure that enough bone was available to fix the distractor at the angle of the mandible and the cut segment (Fig. 6). Distraction osteogenesis was done with monoplanar distractors.

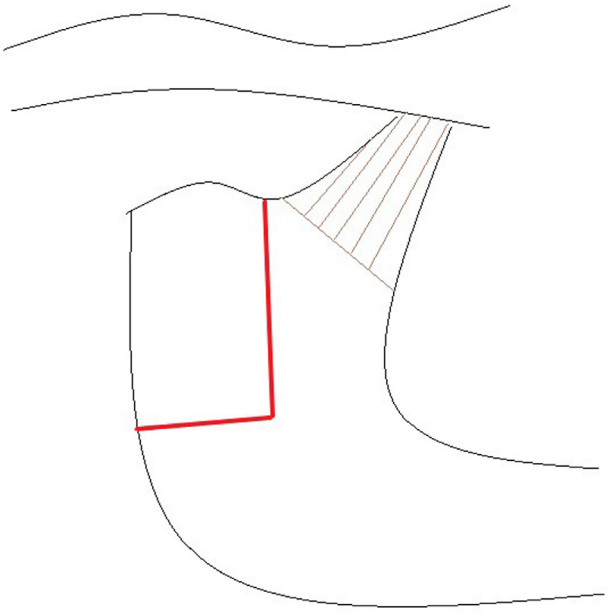

Fig. 5. Osteotomy cut for stage II in patients in group 2.

Fig. 6. Transport distraction for cases with short mandibular ramus, in patients in group 2.

In adults who had had multiple operations and reankylosis, we replaced the whole joint using a Biomet 3i (Zimmer) joint prosthesis, which was fixed with a minimum of six screws in the mandibular component and five screws in the fossa component.

Table 1
Results in the two groups.

	Method	No. of patients	No. of recurrence	No. with facial nerve paresis	Mean (SD) mouth opening after 2 years follow up (mm)
Group 1:					
	Temporalis myofascial flap costochondral graft, and distraction, after 6 months	168	0	27	30 (3.50)
Group 2:					
	Interpositional arthroplasty with temporalis myofascial flap After 3 months, posterior border sliding osteotomy	14	0	4	35 (2.28)
Group 2:					
	Temporalis myofascial flap and after 3 monthsTransport distraction	6	0	0	30 (1.18)
Group 2:					
	Gap arthroplasty and placement of Temporomandibular joint prosthesis	5	0	1	35 (1.41)

Group 1 = ankylosis started during the growth phase; Group 2 = ankylosis that developed after the growth phase.

Results

Of the 193 patients included in the study, 168 were under the age of 14, and 25 were aged 14+ (Table 1). There were no recurrences. Paresis of the facial nerve was reported in 32, all of whom improved gradually over 3–6 months with exercises. Mean mouth opening was 32.5 mm.

Discussion

Treatment of ankylosis of the TMJ should be based on reproducing a joint that will function in the required way, have the ability to adapt to functional changes, and the ability to repair itself and survive in the long term.

Patients in group 1 were treated by release of the ankylosis and arthroplasty using a temporalis myofascial flap and a costochondral graft. Muscle with fascia acts as a cushion and lubricant, giving frictionless movements.[4–6] The flap was rotated under the zygomatic arch because taking the flap over the arch causes an undesirable bulge over the zygomatic arch and may also cause atrophy of the flap as a result of compression of its blood supply.[7]

Costochondral grafts have proved to be best, as there is similarity between the costochondral graft and the condyle in its capacity to repair and adapt to functional requirements.[8–11]

Just 4 mm of contoured cartilage was taken, because a long portion of cartilaginous tissue was prone to disarticulation at the costochondral junction, with the cartilage being displaced and dislocated. This resulted in the ramus being ankylosed to the cranial base. A longer cartilaginous segment always led to unpredictable growth.[12–14]

We are not in favour of aggressive physiotherapy. Underdeveloped soft tissues, muscles, and ligaments resist excessive opening. Aggressive physiotherapy causes excessive strain on the musculature and painful mouth opening, which makes patients less likely to cooperate. Vigorous physiotherapy also interferes with the "take" of the costochondral graft. Physiotherapy that is tolerated by patients includes day-to-day movements of jaw while eating. We think that reankylosis occurs as a result of: inadequate resection of the ankylotic mass; inadequate interposition; inadequate covering of the cranial aspect; or fracture of the costochondral graft.

It has been mentioned that mouth opening during exercise causes collapse of the upper airway that exacerbates apnoea-like episodes.[15] If the exercises are done when the patient is fully awake there are no such problems.

In adults, posterior border sliding osteotomy was done 3 months after stage 1. This technique provides the bone of required size, shape, and histological characteristics of neo condyle similar to lost condyle. Also the medial pterygoid muscle carries enough blood supply preventing chances of resorption or necrosis.[16] Moderate displacement of the bony fragments leaves enough bone contact to form a fracture callus, restoring continuity of the new ramus that is capable of resisting mastication forces.[17–19]

For transport distraction, the transport disc was created by reverse-L osteotomy with attached periosteum, and the medial pterygoid muscle was distracted towards the cranial base until they made contact and the required height of ramus was achieved. The distractor device should be removed after radiographic confirmation of consolidation (usually after 2–3 months). When distraction was more than 2 cm the consolidation period was extended to 4–6 months, and the device was removed only after radiographic confirmation. Stucki–McCormick suggested that by five weeks the transported disc gets covered with fibrocartilage and becomes neocondyle. He noted an intervening fibrous tissue layer in magnetic resonance scans taken after distraction, which apparently acted as a pseudodisc.[20] Other studies have reported the biological principles of bone formation at the trailing edge and fibrocartilage formation at the leading edge of the disc.[21,22]

Table 2
Protocol for the future management of ankylosis of the temporomandibular joint.

Stage:	Children	Adults
I	Gap arthroplasty Coronoidectomy bilaterally, mouth opening >40 mm Interposition with temporalis myofascial flap Costochondral graft No active physiotherapy	Gap arthroplasty Bilateral coronoidectomy, mouth opening >40 mm Interposition with temporalis myofascial flap No active physiotherapy
II	After six months: distraction osteogenesis Orthognathic procedures after patient is 18 years old	After three months, depending on the height of the ramus: Posterior border sliding osteotomy, if ramus length is adequate **OR** Transport distraction if height is less **OR** Total joint replacement

When distraction was necessary before release of ankylosis, particularly in bilateral cases, we found that when a uniplanar distractor was used during the process of distraction, the advanced segment got stuck behind the premaxilla, which prevented further distraction. There was also an increased risk of airway obstruction by postoperative oedema. In these cases we stopped distraction, released the ankylosis, and then finished the distraction.

When the release of the ankylosis and distraction were done simultaneously, we found that after release of the ankylosis and interposition with a temporalis myofascial flap and costochondral graft, the joint was not strong enough to take the pressure of distraction. It therefore gave in to the stress and directly affected the distraction, resulting in a poor outcome.[23]

We therefore recommend the two-stage protocol, where we release the ankylosis, place the temporalis myofascial flap and costochondral graft, and then wait for six months before distraction. By this time, the neojoint has stabilised, and is strong enough to take the load of the distraction.

Distraction osteogenesis and genioplasty stop the patient from developing obstructive sleep apnoea. Distraction gives a controlled distractive force, which leads to elongation of the bone and the surrounding soft tissues, and stabilises the result. Genioplasty after distraction further pulls the geniohyoid, genioglossus, and anterior belly of the digastric muscles, and repositions them to minimise the fall of the tongue that is responsible for obstructive sleep apnoea.

Indications for total joint replacement were limited to adult patients with recurrent ankylosis. We do not use total joint replacement in children as it does not work and would need to be replaced. It is also too expensive for many patients. We have used TMJ prostheses in a few cases, but do not have long-term follow up so we cannot comment at this stage.

Conclusion

We have drawn up a protocol for the management of TMJ ankylosis (Table 2) with the objectives of reconstructing a joint that will fulfill its functional requirements, correct the deformity and aesthetics in the long term, and add to the choice of procedures for correcting the aesthetic deformity.

Ethics statement/confirmation of patients' permission

Neither was required.

Conflict of interest

We have no conflicts of interest.

References

1. Bello SA, Aluko Olokun B, Olaitan AA, et al. Aetiology and presentation of ankylosis of the temporomandibular joint: report of 23 cases from Abuja, Nigeria. *Br J Oral Maxillofac Surg* 2012;**50**:80–4.
2. Arakeri G, Kusanale A, Zaki GA, et al. Pathogenesis of post-traumatic ankylosis of the temporomandibular joint: a critical review. *Br J Oral Maxillofac Surg* 2012;**50**:8–12.
3. Al-Moraissi EA, El-Sharkawy TM, Mounair RM, et al. A systematic review and meta-analysis of the clinical outcomes for various surgical modalities in the management of temporomandibular joint ankylosis. *Int J Oral Maxillofac Surg* 2015;**44**:470–82.
4. Pogrel MA, Kaban LB. The role of a temporalis fascia and muscle flap in temporomandibular joint surgery. *J Oral Maxillofac Surg* 1990;**48**:14–9.
5. Zhi K, Ren W, Zhou H, et al. Management of temporomandibular joint ankylosis: 11 years' clinical experience. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009;**108**:687–92.
6. Feinberg SE, Larsen PE. The use of a pedicled temporalis muscle-pericranial flap for replacement of the TMJ disc: preliminary report. *J Oral Maxillofac Surg* 1989;**47**:142–6.
7. Chossegros C, Guyot L, Cheynet F, et al. Comparison of different materials for interposition arthroplasty in treatment of temporomandibular joint ankylosis surgery: long-term follow-up in 25 cases. *Br J Oral Maxillofac Surg* 1997;**35**:157–60.
8. Medra AM. Follow up of mandibular costochondral grafts after release of ankylosis of the temporomandibular joints. *Br J Oral Maxillofac Surg* 2005;**43**:118–22.
9. Qudah MA, Qudeimat MA, Al-Maaita J. Treatment of TMJ ankylosis in Jordanian children—A comparison of two surgical techniques. *J Craniomaxillofac Surg* 2005;**33**:30–6.
10. Matsuura H, Miyamoto H, Kurita K, et al. The effect of autogenous costochondral grafts on temporomandibular joint fibrous and bony ankylosis: A preliminary experimental study. *J Oral Maxillofac Surg* 2006;**64**:1517–25.
11. Kaban LB, Bouchard C, Trouli MJ. A protocol for management of temporomandibular joint ankylosis in children. *J Oral Maxillofac Surg* 2009;**67**:1966–78.
12. Movahed R, Mercuri LG. Management of temporomandibular joint ankylosis. *Oral Maxillofacial Surg Clin N Am* 2015;**27**:27–35.

13. Perrott DH, Umeda H, Kaban LB. Costochondral graft construction/reconstruction of the ramus/condyle unit: long-term follow-up. *Int J Oral Maxillofac Surg* 1994;**23**:321–8.
14. Katsnelson A, Markiewicz MR, Keith DA, et al. Operative management of temporomandibular joint ankylosis: a systematic review and meta-analysis. *J Oral Maxillofac Surg* 2012;**70**:531–6.
15. Andrade NN, Raikwar KR. Management of patients with obstructive sleep apnoea induced by temporomandibular joint ankylosis: a novel 2-stage surgical protocol and report of 5 cases. *Asian J Oral Maxillofac Surg* 2009;**21**:27–32.
16. Liu Y, Khadka A, Li J, et al. Sliding reconstruction of the condyle using posterior border of mandibular ramus in patients with temporomandibular joint ankylosis. *Int J Oral Maxillofac Surg* 2011;**40**:1238–45.
17. Loftus MJ, Bennett JA, Fantasia JE. Osteochondroma of the mandibular condyles. Report of three cases and review of the literature. *Oral Surg Oral Med Oral Pathol* 1986;**61**:221–6.
18. Martinez-Lage JL, Gonzales J, Pineda A, et al. Condylar reconstruction by oblique sliding vertical ramus osteotomy. *J Craniomaxillofac Surg* 2004;**32**:155–60.
19. González-Otero S, Navarro-Cuéllar C, Escrig-de Teigeiro M, et al. Osteochondroma of the mandible condyle: Resection and reconstruction using vertical sliding osteotomy of the mandibular ramus. *Med Oral Pathol Oral Cir Buccal* 2009;**14**:e194–7.
20. Stucki-McCormick SU. Reconstruction of the mandibular condyle using transport distraction osteogenesis. *J Craniofac Surg* 1997;**8**:48–53.
21. Bosanquet AG, Goss AN. The sheep as a model for temporomandibular joint surgery. *Int J Oral Maxillofac Surg* 1987;**16**:600–3.
22. Zhu S, Hu J, Li J, et al. Reconstruction of mandibular condyle by transport distraction osteogenesis: Experimental study in rhesus monkey. *J Oral Maxillofac Surg* 2006;**64**:1487–92.
23. Zhang W, Yang X, Zhang Y, et al. The sequential treatment of temporomandibular joint ankylosis with secondary deformities by distraction osteogenesis and arthroplasty or TMJ reconstruction. *Int J Oral Maxillofac Surg* 2018;**47**:1052–9.