Surgical treatment of type III temporomandibular joint ankylosis with a lateral arthroplasty while retaining the medially displaced condyle

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ABSTRACT

INTRODUCTION We discuss our findings on the retention of the medially displaced residual condyle during the treatment of type III temporomandibular joint ankylosis, as well as the postoperative results observed during follow-up.

MATERIALS AND METHODS Thirty-two patients with type III temporomandibular joint ankylosis that met the inclusion criteria of the study were included as subjects. The morphological integrity of the medially displaced residual condyle was verified in all of the participating patients through the use of cone beam computed tomography. The duration of the ankylosis ranged from 2 to 12 years. The maximum length that patients were able to open their mouths ranged from 6 mm to 14 mm. The surgical treatments used in this report included the separation of bony fusions between the condyle and the glenoid fossa, resection of the ankylosed sites, preservation of the displaced condyles in their medial position and suturing the remains of the disc to its typical position or taking the temporalis myofascial flap instead. The long-term results were evaluated by computed tomography and clinical follow-up examinations.

RESULTS Three-year postoperative follow-up examinations were performed for all of the patients included in this study. No recurrences were observed in the patients who adhered to the postoperative therapeutic advice. Patients had an average maximal mouth opening distance of 34.50 ± 5.75 mm as recorded during the final follow-up examination.

CONCLUSIONS The released medially residual condyle can still function normally in temporomandibular joint movement and without reankylosis after a bone fusion resection. The displaced condyle should thus be preserved instead of being removed during the treatment of type III temporomandibular joint ankylosis.

KEYWORDS

TMJ ankylosis – Temporomandibular joint – Medially displaced condyle – Maximal mouth opening

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Introduction

Temporomandibular joint (TMJ) ankylosis is a refractory disease that restricts the movement of the mouth and its ability to open and can lead to subsequent maxillofacial deformities, speech impediments, difficulty chewing and narrow airways for patients who are at ages of active growth. The aetiology of TMJ ankylosis includes the fusion of the condyle and disc to the glenoid fossa by bone or fibrous tissue and is primarily caused by trauma, infection or secondary to treatment of a mandibular condylar fracture or other TMJ diseases.^{1,2}

In general, the treatment for TMJ ankylosis aims to establish mandibular movement and TMJ functionality. To accomplish this, the bone fusion must be completely removed and the condyle or its substitute needs to maintain normal physiological function. A key component in the treatment of TMJ ankylosis is the approach taken to restore

the original height of the mandibular ramus while preventing direct contact between the condylar process and the glenoid fossa. The most commonly used treatment involves completely removing the joint ankylosis and displacing the residual condyle by a graft of costal cartilage or the mandibular coronoid process.^{3,4} However, it can be difficult to achieve these goals perfectly through the use of prosthetics or autogenous costochondrals. Additionally, these surgeries are generally time consuming and traumatic. As a result, it is important to determine whether it is possible to preserve the original condyle during surgery, as well as the circumstances under which the original condyle is retained.

In 1986, Sawhney was the first to classify TMJ ankylosis into four types according to the anatomical relationships between the TMJ structure and the osseous fusion.⁵ According to this classification, ankylosis type I is caused by fibrous adhesion in and around the joints but with less bone fusion in the TMJ. Ankylosis type II has bone fusion

around the lateral surface of the joint, but there is no additional bone fusion in the central region of the TMJ. Ankylosis type III can be caused by any injury to the condyle, whether treated or not, and is characterised by bone fusion between the mandibular ramus and glenoid fossa, and can even implicate the zygomatic arch. The condyle is medially displaced and may be reduced in size, but the surface of the joint maintains an identifiable anatomical structure. In ankylosis type IV, the entire joint is replaced by a bone fusion, which can even implicate the mandibular coronoid process, making it difficult to identify the anatomical structure of the TMJ.

In 1998, Nitzan *et al* reported that four patients with ankylosis type III underwent a bone fusion resection, and the medially displaced condyles were left in that position.⁶ Normal functionality of the TMJ was restored for all patients and the mandibles of the two young patients resumed normal development. As a result, we believe that when the anatomical structure of the medially displaced condyle is relatively identifiable and the condyle is properly positioned in patients with ankylosis type III, the condyle can be preserved rather than having it removed and replaced by a grafted substitute. A lateral arthroplasty that respects the lateral bone fusion but does not replace the joint could be sufficient to release type III TMJ ankylosis, and the long-term results of this method should be studied. Here, we seek to further confirm this hypothesis and to report our experiences.

Materials and methods

Patient inclusion

This retrospective study was approved by the regional ethics committee of Guangxi Medical University. A signed informed consent was obtained from all patients. The study included 32 patients with type III TMJ ankylosis who were treated between 2013 and 2015 at the oral and maxillofacial surgery department of the College and Hospital of Stomatology, Guangxi Medical University. The study group consisted of 20 unilateral and 12 bilateral cases and, within the unilateral group, there were 11 left-sided cases and 9 right-sided cases. The duration of TMJ ankylosis ranged from 2 to 12 years. Detailed clinical information for the patients is presented in Table 1. The chief complaint registered by patients was that their ability to open their mouth was severely limited, which led to difficulties with eating and speech. The diagnosis was established using clinical examinations and cone beam computed tomography (CBCT) of the TMJ. The coronal reconstructions of radiographic findings showed medially displaced condyles with bony fusions on their lateral aspects, and the residual condyle fragments maintained their basic original morphological integrity. Clinical examination included the evaluation of facial appearance and maximal mouth opening, which ranged from 6 mm to 14 mm. Exclusion criteria included cases that involved other types of TMJ ankylosis or recurrence.

Surgical method

Surgical procedures were performed under general anaesthesia via nasotracheal intubations. An extended approach with sufficient exposure was made in the preauricular region, and tissues were dissected by layers to expose the bony fusion through the use of blunt separation (Figure 1). Using CBCT images as a guide, a careful resection was performed with an electric saw to remove the lateral portion of the bony fusion. Next, a bone slot between the glenoid fossa and the ankylosed condyle was made using an electric drill, and care was taken to protect the residual medially displaced condyle while resecting the bony fusion. The fused condyle and joint fossa were separated using a chisel (Figures 2 and 3).

Once these steps have been completed, the displaced condyle could be exposed (Figure 4). A search was then conducted to identify the residual disc. When the structure of disc was relatively intact, it was released from the bony fusion and sutured to its typical position. When the disc was broken or degenerated, the temporal fascia flap was used to replace it by interposing it into the space of the lateral bone resection to prevent the recurrence of ankylosis. Mandibular movement and maximal mouth opening were checked once the TMJ was released. If maximal mouth opening after surgery was less than 30 mm, a coronoidectomy was considered for the ankylosed side to increase maximal mouth opening.

Postoperative management and follow-up evaluation

Physiotherapy began from postoperative day 5 and lasted for seven days, to facilitate the rehabilitation of mandibular movements and to prevent the recurrence of ankylosis. The rehabilitation methods included active and passive exercises for mandibular movement and maximal opening of the mouth. A follow-up was performed for all patients at one month, one year and three years postoperatively (Figures 5 and 6). The postoperative findings were compared with preoperative symptoms through clinical examination of maximal mouth opening, imaging features and CBCT. The statistical analyses were performed using SPSS version 19.0. A paired *t*-test was used to determine the significance of improvements in maximal mouth opening. A *P*-value of ≤ 0.05 was considered significant.

Results

A total of 32 patients and 44 ankylosed joints were evaluated in this study. Contact was maintained with all patients and a three-year follow-up was performed. A surgical release was performed on all joints with ankylosis and the temporalis myofascial flaps were used to replace the original discs in six joints. Ipsilateral coronoidectomy was also performed in four cases. Significant improvements in maximal mouth opening and mandibular movement were observed for all cases. The mean length of preoperative maximal mouth opening was 9.87 ± 2.39 mm (ranging from 6–14 mm), which improved to 34.50 ± 5.75 mm (ranging from 7–42 mm) when measured at the latest

Table 1 clinical information of all the patients with ankylosis type III in the study.

Patient number	Sex	Age (years)	Aetiology	Age at the time of injury (years)	Previous treatment	Side of TMJ ankylosis	Angulation between condylar and ramus	Preoperative maximal mouth opening (mm)	Maximal mouth opening at last follow-up (mm)	Disc material in joint cavity
1	M	19	accidental fall	17	untreated	bilateral	R: 148 degrees L: 122.1 degrees	12	36	original discs in both sides
2	M	24	violence	20	untreated	left	149.1 degrees	14	39	original disc
3	M	14	accidental fall	10	untreated	bilateral	R: 127.2 degrees L: 121.4 degrees	10	7	original discs in both sides
4	F	16	accidental impact	11	untreated	right	155.7 degrees	9	35	original disc
5	F	18	accidental fall	16	untreated	right	134.8 degrees	12	40	original disc
6	F	22	traffic accident	18	untreated	left	154.7 degrees	14	35	TMF
7	F	18	unknown	unknown	untreated	bilateral	R: 135.2 degrees L: 120.8 degrees	7	36	original discs in both sides
8	M	25	traffic accident	13	details missing	right	138.4 degrees	13	34	original disc
9	M	16	traffic accident	13	untreated	left	144.7 degrees	9	33	original disc
10	M	18	accidental fall	16	untreated	right	134.4 degrees	10	32	TMF
11	F	21	violence	17	details missing	bilateral	R: 154.4 degrees L: 132.0 degrees	12	31	original discs in both sides
12	M	7	unknown	unknown	untreated	right	126.9 degrees	8	42	original disc
13	F	32	accidental impact	24	open surgery	left	146.6 degrees	12	39	TMF
14	F	25	violence	21	untreated	left	127.1 degrees	9	36	original disc
15	F	21	traffic accident	19	conservative treatment	bilateral	R: 138.0 degrees L: 150.6 degrees	6	34	original discs in both sides
16	F	19	unknown	unknown	untreated	bilateral	R: 143.7 degrees L: 149.0 degrees	9	34	original discs in both sides
17	M	11	accidental impact	8	conservative treatment	bilateral	R: 130.4 degrees L: 152.4 degrees	11	31	original discs in both sides
18	F	21	accidental impact	16	untreated	right	135.8 degrees	8	35	TMF
19	F	17	accidental fall	12	untreated	left	124.2 degrees	6	38	TMF
20	F	10	accidental impact	7	conservative treatment	left	157.3 degrees	13	35	original disc
21	F	22	accidental fall	18	conservative treatment	left	114.2 degrees	7	33	TMF
22	M	18	unknown	15	untreated	bilateral	R: 149.5 degrees L: 136.5 degrees	10	38	original discs in both sides
23	M	24	unknown	18	untreated	left	131.7 degrees	11	32	TMF
24	F	12	accidental impact	9	conservative treatment	left	139.5 degrees	8	33	original disc

Table 1 (Continued)										
25	M	19	unknown	unknown	untreated	bilateral	R: 142.8 degrees L: 144.6 degrees	6	31	TMF in left side; original disc in right side
26	F	16	violence	13	untreated	bilateral	R: 137.5 degrees L: 130.2 degrees	12	34	TMF in left side; original disc in right side
27	F	22	accidental fall	17	untreated	right	143.9 degrees	9	35	TMF
28	M	23	accidental impact	20	untreated	bilateral	R: 155.6 degrees L: 156.3 degrees	13	37	original discs in both sides
29	F	18	unknown	unknown	untreated	right	160 degrees	11	34	original disc
30	M	23	accidental fall	16	open surgery	left	135.2 degrees	8	37	original disc
31	M	18	accidental fall	12	untreated	right	142.2 degrees	10	38	TMF
32	F	21	accidental fall	16	untreated	bilateral	R: 142.4 degrees L: 148.0 degrees	7	40	original discs in both sides
F, female; L, left; M, male; R, right; TMF, temporalis myofascial flaps.

Figure 1 The temporomandibular joint ankylosis.

follow-up. The difference in maximal mouth opening between pre- and postoperative time points was statistically significant with a *P*-value less than 0.05. The postoperative data for maximal mouth opening are shown in Table 1. There were no instances of haemorrhages, severe

Figure 2 Preoperative cone beam computed tomography.

Figure 3 Postoperative cone beam computed tomography.

infections or neurosensory deficits of the facial nerve following surgery. Additionally, palpation of the masticatory muscles or on the region of the joint elicited no pain. Follow-up CBCT was performed for comparison with the

Figure 5 Preoperative mouth opening.

previous CBCT and to evaluate changes in the joint. One patient did not choose to undergo postoperative physiotherapy and experienced gradual restrictions in mouth opening

Figure 4 The residual condyle (point by black arrow) and disc after resecting lateral bone fusion.

Figure 6 Patient's mouth opening at final follow-up.

within one year and a subsequent relapse that was confirmed by CBCT after postoperative year 3. The periodic CBCT for all other patients showed that the medially bending condyles and glenoid fossas form new and functional joints. The lateral osseous fusion had been completely resected and an adequate intra-articular space was maintained without ankylosis (Figure 3). Occlusion was normal in all cases after the procedure, and the original height of the mandibular ramus was maintained. No postoperative open bites or deviations in the mouth opening were observed.

Discussion

TMJ ankylosis is one of the most severe maxillofacial diseases and has a profound effect on a patient's daily life. The most commonly used surgical method is to completely remove the bone fusion and replace the condyle with a graft of costal cartilage, the mandibular coronoid process or an artificial joint. However, studies now show that the graft surgery may be associated with several complications and impacts after surgery. First, the donor sites may experience postoperative trauma, including pneumothorax or fractures.⁵ Second, the artificial materials can be rejected, which is a common and troublesome risk in joint reconstruction. Third, errors in determining the correct height of ramus during joint replacement surgery can lead to an open bite or mandibular deviations, which often require long periods of elastic traction or even a sagittal split ramus osteotomy. Finally, the autologous bone graft may result in unpredictable overgrowth of the mandibular ramus.⁷⁻⁹ Therefore, it is clear that the surgical approach taken for condyle replacement should be chosen with caution.

In the cases with ankylosis type IV, the condyle, disc and glenoid fossa are bridged together by an osseous fusion and cannot be separated from each other since their basic anatomical structure has been lost. As a result, a joint reconstruction following the complete resection of the bone fusion is required. However, the bone fusion that occurs in ankylosis type III is typically between the mandibular ramus and the zygomatic arch and, since the condyle maintains its basic anatomical structure, it is possible to reach a satisfactory therapeutic outcome by retaining the medially displaced condyle and resetting the original joint disc. This hypothesis was first proposed by Nitzan *et al* and our results support the hypothesis.⁶ Although bone fusion can occasionally affect portions of the glenoid fossa in cases of ankylosis type III, we found that the majority of the medially displaced condyles maintained their basic anatomical structure and were opposite of the working surface of the glenoid fossa.

After removing the bone fusion from the lateral aspect of the TMJ, the residual condyles of the 32 patients were retained at their medially displaced positions. The mean measurement of maximum mouth opening for all patients was 34.50 ± 5.75 mm and excluding the one patient who neglected postoperative physiotherapy and eventually experienced a relapse, a total of 31 of the 32 patients stably

maintained these effects at their follow-up examinations. Our results demonstrate that it is possible to preserve the condyle. We believe that, when compared to graft procedures, there are a number of advantages offered by a lateral arthroplasty paired with the preservation of the residual condyle. First, the medially displaced condyle is more likely to maintain normal functionality while avoiding the risks associated with graft surgery. Second, the height of the remaining mandibular ramus did not change, which reduces the risk of developing an open bite. Finally, preserving the condyle may help to maximise the retention of growth potential. For example, Long X *et al* reported an 11-year-old girl that developed a new condyle 3 years postoperatively.¹⁰ Moreover, in instances where a patient's mouth cannot open more than 30 mm following condyle preservation, a coronoidectomy may be sufficient to restore function without necessitating a condylar replacement. Kumar P *et al* reported that patients who underwent an additional coronoidectomy displayed better mouth opening when compared to patients who did not.¹¹ Reaching a sufficient degree of improvement in mouth opening in this procedure helps reduce the risk of recurrence and facilitates the patient's postoperative physical therapy, so an additional coronoidectomy should be performed when deemed necessary. Additionally, postoperative physiotherapy should begin as early as possible, as the only case of recurrence observed in this study resulted primarily from the negligence of postoperative physiotherapy.

In this study, radiographic examination played a vital role in developing the preoperative plans and in evaluating the results. Radiographic findings enabled the identification of the type of ankylosis, the residual condyle size and the condyle's spatial relationship with the glenoid fossa. It is also important to identify the thickness of the condylar neck using preoperative CBCT. Surgeons may find it difficult to intuitively assess the thickness of the osteotomy when resecting the bone fusion on the lateral side of the condyle, which may lead to excessive bone resection and a weakening of the condyle neck. Using CBCT to predict preoperative osteotomy determination can help mitigate this risk. However, the joint disc could not be clearly identified with CBCT, so preparations for the reconstruction of the disc should still be made. A broken disc could still be identified during the procedure but may have developed breakable scar tissue or adhered to the bone fusion. He *et al* believed that the absence of a relatively complete disc or adipose tissue in the joint space can lead to significant increases in the re-ankylosis rate.¹² Singh *et al* reported that patients with ankylosis type III who accepted temporalis myofascial flaps as discs had long-term stable therapeutic effects.¹⁵ In a study of 791 patients with TMJ ankylosis, Mehrotra *et al* mentioned dermal fat interposition arthroplasty should be considered as an important choice for management of TMJ ankylosis.¹⁴ Dimitroulis *et al* also found that free fat insertion can reduce the recurrence of TMJ ankylosis through clinical and animal experiments.^{15,16} Thangavelu *et al* confirmed the long-term survival rate of free fat which insert in joint space by magnetic resonance imaging.¹⁷ Importantly, disc destruction is not uncommon.

In this study, 15.6% (6/44) joints required the use of temporalis myofascial flaps to replace broken discs. The insertion of soft tissue between the condyle and glenoid fossa is essential for the reduction of recurrence.

In conclusion, our findings suggest that medianly displaced condyles should be retained in ankylosis type III when they maintain their basic anatomical structure. Further, we show that a lateral arthroplasty that only resects the lateral bone fusion without replacing the joint can be sufficient to release type III TMJ ankylosis. This method may enable young patients to maintain the growth potential of their mandibular ramus.

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