The Sequential Treatment of Temporomandibular Joint Ankylosis with Secondary Deformities by Distraction Osteogenesis

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Abstract

Objective: To evaluate the effect of the sequential treatment of temporomandibular joint ankylosis with secondary deformities by distraction osteogenesis.

Methods: We retrospectively studied 40 patients with temporomandibular joint ankylosis, whose age varied from 9 to 53 years old (average 24.5 years old), in the department of Oral and Maxillofacial Surgery, Stomatological Hospital, the Fourth Military Medical University. Among them, 11 patients were diagnosed as unilateral temporomandibular joint ankylosis, 29 were diagnosed as bilateral joint ankylosis. OSAHS was found in 27 patients. All patients underwent distraction osteogenesis as the initial surgery, followed by arthroplasty. The orthognathic treatment was performed along with or after the arthroplasty. The therapeutic effect was evaluated by the improvement of MIO, appearance, and respiratory function.

Results: After the treatment procedure was ended, all patients' mouth opening and appearance were improved remarkably, and the symptom of snoring disappeared. The patients were followed up for 4 to 72 months (average 20.5), only 4 patients were recurrent, and needed further surgical treatment.

Conclusion: Our data suggests that the sequential treatment of temporomandibular joint ankylosis with secondary deformities by distraction osteogenesis, arthroplasty, and orthognathic surgery could achieve satisfactory and stable results.

ABBREVIATIONS

TMJ: Temporomandibular Joint; OSAHS: Obstructive Sleep Apnea and Hypopnea Syndrome; DO: distraction osteogenesis; MIO: Maximal Incisal Opening

INTRODUCTION

Temporomandibular joint ankylosis is a serious condition which refers to adhesion of mandibular condyle to the glenoid fossa and the surrounding structures leading to the succedent loss of function [1]. Due to the condyle’s special function as the mandibular growth center, if TMJ ankylosis occurs at childhood, it may predispose patients to growth deformities, which can result in either mandibular asymmetry deformity in unilateral TMJ ankylosis or maxillo-mandibular disharmony in bilateral ankylosis. But if TMJ ankylosis happens after the patients have already completed growth, it just result in are striction of jaw opening. The typical clinical features including: limited mouth opening, hypomobility of the mandible, facial asymmetry, retrogenia, micrognathia, crowded dentition, malocclusion and even obstructive sleep apnea and hypopnea syndrome (OSAHS). Trauma, local or systemic infection, iatrogenic factors including previous TMJ surgery and irradiation, burn, genetic factor may all contribute to this disease. Among of above factors, trauma and infection are the major pathogeny [2,3]. The surgical management of TMJ ankylosis accompanied by dentofacial deformities requires restoration of facial morphology and function, along with occlusal stability and prevention of re-ankylosis. A variety of surgical procedures have been described in the literature, including gap arthroplasty, interpositional arthroplasty, joint reconstruction using autogenous bone grafting or alloplastic materials, and orthognathic surgery. Due to the unique structure of TMJ and its special physiological functions, no single technique could produce complete satisfactory outcomes. Besides traditional bone grafting and orthognathic surgery have the following disadvantages: bone absorption, osteonecrosis, donor site morbidity, limited advancement, and so on [4]. Recently distraction osteogenesis has become more and more popular after Gavril Ilizarov applied this technology to widen or lengthen limbs in 1950s. It could...
stretch the bone and surrounding soft tissues at the same time through progressively controlled fracture separation, and it is theoretically possible to extend any distance. Besides this technology may replace the traditional bone graft, reduce surgical trauma, avoid functional defects of the donor sites, and decrease the recurrence risk [5,6]. However, there is still controversy over the sequence of using distraction osteogenesis and arthroplasty to deal with TMJ ankylosis with secondary deformities. In this study, we report the therapeutic efficacy and procedure of 40 patients with TMJ ankylosis and secondary deformities in our department from April 2006 to December 2014.

MATERIALS AND METHODS

Patients

40 patients (male 19, female 21) presenting with TMJ ankylosis and secondary deformities, ranging in age from 9 to 53 years (mean 24.5 years), were selected for this study. 11 patients were diagnosed as unilateral TMJ ankylosis, and 29 patients were bilateral TMJ ankylosis (Table 1). The etiologies include trauma 31 patients, 77.5%, infection 1 patient, 2.5%), congenital (1 patient, 2.5%), unknown 7 patients, 17.5%, 3 of them may caused by forceps injury (Chart 1). Among of them, 17 patients

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Abbreviations: Pre—pre-operative; Post—post-operative
hemostasis, and then closed the soft tissues carefully. 8 patients
the wound was closed. Irrigated with saline after meticulous
make sure that there didn't exist obvious bone resistance before
2 or 3 screws on each side. The distractor should be activated to
the intraoral distractor in the original site, and then fixed with
mind to protect the inferior alveolar nerves and vessels. Placed
cortex and cancellous bone completely by osteotome, and kept in
the designed position during the preparation phase. Chiselled the
oscillating saw to mark the location of osteotomy cut according to
and (or) ramus of the mandible adequately. Then we used
operation. Separated surrounding tissues to exposure the body
and preserving the marginal mandibular nerve in the first
approach was through a submandibular incision for aesthetics
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3 to 6 months for the chamb
distraction proceeds, the regenerate chamberbe came enlarged
regularly to know the proceeding of distraction osteogenesis. As
During the activation period, the patients should take X-ray films
of 0.8 to 1.0mm/day, which should divide into two to four times.
latency period, activation of the distractor was initiated at a rate
intubation postoperatively for 24 to 48 hours. After 4 to 7 days of
and submental region. Most patients kept with endotracheal
activation arms were taken out from angle of the mandible
underwent prophylactic
Etiology of the 40 patients with temporomandibular joint
ankylosis.
(42.5%) had the history of TMJ surgery to release the ankylosis. All patients were accompanied by retrogenia or micrognathia. 27 patients were accompanied with obstructive sleep apnea and hypopnea syndrome(OSAHS) confirming by Polysomnography examination (PSG), and 8 of them was diagnosed as mild OSAHS, 5 was moderate, 14 was severe.

The medical history, physical examination, radiographic
examination including panoramic, cephalometric radiographs
and computed tomography (CT) are essential to determine the
diagnosis and evaluate the extent of ankylosis mass.

Treatment

Surgery for distraction device insetting: The surgical
approach was through a submandibular incision for aesthetics
and preserving the marginal mandibular nerve in the first
operation. Separated surrounding tissues to exposure the body
and (or) ramus of the mandible adequately. Then we used
oscillating saw to mark the location of osteotomy cut according to
the designed position during the preparation phase. Chiselled the
cortex and cancellous bone completely by osteotome, and kept in
mind to protect the inferior alveolar nerves and vessels. Placed
the intraoral distractor in the original site, and then fixed with
2 or 3 screws on each side. The distractor should be activated to
make sure that there didn’t exist obvious bone resistance before
the wound was closed. Irrigated with saline after meticulous
hemostasis, and then closed the soft tissues carefully. 8 patients
underwent prophylactic tracheostomy at the same time. The
activation arms were taken out from angle of the mandible
and submental region. Most patients kept with endotracheal
intubation postoperatively for 24 to 48 hours. After 4 to 7 days of
latency period, activation of the distractor was initiated at a rate
of 0.8 to 1.0mm/day, which should divide into two to four times.
During the activation period, the patients should take X-ray films
regularly to know the proceeding of distraction osteogenesis. As
distraction proceeds, the regenerate chamberbe came enlarged
and was filled initially with a weak fibrous matrix. When the
desired position and distance was achieved, there still needed
3 to 6 months for the chamber to complete bone mineralization
and reconstruction.

Surgery for releasing of ankylosis: Distractors could be
removed at the second stage when a cortical outline can be seen on
radiographs. At the same time, all patients underwent arthroplasty
to release the ankylosed joints. An extended preauricular incision
was used to expose the TMJ region and the root of the zygomatic
arch sufficiently. The temporal branches of facial nerve should be
protected carefully. Opened the articular capsule to fully expose
the condyle, and then marked the osteotomy cut by round bur.
Ankylyotic mass should be totally resected, keeping in mind to
protect the surrounding tissues. Rubed off the bone tips of the
condyle and glenoid fossa to generate smooth bone surface and
create a gap of about 1.0 to 2.5cm, which was depended upon the
size of the ankylosic mass. Anipsilateral and/or contralateral
coronoidectomy was performed if the passive maximal opening
was less than 3cm to guarantee the MIO was at least 3.5cm.
According to the patient personal condition to choose the residual
disc, temporals fascia flap or titanium mesh to interpose in the
resulting gap. If the absolute height was not enough, we used
autogenous coronoid process, costochondral graft or prosthesis
to reconstruct the condyle. Active physical exercises should be
started on the seventh day postoperative, and exercises should
be done at least 4 times each day and at least 20 minutes each
time. Patients should perform the exercises for at least 6 months
to reduce the risk of relapse (Figures 1-4).

Surgery for Correction of the Secondary Deformities:
According to patients’ financial condition, they could choose
orthognathic surgery to further improve the facial profile. The
orthognathic surgical procedures mainly included genioplasty,
LeFort I osteotomy of maxilla and sagittal split ramus osteotomy.
The orthognathic surgery could come along with the arthroplasty
at the second stage or perform as the third stage.

Evaluation Criteria

Clinical outcomes were evaluated by maximal in cisal opening
(MIO), appearance and respiratory function. The improvement
of MIO was accessed by pre-operative MIO, post-operative MIO and
MIO at the latest follow-up. The esthetic outcome was judged by
the patients themselves by medical photography, and airway and
snoring were used to evaluate the respiratory function of OSAHS

Figure 1 This patient was a 20-year-old male who suffered from
trauma at six, and was diagnosed as bilateral TMJankylosis, micrognathia and severe OSAHS. A, Frontal view before treatment; B, Lateral view before treatment; C, Lateral cephalogram before treatment; D, Frontal view after treatment; E, Lateral view after treatment; F, Lateral cephalogram after treatment.

Chart 1 Etiology of the 40 patients with temporomandibular joint
ankylosis.
patients. Relapse of ankylosis was confirmed if MIO was less than 25 mm.

RESULTS AND DISCUSSION

All patients’ MIO had been improved significantly after arthroplasty. The post-operative MIO of all patients was at least 3.5 cm, and the MIO at the latest follow-up was at least 2.5 cm except 4 recurrent patients. As to the esthetic outcome, 40 patients were all satisfied with the surgical outcome.

As to the 27 patients that accompanied by OSAHS, the airway space was all significantly amplified assessed by cephalometric radiographs after DO. The symptom of snoring of 2 patients with severe OSAHS disappeared, and the others alleviated significantly after DO. The snoring disappeared completely after the arthroplasty and genioplasty.

1 patient with unilateral TMJ ankylosis felt endurable pain in the contralateral healthy joint when the distractor was activated, but the pain was alleviated after reducing the distraction rate. 10 patients were complicated by numbness of lower lip due to intraoperative traction after distractor implanting operation, and 1 felt lower lip numbness because of excessive distraction rate. All of them recovered after taking methocellamine tablets or decreasing distraction speed. 3 patients were infected at rod/pin site and this was managed by daily dressings and oral antibiotics. 1 patient who was diagnosed as infection of submandibular space healed after incision and drainage. There were 2 patients who were found poor bone formation that needed to implant titanium plate for fixation. 2 patients suffered great resistance and severe pain as a result of dental root barrier revealed on the panoramic radiographs that needed surgical procedure to eliminate the resistance.

After the arthroplasty, we adopted two methods to follow up: face to face in hospital and telephone consultations. The patients were followed for 4 to 72 months (average 20.5), 4 patients relapsed. Among of the 4 patients, 3 patients’ MIO was about 1 cm, and 1 patient was 0 cm.

DISCUSSION

Treatment of TMJ ankylosis and secondary deformity remains a significant clinical challenge for surgeons. Currently a variety of surgical technique, such as arthroplasty with or without reconstruction orthognathic surgery distraction osteogenesis autologous bone or bone replacement materials graft and plastic surgery have been described in the literature. In most cases these techniques should be used in combination to achieve satisfactory outcomes. But there is still controversy on the sequence of using distraction osteogenesis and arthroplasty to deal with TMJ ankylosis with secondary deformities. Some surgeons advocate that arthroplasty and distraction osteogenesis should be performed in the same period, thus could improve the restriction of mouth opening and maxillofacial deformity simultaneously, avoid second surgery, and reduce the economic burden of patients. However, it may have the following disadvantages: 1, the effect of distraction osteogenesis may be unsatisfactory because of the unstable condyle; 2, there may exist interference between physical exercises and distraction; 3, there still needs the second surgery to remove the distraction devices [7]. Recently,
transport distraction technique has been utilized to reconstruct a neocondyle. This technique does not require bone graft, and could form a false fibrous disk by compression of the connective tissue between the neocondyle and glenoid fossa to minimize the risks for relapse [8]. But a long-term follow-up study found that the stability and height of the neocondyle is less desirable and stable [9]. Other surgeons persist that arthroplasty should be performed at the first stage to solve the problem of limited mouth opening, and distraction osteogenesis at the second stage. This combination could restore the mobility of mandibular at early phase to ensure the adequate food intake which could prepare themselves for the subsequent more complex operations. And surgeons could adjust the surgical planning based on the individual condition to improve the deformity more accurately. But it may inevitably result in the need of more surgery, and increasing of treatment difficulty of deformity at later stage [10]. We recommend that first utilize distraction osteogenesis to restore the length and location of the mandibular, and then employ arthroplasty and orthognathic surgery to recover the mouth opening and occlusion. This treatment sequence has the following advantages over that 2 procedures above. 1, For OSAHS patients, this treatment sequence has it’s unique advantage of reducing the incidence of postoperative crisis. For patients who were diagnosed as TMJ ankylosis with OSAHS, distraction osteogenesis should be performed before release of the TMJ ankylosis, and thus we could treat mandibular bone deficiency and increase the airway volume at the same time, and the late surgery would be safer. If TMJ ankylosis was released at the first stage, then the already diminished airway space would be further shrunk and may lead to lower blood oxygen saturation or even apnoea that requiring emergency tracheotomy in the post operative period or the late surgery [11]. Jing Hu et al., reported 12 bilateral TMJ ankylosis patients with OSAHS who underwent arthroplasty as the initial stage, followed by orthognathic surgery and distraction osteogenesis. They found 7 patients needed emergency tracheotomy due to apnea and hematomas after mandibular osteotomy. All of our 27 patients with OSAHS underwent preoperative airway evaluation, and 8 of them were given preventive tracheotomy along with the distractor implanting surgery because of the high possibility of apnoea in the post-operative period, and none of the others need emergency tracheotomy. 2, This treatment procedure would be more accurate in improving the appearance. The ankylosed TMJ could act as an anchorage to restrict the proximal bone segment to move backward. If distraction osteogenesis and arthroplasty were performed at the same time, the proximal bone segment would inevitably move backward and neutralize part of effect of distraction osteogenesis. Thus the actual distraction distance would less than the previously designed distance, and this could lead to facial asymmetry and shortage of bone. In preparation phase, we determine the osteotomy site and direction of distraction according to lateral cephalometric X-ray film and computer-aided design. In order to keep the integrity of the dentition and create a large and robust regenerate chamber, the osteotomy cut of mandibular body usually located on the distal part of the second molar. If there is no enough space to insert the distractor, the osteotomy location could be placed between the first and second molar. Bone regeneration during distraction osteogenesis mainly depends on intramembranous ossification, and that the process of healing and mineralization needs sufficient blood supply, so the incision to perform the surgery must be as limited as possible and the periosteum must be kept intact. Bone cortex must be cut completely to reduce the bone resistance during distraction osteogenesis, and pay attention to protect the tooth buds/roots and the inferior alveolar nerve. The stability of the bone segment during distraction osteogenesis must be guaranteed, otherwise instability may lead to chondral ossification, not intramembranous ossification, and also may result in disordered bone trabecular, slow process of mineralization and bone maturation, even fibrous healing. So the vector must keep close contact with the bone, and no space should be left. The consolidation period generally varies from 3 to 6 months which is just based on the quality and quantity of the original bone, the distance of movement, the age of the patient, and the osteotomy site. There were 2 patients who developed complication of poor bone ossification, and we thought that insufficient consolidation period (3 months) and instability might contribute to the complication. So we suggest that the consolidation period should be properly prolonged, but had better not more than 24 months, because that a long-term fixation may result in osteoporosis during to the stress shielding effect. Most surgeons advocate surgery treatment to release the ankylosis as early as possible. The severe extent of secondary deformities depends on the onset, severity and duration of TMJ ankylosis. The earlier the TMJ ankylosis occurs, the longer the duration of the ankylosis, the more serious of the deformities [5]. However we prefer to resolve the TMJ ankylosis and secondary deformities at adulthood, unless the child was accompanied by severe OSAHS or the mouth opening was too small to guarantee adequate nutrition intake. Children are in the growth stage, the development of the profile shows uncertainty. If the patients underwent surgery at childhood, no one could predict the final outcome, and may need extra surgeries to improve the esthetics. Besides children are less cooperative, it is difficult to persist jaw exercises and could lead to a high rate of re-ankylosis [12]. Our experience with releasing TMJ ankylosis in childhood indicates early surgery would have more chance to recurrence. 3 of the four recurrent patients that treated in our hospital were under 18 years old. The problem of re-ankylosis after arthroplasty has always plagued our surgeons. There were 17 of the 40 patients, accounting for 42.5% who had the history of arthroplasty before coming to our department for help. And after being treated with distraction osteogenesis and arthroplasty, unfortunately there were still four patients that had to suffer limited mouth opening again within 2 years. In our department, we try to prevent the recurrence of ankylosis mainly through the following measures: 1, The ankylosic block should be removed completely to create a gap of about 1.0 to 2.5cm. The extent of the resected ankylosic mass is depended on the ankylosis type, volume of the ankylosic block and pathogenic factor. 2, Rub off the bone tips of the condyle and glenoid fossa to generate smooth bone surface. 3, Application of the inter positional graft. Interpositions like temporalis muscle flap, fat, dermis, silicon rubber and titanium all have been described in the literature [1,13-15]. We prefer the temporal fascia flap to reconstruct the disc to reduce the possibility of recurrence. Some researchers believe that the interpositions make little sense for repeatedly relapsed patients, they recommend ramus—condyle unit reconstruction or
interpositional arthroplasty. 4. Coronoidecotomy. Constant tension coming from the temporals of patients with long-term ankylosis could elongate the coronoid process. In view of that, excision of the ankytic joint alone is usually insufficient to provide a satisfactory improvement in mouth opening. In our experience, additional coronoidecotomy (ipsilateral and/or contralateral) is necessary in all patients to achieve an opening of over 35 mm.5. Appropriate time of the operation. If the patient’s condition permits, it is recommended that surgical treatment should be performed after growth basically completed. 6. Early and prolonged postoperative physical therapy. Early mouth-opening exercises could promote absorption of hematocele, and prevent formation and fibrosis of the granulation tissue. Consequently, we recommend that exercises should start 5 to 7 days postoperatively. We found that 3 of our recurrent patients were mainly caused by not keeping up the mouth-opening exercises. So the exercises should continue for at least 6 months, usually 2 years [8,16,17].

CONCLUSION

In conclusion, we recommend distraction osteogenesis as the initial stage and arthroplasty as the second surgery to manage TMJ ankylosis patients with secondary deformities especially those accompanied by OSAHS. This treatment procedure could significantly restore and improve MIO, appearance and airway volume.

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REFERENCES


