

Recurrence-Related Factors of Temporomandibular Joint Ankylosis: A 10-Year Experience



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Purpose: The treatment of temporomandibular joint (TMJ) ankylosis can be challenging for surgeons because of technical difficulties and a high incidence of recurrence. In the present study, we reviewed the data from patients with TMJ ankylosis during a 10-year period and explored the risk factors for recurrence.

Materials and Methods: A retrospective cohort study was conducted to review the data from patients with TMJ ankylosis from January 1, 2006 to December 31, 2015. The predictor variables were age, TMJ ankylosis classification, and treatment method. The primary outcome variable was the recurrence rate of TMJ ankylosis during follow-up. The χ^2 test or Fisher exact test was performed to analyze the differences in the recurrence rate.

Results: A total of 130 patients (59 females and 71 males; age, 3 to 67 years) were included in the present study. All the patients were divided into 3 groups according to their age. The rate of joint reankylosis among the children was 19.1%, which was significantly greater than that of the adults (7.3%; $P < .05$). In the adults, the joint was reconstructed using a coronoid process graft (CPG), distraction osteogenesis, or prosthesis implantation for type III. Among these treatments, CPG resulted in the greatest recurrence rate (26.7%).

Conclusions: Children with ankylosis were found to be more prone to recurrence compared with adults. TMJ ankylosis was also more likely to recur in adults undergoing reconstruction with a CPG.

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Temporomandibular joint (TMJ) ankylosis is a severe mandible movement disorder that causes limited mouth opening, and difficulties in speech and mastication. In a growing pediatric patient, it will affect the development of the mandible, leading to secondary facial deformity, malocclusion, a compromised airway,

and psychological stress.¹ Trauma has been considered the most common cause of ankylosis.^{2,3} Many operative techniques, including gap arthroplasty,^{4,5} interpositional arthroplasty,^{6,7} and TMJ reconstruction with autogenous or alloplastic materials⁸⁻¹¹ have been described. However, they

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have yielded different and unsatisfactory results. Reankylosis has been the most frequently reported complication.^{3,12-15}

However, to the best of our knowledge, no study has yet investigated the risk factors for reankylosis in large samples. In the present study, we reviewed the data from patients with TMJ ankylosis during a 10-year period and explored the risk factors for recurrence.

Materials and Methods

The institutional review board of Peking University School and Hospital of Stomatology approved the present retrospective cohort study (approval no. PKUSSIRB-201734048). The study population was composed of patients who had been admitted to the Department of Oral and Maxillofacial Surgery in our hospital for the evaluation and management of TMJ ankylosis from January 1, 2006 to December 31, 2015. All the patients seeking treatment had been informed of the possibility that their medical records might be used for teaching or research purposes; hence, all the patients had provided written informed consent. The inclusion criteria were as follows: 1) ankylosis secondary to trauma; 2) initial treatment in our hospital; and 3) operations performed by the same surgeon (Y.Z.). Patients with ankylosis secondary to infection or systemic disease were excluded.

CLASSIFICATION OF TMJ ANKYLOSIS

A computed tomography (CT) scan was acquired before surgery. The type of ankylosis was determined in the coronal view using the classifications of Sawhney² and He et al.¹⁴ In our study, TMJ ankylosis was classified into 3 types (Fig 1). Type I was defined as fibrous ankylosis without the bony fusion of the joint. Type II was defined as ankylosis with bony fusion from the lateral ramus to the zygomatic arch, with the residual condyle fragment large enough to bear the TMJ load. Finally, type III was ankylosis with a residual condylar fragment too small to bear the load or complete bony fusion of the joint.

TREATMENT PROTOCOL FOR ANKYLOSIS

Our treatment protocol, in accordance with the classification systems, was as follows:

For type I ankylosis, joint release and TMJ disc reposition were conducted. A temporalis myofascial flap (TMF) was used as interposition material if the TMJ disc was inadequate to cover the condyle. The TMF was pedicled inferiorly and extended as far superiorly as necessary to give proper length for lining the joint. The flap was then turned outward and downward over the zygomatic arch and sutured medially, anteriorly, and posteriorly to line the glenoid fossa. The TMF consisted of the deep temporalis fascia and the very

superficial temporalis muscle. The middle temporal artery, a branch of the superficial temporal artery, provided the blood supply to the deep temporalis fascia.¹⁶

For type II ankylosis, the lateral bony fusion was resected, and the medially displaced condyle and disc, which were intact, were retained. The TMF was sutured to the disc to fill the lateral space.^{17,18}

For type III ankylosis, the bony fusion and residual condylar head (if present) were completely removed. After excision of the bony mass, the gap should be 15 to 20 mm. TMF was used to line the glenoid fossa.^{12,19} The joint was then reconstructed with distraction osteogenesis (DO), a costochondral graft (CCG), a coronoid process graft (CPG), or prosthesis implantation (PI; Fig 2).

For the patients whose TMJ was reconstructed with DO, the mandibular stump was reshaped to round it at the top. The distraction device was attached, and the direction of distraction was marked. Corticotomy was completed distally, and the distraction device was installed. The transport segment was about 10 mm wide and 15 to 20 mm tall. The latency period was 6 days for the adults and 4 days for the children. When the distance between the transport segment and skull base reached 2 to 3 mm, the distraction was stopped.²⁰ The distraction device was removed after a consolidation period of 2 to 3 months without a fixed fixation device. For the patients whose TMJ was reconstructed with an autogenous bone or alloplastic material, the end gap after grafting was also 2 to 3 mm. For type III ankylosis, intermaxillary fixation was applied before TMJ reconstruction. After reconstruction, IMF was removed, and the occlusion was checked.

TMJ surgery was approached through a standard preauricular incision with temporal extension. The deep temporal flap was dissected to protect the superficial temporal vessels and the branches of the facial nerve. Coronoidectomy on the affected side with or without the contralateral side was completed if the passive maximal incisal opening (MIO) was less than 35 mm or dislocation of the unaffected temporomandibular joint was difficult to achieve. Coronoidectomy was performed at the base of the coronoid process, along the sigmoid notch level. The ipsilateral coronoid process was trimmed, shaped, and rigidly fixed with an L-shaped titanium miniplate for patients reconstructed with a CPG.

Tight elastics were applied postoperatively for 1 week to prevent an open bite. These were then changed to light guiding elastics to keep the mandible in proper occlusion for 2 or 3 more weeks. Physiotherapy was begun 5 to 7 days after surgery. Physiotherapy involved active hinge opening and manual finger stretching in front of a mirror combined with heat and massage. The exercises were performed 3

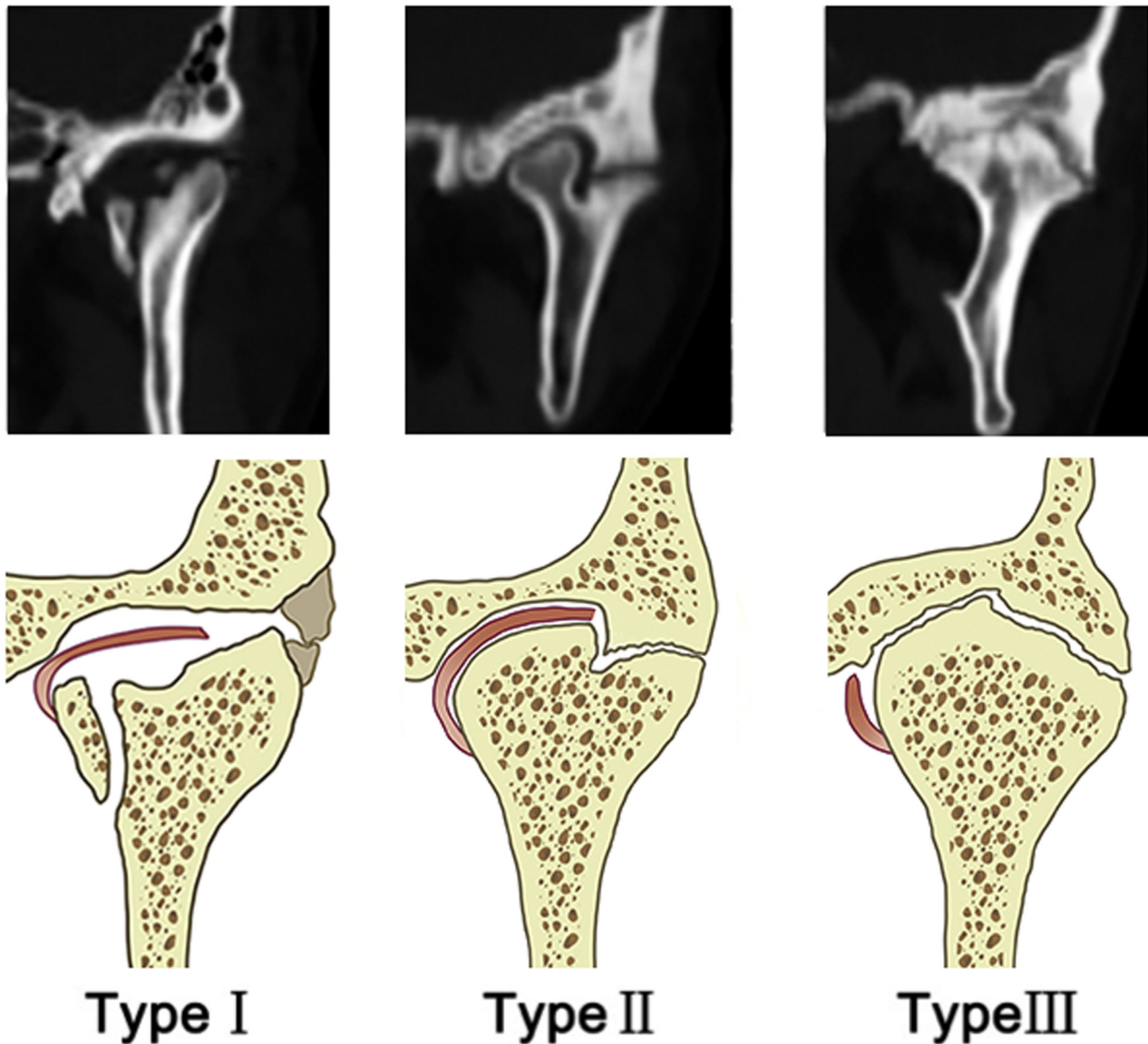


FIGURE 1. Temporomandibular joint ankylosis classified into 3 types.

Chen et al. Recurrence-Related Factors of TMJ Ankylosis. J Oral Maxillofac Surg 2019.

to 5 times daily for 5 to 10 minutes each time. Physiotherapy was usually performed under supervision for the first 2 weeks and then by the patient alone. The patients were allowed a soft diet for 3 to 4 weeks and then solid foods.

VARIABLES AND DATA COLLECTION

Patient age, classification, and treatment method for TMJ ankylosis were considered the primary variables. The other study variables included gender, interval to recurrence, and the follow-up duration. The preoperative and follow-up information was acquired by reviewing the medical history of the patients.

Reankylosis was diagnosed according to the clinical assessment and imaging data acquired at least

3 months after surgery. An MIO of less than 15 mm and bony/fibrous fusion observed on the CT scan during the follow-up period were confirmed as recurrence (Fig 3).

STATISTICAL ANALYSIS

A χ^2 test or Fisher exact test was performed to analyze the differences in the recurrence rate ($P \leq .05$).

Results

GENERAL FINDINGS

A total of 277 patients with TMJ ankylosis had undergone surgery from 2006 to 2015 at our hospital. Of

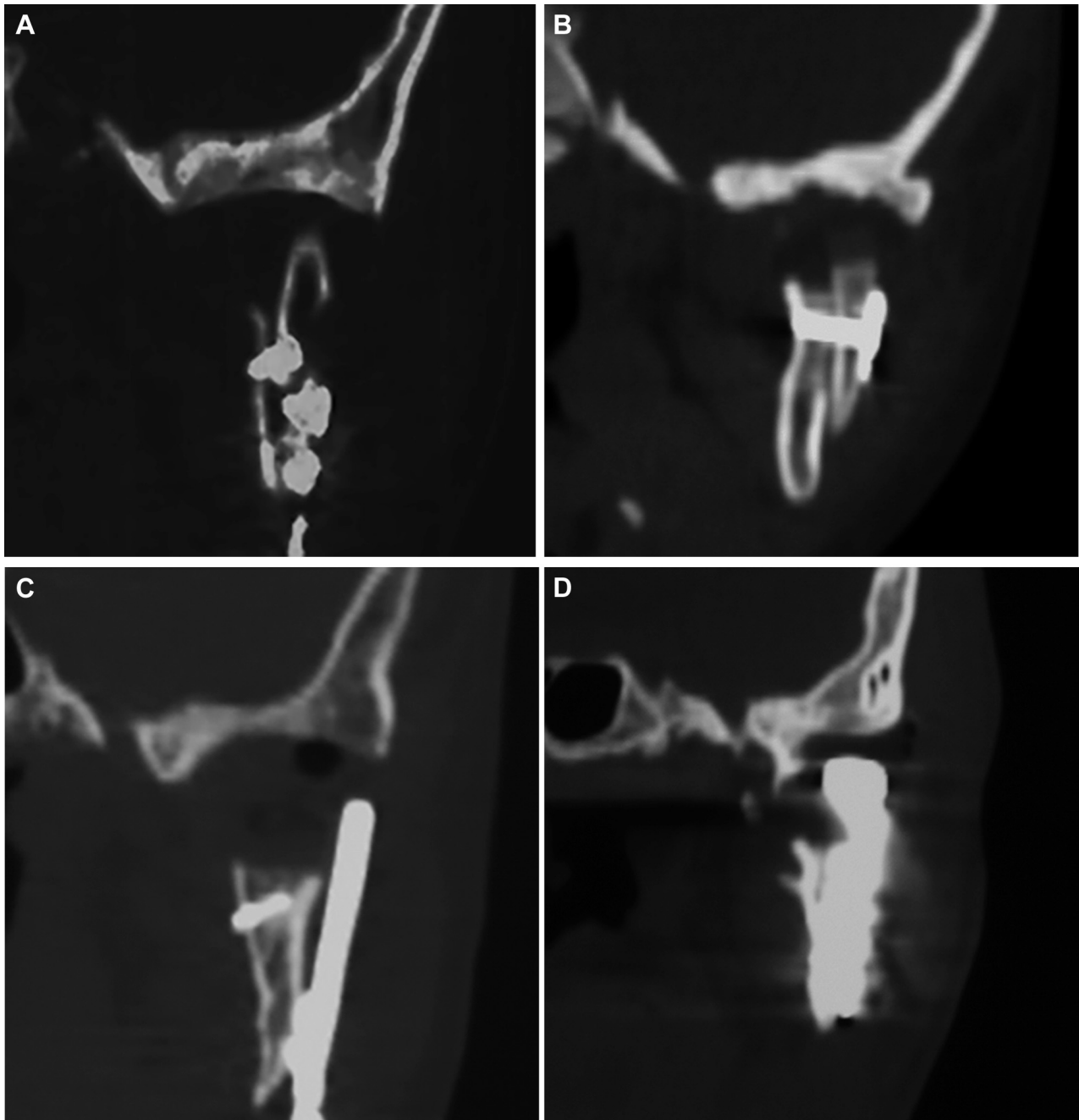


FIGURE 2. Different reconstruction methods for type III temporomandibular joint ankylosis: A, coronoid process graft; B, costochondral graft; C, distraction osteogenesis; and D, prosthesis implantation.

Chen et al. Recurrence-Related Factors of TMJ Ankylosis. J Oral Maxillofac Surg 2019.

these 277 patients, 11 with ankylosis that had developed secondary to infection and 1 with ankylosis secondary to systemic disease were excluded. A total of 157 patients had fulfilled the inclusion criteria. Of these 157 patients, 27 had no follow-up data available, leaving 130 patients in the present study. In our inclusion criteria, all the operations were performed by the same surgeon (Y.Z.). 108 patients' surgeries were performed by other surgeons. Of these 130 patients, 59

were females and 71 were males, with an age range of 3 to 67 years (mean, 25.4 ± 16.5 years). The mean follow-up duration was 23.4 months (range, 12 months to 10 years). Of these 130 patients, 81 had had unilateral joint ankylosis and 49 had had bilateral joint ankylosis. The patients were divided into 3 groups according to age; 39 patients (47 joints) were aged 12 years or younger and were included in the child group; 6 patients (8 joints) were aged 12 to 18 years



FIGURE 3. Recurrence was diagnosed according to the clinical and computed tomography (CT) findings. A, Preoperative complete bony fusion; B, bony mass resection and temporomandibular joint reconstruction with coronoid process; **(Fig 3 continued on next page.)**

Chen et al. Recurrence-Related Factors of TMJ Ankylosis. J Oral Maxillofac Surg 2019.

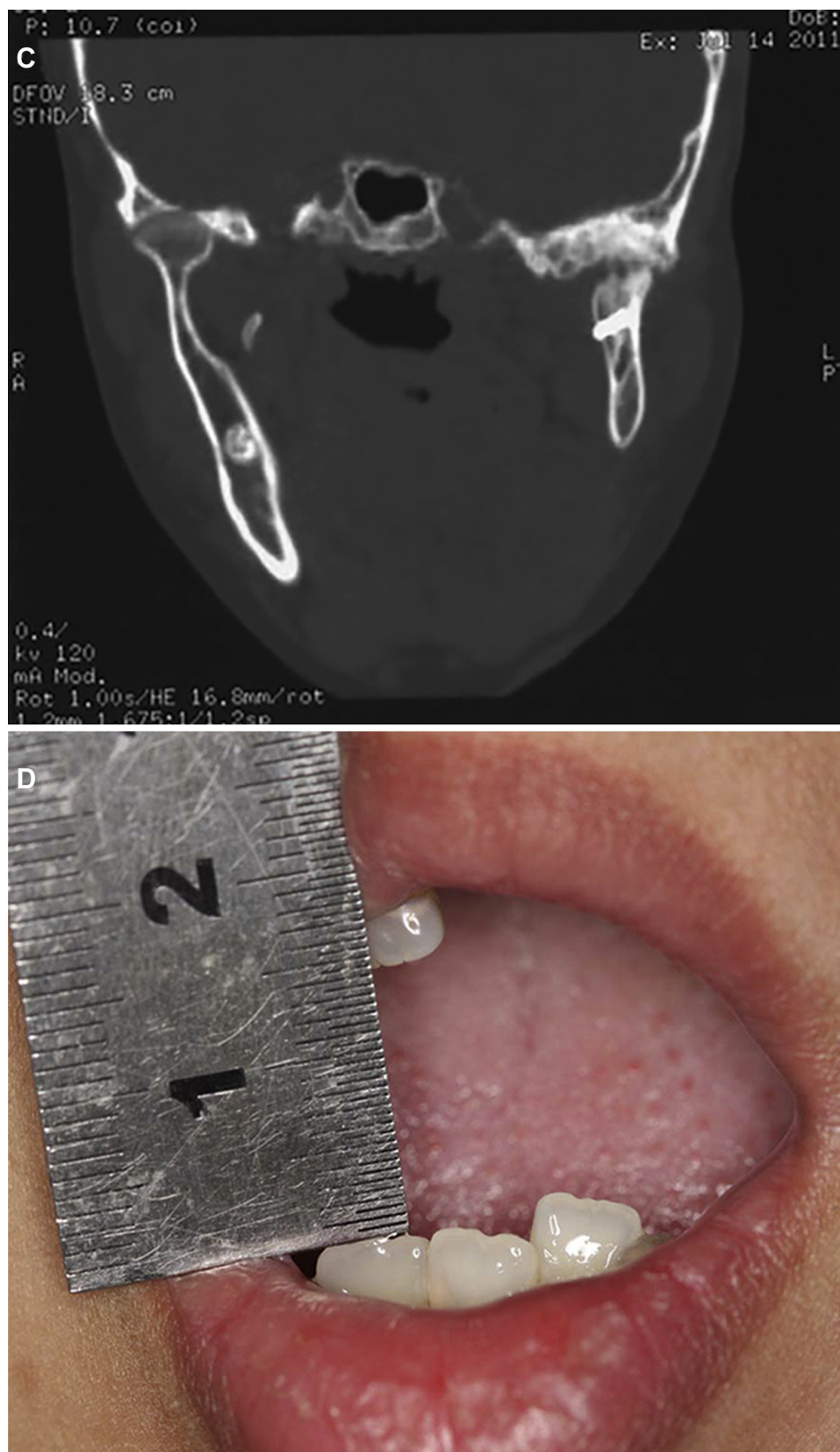


FIGURE 3 (cont'd). C, CT image 22 months after surgery showing recurrence of bony fusion; D, photograph showing maximal incisal opening was less than 15 mm.

Chen et al. Recurrence-Related Factors of TMJ Ankylosis. J Oral Maxillofac Surg 2019.

Table 1. GENERAL INFORMATION OF STUDY POPULATION

Age (yr)	Patients (n)		Gender (n)		TMJ Ankylosis (n)	
	Recurrence	Total	Male	Female	Unilateral	Bilateral
≤12	6	39	17	22	31	8
12-18	1	6	3	3	4	2
≥18	6	85	51	34	46	39
Total	13	130	71	59	81	49

Abbreviation: TMJ, temporomandibular joint.

Chen et al. Recurrence-Related Factors of TMJ Ankylosis. J Oral Maxillofac Surg 2019.

and were included in the adolescent group; and 85 patients (124 joints) were aged 18 years or older and were included in the adult group (Table 1). Reankylosis was confirmed in 13 patients (19 joints; see supplementary data available at the Mendeley website; available at: <https://doi.org/10.17632/ngrrcwzfnp.2>). Only the data from the patients in the child and adult groups were used for statistical analysis because the sample size in the adolescent group was too small (only 6 patients, with 1 case of reankylosis).

RECURRENCE RATE IN THE DIFFERENT GROUPS

The rate of joint reankylosis in the child group was 19.1%, which was significantly greater than that in the adult group (7.3%; $P < .05$; Table 2). The recurrence rates in types I, II, and III were 0, 30.8, and 15.2% in the child group and 17.4, 3.3, and 5.6% in the adult group, respectively (Table 3). The recurrence rate was not significantly different when stratified by type in the child and adult groups (Table 3).

RECURRENCE RATE IN UNILATERAL OR BILATERAL ANKYLOSIS

In the child group, 6 patients developed a recurrence. Of these 6 patients, 3 had had unilateral ankylosis and 3 had had bilateral ankylosis. The recurrence rate was 37.5% in those with bilateral joint ankylosis and 9.7% in those with unilateral ankylosis

(Table 4). In the adult group, 6 patients had developed recurrence. Of these 6 patients, 2 had had unilateral ankylosis and 4 had had bilateral ankylosis. The recurrence rate was 9.0% in those with bilateral joint ankylosis and 4.3% in those with unilateral ankylosis (Table 4). One of the patients with bilateral ankylosis had developed recurrence on 1 side only.

RECURRENCE STRATIFIED BY DIFFERENT RECONSTRUCTION METHODS FOR TYPE III

For type III, the joint was reconstructed with CCG or DO in the child group. No significant differences were found in the recurrence rate between DO (28.6%) and CCG (5.3%; $P > .05$; Table 5). In the adult group, the joint was reconstructed with CPG, DO, or PI for type III ankylosis. The recurrence rate for DO and PI was 0%. The recurrence rate for CPG (26.7%) was significantly greater than that with DO and PI ($P < .01$; Table 5).

Discussion

In the present retrospective study, we have discussed the factors related to the recurrence of TMJ ankylosis. Our results showed that the recurrence rate of ankylosis in children was greater than that in adults. We further compared the recurrence rates of different methods for TMJ reconstruction in type III ankylosis. The recurrence rates after DO and CCG in the children were not significantly different; however, the use of the CPG had the greatest recurrence rate in the adults.

The treatment of TMJ ankylosis has been greatly challenging for surgeons because of the technical difficulties and high incidence of recurrence. TMJ ankylosis can be managed by many surgical techniques; however, no single method has been universally accepted. In general, we followed the protocol proposed by Kaban et al¹² in 1990 and improved further in 2009.¹⁹ In the present study, TMJ ankylosis was classified into 3 types according to the severity of the ankylosis and the treatment method used. The

Table 2. RECURRENCE OF ANKYLOSIS IN CHILD AND ADULT GROUPS*

Variable	Child Group	Adult Group	<i>P</i> Value*
Recurrence (n)	9	9	NS
Joints (n)	47	124	NS
Rate (%)	19.1	7.3	<.05

Abbreviation: NS, not statistically significant.

* The χ^2 test was used for statistical analysis.

Chen et al. Recurrence-Related Factors of TMJ Ankylosis. J Oral Maxillofac Surg 2019.

Table 3. RECURRENCE RATE STRATIFIED BY TYPE IN CHILD AND ADULT GROUPS

Variable	Child				Adult			
	Type I	Type II	Type III	P Value	Type I	Type II	Type III	P Value
Recurrence (n)	0	4	5	NA	4	1	4	NA
Joints (n)	1	13	33	NA	23	30	71	NA
Rate (%)	0	30.8	15.2	>.05*	17.4	3.3	5.6	>.05*

Abbreviation: NA, not applicable.

* The χ^2 test was used.

Chen et al. Recurrence-Related Factors of TMJ Ankylosis. *J Oral Maxillofac Surg* 2019.

classification was slightly different from previous classification methods.^{2,14}

We defined type I as fibrous ankylosis, which is treated with joint release and TMJ disc reposition. Bony bridge formation on the lateral side of the joint was considered type II, which was treated with TMJ lateral arthroplasty.^{17,18} If a residual condylar fragment was too small to bear the load or complete bony fusion had occurred, the ankylosis was considered type III. For type III ankylosis, aggressive ankylotic bone excision and joint reconstruction were required.¹⁹

The recurrence rate of TMJ ankylosis has ranged from 0 to 20.5%.^{3,13-15,21,22} Typically, the recurrence rate has been ~9 to 12% in children and 2 to 7% in adults. However, to the best of our knowledge, studies have yet to compare the recurrence rates between children and adults in 1 sample. In the present study, we compared the recurrence rates between these 2 groups. The results revealed that the recurrence rate in children (19.1%) was higher than that in adults (7.3%). This was likely because postoperative bone remodeling is more active in children, who are still growing. In addition, adults will understand the objective of the treatment and will likely cooperate better with the physical exercises, resulting in a favorable outcome.¹⁵ Despite the high recurrence rate in children, ankylosis should

be treated as soon as possible to expect patient cooperation with physical exercise after the operation. Untreated TMJ ankylosis in children will lead to several adverse effects, including facial asymmetry, muscle dysfunction, and psychological disorders. Kaban et al¹⁹ considered children aged 3 years or older to be as candidates for ankylosis release.

The recurrence rate in the different types showed no significant differences in either the child group or the adult group, indicating that recurrence was only slightly related to the severity of the ankylosis. This result was consistent with the view of Kaban et al^{12,19} that complete excision of the bony mass and interpositional grafting are key steps in preventing recurrence. The TMF is still the most popular choice of grafts as interpositional material, because it is autogenous tissue with an adequate blood supply and has close proximity to the joint and good resilience. A previous study showed that the TMF could remain biologically viable and serve as a satisfactory TMJ lining when inferiorly based to the preserve blood supply.²³ Several studies have also reported on the use of dermis-fat grafts as interpositional material. Dermis-fat grafts are harvested from the abdomen or groin with minimal donor site morbidity. It is available in any desired quantity, is resistant to impact and pressure, and can be adapted to any size cavity.^{24,25} It might be a good adjunct to

Table 4. RECURRENCE OF UNILATERAL AND BILATERAL ANKYLOSIS IN CHILD AND ADULT GROUPS

Variable	Child Group			Adult Group		
	Unilateral	Bilateral	P Value	Unilateral	Bilateral	P Value
Recurrence (n)	3	6	NA	2	7	NA
Joints (n)	31	16	NA	46	78	NA
Rate (%)	9.7	37.5	>.05*	4.3	9.0	>.05*

Abbreviation: NA, not applicable.

* Yates' continuity-corrected χ^2 test was used.

Chen et al. Recurrence-Related Factors of TMJ Ankylosis. *J Oral Maxillofac Surg* 2019.

Table 5. RECURRENCE AFTER DIFFERENT RECONSTRUCTION METHODS FOR TYPE III IN CHILD AND ADULT GROUPS

Variable	Child Group			Adult Group			
	CCG	DO	P Value	CPG	DO	PI	P Value
Recurrence (n)	1	4	NA	4	0	0	NA
Joints (n)	19	14	NA	15	48	8	NA
Rate (%)	5.3	28.6	>.05*	26.7	0	0	<.01†

Abbreviations: CCG, costochondral graft; CPG, coronoid process graft; DO, distraction osteogenesis; NA, not applicable; PI, prosthesis implantation.

* Fisher's exact test was conducted for statistical analysis.

† The χ^2 test was used for statistical analysis.

Chen et al. Recurrence-Related Factors of TMJ Ankylosis. *J Oral Maxillofac Surg* 2019.

temporalis myofascial interposition. For type III ankylosis, tight elastics were applied for 1 week postoperatively and then changed to light guiding elastics to keep the mandible in the proper position. The availability of stable occlusion provides persistent support for postoperative physiotherapy, which plays an important role in preventing recurrence.

In the child group, the recurrence rate in the patients with bilateral ankylosis was 37.5% compared with 9.7% in those with unilateral ankylosis. The outcomes after treatment of bilateral ankylosis in the adults was also unsatisfactory (9.0% recurrence rate in those with bilateral ankylosis compared with 4.3% in those with unilateral ankylosis). This finding was similar to our clinical experience, although no statistically significant difference was found. The poor long-term results in the bilateral cases might have resulted from the associated muscular or neuromuscular coordination difficulties or muscular disuse atrophy.²⁶ Furthermore, we reviewed the CT images at the time of injury of the patients with bilateral ankylosis. CT images were available for 4 of the 7 patients, all of whom had had bilateral intracapsular condylar fractures (sagittal splitting), concomitant with symphyseal or parasymphyseal fractures, a special type of fracture we have discussed previously.^{27,28} The lateral ramus stump will displace outwardly and upwardly over the outer rim of the glenoid fossa, and the inner pole, where the lateral pterygoid muscle is attached, will be displaced anteromedially. The contact between the ramus stump and the TMJ fossa accompanying the loss of mobility will frequently cause ankylosis. Although the relationship between the type of fracture and reankylosis was impossible to confirm from the data we have presented, this type of fracture should still gain surgeons' interest. Furthermore, the recurrence of type I in adults was manifested by 2 patients with bilateral intracapsular condylar fractures concomitant with symphyseal

fracture. The high recurrence rate of type I (17.4%) might have been related to the fracture type.

In the present study, we compared the recurrence rate after different reconstruction methods in children and adults. The recurrence rate after DO and CCG in children was not significantly different. However, the recurrence rate after CPG was significantly greater than that after DO and PI in the adults. CPG has been studied widely and has the advantages of avoiding a second surgical site and donor morbidity, providing easy accessibility, and possessing a favorable shape and thickness.^{21,29-32} However, notable bone resorption has been observed, especially in adults.²⁹⁻³² The bone resorption induced by osteoclasts will be accompanied by bone formation stimulated by osteoblasts.³³ Osteoclasts respond to the osteoblast lineage by releasing matrix-derived growth factors,³⁴ osteoclast-derived coupling factors,³⁵ and cell-cell contact mechanisms.³⁶ Therefore, coronoid process resorption could promote osteoblast differentiation and bone formation in the TMJ biomechanical environment, resulting in reankylosis. In our study, the therapeutic effect of DO and PI replacement was satisfactory. We preferred DO for adults in our hospital because only a few patients could afford TMJ replacement.

In conclusion, our results have shown that children with ankylosis are more prone to develop recurrence than are adults. We also found that ankylosis is more likely to recur in adults who have undergone reconstruction with the CPG.

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