

A Clinical Study on Temporomandibular Joint Ankylosis in Children

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Temporomandibular joint (TMJ) ankylosis is a disabling condition of the masticatory system and is most commonly due to trauma, infections, and some systemic diseases. Hypomobility affects the surrounding structures as well as the joint itself. Ankylosis arising in early childhood usually leads to facial asymmetry. Ankylosis in children usually occurs from an intracapsular compression fracture or rarely from a suppurative arthritis of middle ear infection.

Treatment of the ankylosis is probably one of the greatest challenges in TMJ surgery, and the treatment of TMJ ankylosis in children is much more challenging than in adults because of high recurrence and the probable change in the unpredictable growth of the mandible. In treatment of TMJ ankylosis in children, to maintain a normal growth and the development of the face is as important as to provide a satisfactory mouth opening with free movement of the mandible.

A variety of techniques and various success rates in the treatment of TMJ ankylosis both in adults and in children have been reported. However, no single method has produced uniformly successful results. In this study, gap arthroplasty was applied in 6 patients, and 2 different types of fossa implants were used as interpositional material in the other 8 patients, and the results of the treatments have been evaluated retrospectively.

Key Words: TMJ, TMJ ankylosis, children, growing patients, spacer, TMJ fossa prosthesis, condyle, ramus and condylar growth

Hypomobility resulting from ankylosis is an extremely disabling affliction, causing problems in mastication, digestion, speech, and oral hygiene. Ankylosis

occurring in childhood may grossly alter the facial skeleton, affect the child's psychologic development, and place the individual's life in jeopardy at any time because of the inability to open the mouth. Ankylosis in children usually occurs from a type VI fracture of the condyle¹ or rarely from a suppurative arthritis of middle ear infection.^{2,3} Temporomandibular joint (TMJ), in growing individuals, is particularly susceptible to the spread of infection into the joint. The subarticular layer is composed of a rich vascular network that penetrates the cortical layer.⁴ A blow to the chin results in the force being transmitted to the condyle, which can result in an intracapsular comminuted fracture with fragmentation and hemarthrosis of the highly osteogenic particles.^{4,5} When the mobility of the TMJ is not maintained, the organization of the fibro-osseous mass occurs and bony ankylosis can ensue.

The clinical findings of TMJ ankylosis in children are affected by the age of onset, the duration, and whether the ankylosis is unilateral or bilateral. Unilateral ankylosis reveals unilateral hypoplasia of the mandible and deviation of the chin to the affected side. Bilateral ankylosis results in severe retrognathia, mandibular alveolar protrusion, open-bite deformity, bird-face appearance, and hypertrophic and thick coronoid process. Night snoring and obstructive sleep apnea are the other clinical findings in bilateral ankylosis.⁶

Treatment of the ankylosis is probably one of the greatest challenges in TMJ surgery. The type of operation and the policy of the treatment vary from one country to another. However, actual surgical treatment depends on the following: the extent and the type of ankylosis, the age of the patient, onset and the time of the surgery, and whether the ankylosis is unilateral or bilateral.

The vast number of techniques tried over the years illustrates the difficulty that has been experienced in producing a satisfactory method for the treatment of TMJ ankylosis. Muscle and fascia,⁷ fat,⁸ dermis,⁹ cartilage,¹⁰ metatarsal,¹¹ and sternoclavicular joints¹² were proposed for TMJ arthroplasty. Numerous alloplastic materials such as acrylic,^{13,14} silicone,¹⁵ vitallium,¹⁶ ticonium-proplast,¹⁷ and titanium¹⁸ have

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been used for partial and total reconstruction of the TMJ to prevent reankylosis.

Surgical treatment in children always has a particular importance. The potential for the growth impairment adds some problems. In the treatment of TMJ ankylosis in children, to maintain a normal growth and the development of the face is as important as to provide a satisfactory mouth opening with free movement of the mandible.

A variety of techniques and various success rates have been reported in treatment of TMJ ankylosis both in adults and in children. However, no single method has produced uniformly successful results. In this article, the results of the treatments in TMJ ankylosis in growing patients have been evaluated retrospectively.

PATIENTS AND METHODS

The survey is based on 14 patients (8 males, 6 females). The factors evaluated were sex, age, cause, the type of the ankylosis, preoperative and postoperative maximum interincisal distances (MID), and the previous operations patients had (Table 1). The youngest was 4 years and the oldest was 11 years, with a mean of 6.929 ± 1.900 years. Eleven patients had a history of trauma, and falling during childhood was the most common etiological factor in this study (8 patients). Three patients had been injured in traffic accidents, and they have not received proper treatment of the condyle fractures. Otitis media was the following etiological factor (2 patients). One patient was not

able to provide details regarding the cause of the disorder. The differentiation regarding the degree and severity of the ankylotic process was made according to the classification of Sawhney.¹⁴

General anesthesia was administered using nasotracheal intubation. The standard preauricular incision was used to avoid injury to the superficial temporal vessels and the facial nerve. The dissection was proceeded to the zygomatic arch and extended anteriorly and posteriorly to expose the TMJ ankylosis. The periosteum covering the zygomatic arch and ramus were incised and elevated. Three patients with type IV ankylosis needed submandibular approach. After exposure, the bone was drilled using a round bur until a thin cortical bone was left in the depth and a 3- to 4-mm gap was created. The irregular edges of the segments were shaved by a bur, and the ramus was completely disconnected from the upper bony block.¹⁹⁻²¹

In this study, gap arthroplasty was applied in 6 patients, and 2 different types of fossa implants were used as interpositional material in the other patients. The first one was composed of a titanium mesh and acrylic (titanium/acrylic fossa prosthesis [TAFP]),^{20,21} and the other was a custom-made titanium casting (titanium fossa prosthesis [TFP]) (Fig 1). Fossa implants were secured to the upper, stable segment with 2 to 4 self-tapping screws. Figure 2a to e shows preoperative, intraoperative, and postoperative views of the patient treated by TFP.

After the operation, patients were encouraged to do vigorous exercises according to our treatment protocol. Although physiotherapy was painful

Table 1. Causes of the Ankylosis and Treatments

No.	Age	Etiology	Joint Involved	Type of Operation	Type of Previous Operation/Spacer Used	Preoperative MIO, mm	Immediately Postoperatively MIO, mm	Follow-up Period, Year/MIO, mm	Type of Ankylosis (Sawhney) ¹⁴
1	4	Fall	Unilateral	Gap arthroplasty		10	38	5/32	II
2	4	Otitis media	Unilateral	Gap arthroplasty		8	35	4/30	II
3	5	?	Bilateral	Gap arthroplasty		12	36	2/32	RtII/LtI
4	5	Fall	Bilateral	Gap arthroplasty		12	38	4/35	RtI/LtI
5	6	Otitis media	Unilateral	Gap arthroplasty		13	39	3/34	II
6	7	Fall	Bilateral	TAFP		4	45	5/39	LtIV/RtIV
7	7*	Traffic accident	Unilateral	TAFP	Gap arthroplasty	8	36	2/36	IV
8	7	Traffic accident	Unilateral	TAFP	Sylastic sheet	10	38	2/36	III
9	8	Fall	Unilateral	Gap arthroplasty		13	40	1/38	I
10	8	Fall	Bilateral	TAFP		8	36	2/38	LtIII/RtIII
11	9	Traffic accident	Unilateral	TAFP	Acrylic	10	35	3/35	III
12	9	Fall	Bilateral	TAFP		6	38	2/38	LtII/RtIII
13	8*	Fall	Unilateral	TFP	Sylastic sheet	10	36	2.5/30	III
14	10	Fall	Unilateral	TFP	Acrylic	7	34	1.5/34	III

*Patient previously operated on by the author.

MIO, maximum interincisal distance; TAFP, titanium/acrylic fossa prosthesis^{20,21}; TFP, titanium fossa prosthesis; Rt, right; Lt, left.



Fig 1 Fossa prosthesis composed of titanium mesh and acrylic (TAFP) (left) and titanium casting fossa prosthesis (TFP) (right).

during the first week, most of the patients had tolerated the therapy in time. Furthermore, different types of gags were used to increase mouth opening gradually.^{20,21}

RESULTS

In all unilateral cases, the contralateral TMJ was mobilized effectively immediately after mobilization of the ankylotic side, despite having remained almost functionless for many years. Nine patients had unilateral and 5 had bilateral ankylosis. Five patients had had previous operations. One of them had had only gap arthroplasty. Spherical acrylic in 2 patients^{13,19} and sylvastic in the other 2 patients had been used as spacer. Two of them had been previously operated on in our department.

Preoperative and postoperative were remarkably different, and satisfactory results were achieved in the long-term follow-up. However, there was a slight decrease in MID values of some patients in long-term results (Table 1).

DISCUSSION

The treatment of TMJ ankylosis poses a significant challenge to the surgeon because of its technical difficulties and high incidence of recurrence. Failure



Fig 2 A, Ankylosis of the right TMJ of a 9-year-old boy. B, Intraoperative view of the created gap. C, Postoperative radiograph of TFP. D, Preoperative mouth opening (left) and postoperative mouth opening (right) of the same patient 3 years postoperatively. E, Frontal view of the patient before accident when he was 5 years old (left), frontal view after the formation of ankylosis when he was 8 years old (middle: please note the remarkable deviation of the mandible to the affected side), and improved clinical appearance after treatment of ankylosis by TFP 2.5 years postoperatively (right), without any secondary corrective surgery.

in the treatment of TMJ ankylosis will bring back difficulties in mastication, poor oral hygiene, rampant caries, facial growth disturbances, possible pharyngeal narrowing, and the development of obstructive sleep-related breathing disorders.²²

Trauma is well known as the most predominant factor in TMJ ankylosis particularly in childhood.^{2,5,6,13,22} Accordingly, in the presented study, trauma, including traffic accident, was also the most common cause, and infection was the following etiologic factor. Up to the age of 2 years, there are many vascular channels within the condylar head, but they vanish shortly thereafter.²³ Active movement of the mandible is particularly important in dealing with ankylosis in this highly vascularized and osteogenic environment. There is an enormous potential of regeneration and reshaping in children compared with adults and even adolescents.^{3,8}

Although treatment of ankylosis goes as far back as 2 hundred years, no technique has produced satisfactory results. According to Verneuil,⁷ the first arthroplasty was made by Percy and Burton in 1926. Since then, many techniques have been attempted using a variety of autogenic and alloplastic materials primarily in adults.⁷⁻¹⁸ The treatment of TMJ ankylosis in children is much more challenging than in adults because of high recurrence and the probable change in the unpredictable growth of the mandible. Surgical treatment of ankylosis in children basically has 3 objectives: to release ankylosis, to improve mandibular function, and to maintain normal growth and development of the face. Children who develop ankylosis before the age of 5 are the most susceptible to deformities as the result of interference by ankylosis. Early surgical intervention will reduce the adverse effects on facial development. Serial growth studies of 2-year-old infants who underwent surgery for congenital ankylosis showed that growth of their mandibles was greater than the mandibles in children who underwent surgery at a later age and that their postoperative mandibular growth rate was nearly the same as that observed in normal adults.²⁴

Surgical treatment should be undertaken after the establishment of a correct diagnosis.⁴ The surgical treatment varies, depending on the extent and the type of the ankylosis and the age of the patient and whether the ankylosis is unilateral or bilateral. The clinical and advanced radiographic examinations provide relevant information about the location and the extent of the ankylosis. Sawhney¹⁴ reported 4 types of TMJ ankylosis and discussed the selection of the appropriate surgical treatment. In the treatment of ankylosis types I and II,

recounturing, high-condylar shave, and gap arthroplasty have been recommended in children.^{4,14,19} In this study, in the treatment of the patients who have type I and II ankylosis conservative management has been preferred. Fibrous and fibro-osseous adhesions were removed, and a convenient gap was created (Table 1). The location and the extent of the lesion has a particular importance in selecting the type of treatment; however, it is difficult to find a detailed description in the published literature about the type of the ankylosis and the preferred treatment. The surgical treatment of type III and IV ankylosis includes removal of sufficient bone to create a gap and placement of an interpositional material to prevent reankylosis and to minimize loss of the posterior dimension of the ramus.¹⁴

Interposition arthroplasty of TMJ ankylosis has been in use for more than 100 years: Risdon²⁵ in 1934 used gold foil; later on, Eggers²⁶ used tantalum foil. Borçbakan¹³ and Sawhney¹⁴ reported acrylic spacers for the treatment of ankylosis in adults and also in children. The purpose of using mobile spacers was to provide free movement of the mandible. However, if an alloplastic prosthesis is not secure at the time of implantation, it may fail.²⁷ In this study, in 2 of the patients who had previous operation, spherical acrylic spacer was used as interpositional material.

In 1968, silicone rubber was introduced to the medical community as a biologically inert interpositional material in reconstruction of arthritic or destroyed joints in the hand.²⁸⁻³⁰ In the following years, some studies were reported in the literature concerning the use of silicone rubber in the treatment of TMJ ankylosis.^{31,32} However, long-term results, complications, and disadvantages of silicone rubber in TMJ ankylosis have never been discussed in the literature,³⁰ and no satisfactory explanation was made as to how silicone rubber is fixed and how it is maintained within the gap during the chewing function. In 2000, Mercuri²⁷ reported that motion of prosthesis during function would cause loosening of the device and finally failure. Clinical experience has shown that silicone rubber is not an appropriate material particularly in type III and IV ankylosis to prevent the formation of fibrous and fibro-osseous adhesions, which may result in reankylosis.^{19,21} In this study, 2 silastic sheets, one of which had been previously placed by the author, were found to be functionless and, thus, removed from the patients in this regard (Table 1). Evidence of small particles of silicone rubber in regional lymph nodes adjacent to the site of TMJ silastic implantation was reported.^{30,33,34} Foreign body reactions to silicone rubber in articular area were also reported.^{30,33,35}

In 1964, Small et al³⁶ reported that Teflon seemed to be a better adaptable material in replacement of TMJ components. Later, however, Wolford et al³⁷ reported that the foreign body giant cell reaction to Proplast-Teflon implants was proliferative and worsened by time as more particles were generated. Abnormalities in lymphocyte subset ratios were also found, which then improved toward normal when the Proplast-Teflon implants were removed and replaced with the Techmedica custom-made total joint prosthesis.³⁸ It is still not clear whether the foreign body reactions were caused by the particulate matter from wear of the artificial surface.^{17,38}

Some authors concluded that reconstruction with alloplastic condylar prosthesis may lead to a predictable result in the treatment of functionless TMJs. Gold,³⁹ stainless steel,⁴⁰ vitallium,⁴¹ and ticonium¹⁷ were used for this purpose. However, the possibility of glenoid fossa erosion was the major problem for this type of prosthesis. A total TMJ prosthesis was first described by Kiehn et al.⁴² Then, variety of total TMJ prosthesis made of various materials were reported with various success rates.^{16,17,27,32,38} However, neither the condylar nor total TMJ prosthesis in the treatment of ankylosis in growing patients was reported so far.

In this study, 2 types of fossa implants were used to prevent reankylosis. In 6 patients, a fossa implant composed of a titanium mesh and of acrylic (TAFP) were placed as described earlier.^{20,21} In the other 2 patients, titanium casting fossa prosthesis was placed. Having been used separately for a long time as spacers without any complication, heat-cured acrylic and titanium are well known in maxillofacial surgery.^{13,14,21} Therefore, spacers made of titanium and heat-treated acrylic should not cause any foreign body reaction. In this study, all of the patients with fossa implants were older than 6 years, and 5 of them had been operated on previously. Moreover, most of the ankylosis patients have types III and IV (Table). Because of the high incidence of reankylosis in the patients who have severe (types III and IV) ankylosis and in the patients who had previous operation, we preferred to place a stable interposition material. The main purposes were, first, to prevent reankylosis, and second, to let the ramus mandible grow. Historically, it has been the condyle that has been given all the glory, whether as the primary determinant of mandibular or, as we now see it, as the respondent structure that makes adaptive, truly interrelated growth possible. The term "condylar growth" is misleading and conveys a biologic misconception. More properly, the term needs to be "ramus and condylar growth."⁴² According to Enlow

and Hans,⁴³ in a real sense, the condyle follows the growth of the whole ramus and does not lead it.

The use of autografts was also reported for the treatment of ankylosis.^{6,12} Poswillo¹² reported the functional similarities between condylar head and rib cartilage. Later, Guyuron and Lasa⁴⁴ concluded that the growth pattern of costochondral graft is extremely unpredictable. Overgrowth of the grafted side can be more troublesome than the lack of growth. The patients who are grafted during active growth period might require additional corrective osteotomies, increasing patient morbidity.⁴⁵ Nadal Lopez and Dogliotti⁴⁶ reported that 75% of their patients treated by costochondral grafts needed additional secondary surgery. According to Mercuri,²⁷ placing autogenous grafts, which are growing and remodeling, makes no sense particularly in patients with ankylosis. This is why, in orthopaedic surgery, alloplastic joint reconstruction is always preferred in similar situations.²⁷

The time and the type of correction of the facial deformity including variety of osteotomies and distraction osteogenesis in young and adult patients with ankylosis are a matter of controversy. The long-term results or complications of the immediate corrective osteotomies were not satisfactorily discussed in the literature. Either in adults or in children, the main objectives are to release ankylosis, to provide a satisfactory mouth opening, and, most important of all, to prevent reankylosis. The presented study and also some detailed studies²¹ including changes in MID in long-term have shown slight decrease in MID. The probability of reankylosis always exists. According to our clinical experiences, at least 2 or 3 years should be allowed to make sure of the reliability and the functioning of the newly created joint-like structure and to proceed with facial aesthetic corrections.²¹ An attempt to provide good facial aesthetic by distraction osteogenesis or other osteotomy techniques fails if the patient develops reankylosis. The main principles in treatment of ankylosis in growing patients are to provide and keep a satisfactory postoperative mouth opening and jaw functions in long term, to prevent reankylosis, and to let the mandible grow as much as possible till the end of the growing period. Any early attempt to correct the affected ramus may disturb possible growth and remodeling. In this regard, in treatment of the facial abnormalities due to ankylosis, surgical correction has always been preferred after growing period.²¹ Although some authors^{47,48} preferred to perform distraction at the time of arthroplasty, Nadal Lopez and Dogliotti⁴⁶ declared that recovery of the mandibular function must be the main goal, the

possibility of reankylosis is frequent, and secondary and tertiary distraction may be required after post-pubertal facial growth in the patients who were simultaneously treated.

CONCLUSION

The effects of TMJ implants in growing patients are still debated. However, to provide a satisfactory mouth opening and a normal jaw function and to prevent re-ossification in long term are the most important principles in the treatment of TMJ ankylosis in children. Total TMJ prosthesis, condyle prosthesis, and costochondral grafts may disturb the ramus growth, and the other spacers made by silicone rubber or Teflon may have some side effects, but a fossa implant that is made of inert materials may prevent reankylosis and lets the mandible grow. At the end of the growth period, possible subsequent growth disturbances and asymmetries can be managed later either by distraction or other osteotomy techniques.

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