Ultrathin Silicon Sheet in the Management of Unilateral Post-traumatic Temporo-Mandibular Joint Ankylosis in Children: A Good Alternative to Conventional Techniques

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Abstract We have described a new technique of using ultra-thin silicon sheet (0.2 mm) between two transected bony ends for temporo-mandibular joint (TMJ) ankylosis in children with advantages of short operative time, minimal foreign material insertion and faster recovery time post-operatively which makes our technique a good alternative to conventional techniques. Our study is a non-randomized prospective study conducted on 10 children aged between 4 and 15 years who presented to our tertiary care institute with severe trismus after traumatic injury and were willing to undergo this new technique. The main outcome measure taken into consideration was difference between pre-operative, intra-operative (on table) and post-operative mouth opening (minimum 2 years follow-up). The pre-operative mouth opening in our cases varied from 1 to 5 mm. The intra-operative mouth opening achieved ranged from 2.8 to 3.2 cm. The mouth opening was about more than 2.7 cm in all our cases at 2 years of follow-up. Our technique is a good alternative to conventional techniques used for TMJ ankylosis in children but few more randomized controlled trials are required to assess its effectiveness in comparison to conventional techniques and for universal adoption of this technique.

Keywords Ultra-thin silicon sheet ·
Temporo-mandibular joint ankylosis ·
Novel technique in children

Introduction

Ankylosis is a serious and disabling condition that may cause problems in mastication, digestion, speech, appearance, and oral hygiene. It can also cause facial asymmetry, mandibular retrognathism and impaired mandibular growth causing bird face deformity and acute compromise of the airway. These may lead to severe physical and psychological disability in the child [1, 2].

TMJ ankylosis is most commonly associated with trauma (13–100 %), local or systemic infection (10–49 %), or systemic disease (10 %), such as ankylosing spondylitis, rheumatoid arthritis, and psoriasis. Ankylosis can also occur as a result of TMJ surgery [3].

The treatment of TMJ ankylosis poses a significant challenge because of technical difficulties and a high incidence of recurrence. Different autogenous and alloplastic interposition materials have been used after resection of the ankylotic bone to achieve desirable and long lasting results [1–3]. The basic techniques for surgical correction of ankylosis include the following:

- Gap arthroplasty (resection of the bony mass without interpositional material).
- Joint reconstruction (resection of the bony mass with reconstruction by bone grafts or joint prosthesis).
- Interpositional arthroplasty (resection of the bony mass with interposition of a biological or non-biological material) [4, 5].

In this paper, we are describing a novel technique of using ultrathin silicon sheet (0.2 mm) for management of

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post-traumatic temporo-mandibular joint (TMJ) ankylosis in children which, in our experience, is more effective than conventional techniques and, to the best of our knowledge, it has not been described in the literature so far.

Materials and Methods

Ten children who presented to our tertiary care institute with complaints of inability to open mouth from January, 2008 to June, 2010 were subjected to this novel technique. The age of children varied from 4 to 15 years (Table 1). The chief complaint of all the patients was inability to open mouth after traumatic or iatrogenic injury. Diagnosis of TM joint ankylosis was made in all cases after proper history and clinical examination which was confirmed on 3-dimensional computed tomography (CT) scan (Fig. 1). All patients were taken up for surgery and clinical photographs of all the patients showing jaw opening were taken pre-operatively, intra-operatively and post-operatively to assess the difference in mouth opening. Postoperatively, all patients were put on a custom made acrylic jaw exerciser to ensure early active physiotherapy.

Ethical Considerations

All the patients were informed pre-operatively about the choices of surgery they can undergo and were also informed about the advantages and disadvantages of the different procedures. Patients were also briefed about our novel technique of using ultra-thin silicon sheet and only those patients were selected, whose parents were willing to subject their children to this new technique. Written informed consent was taken from the parents of those children, subjected to this procedure.

Operative Procedure

All patients were operated under general anaesthesia with bronchoscopic guided nasal endotracheal intubation. A standard pre-auricular incision with a small temporal extension was made. The dissection was carried out through the superficial temporal fascia which was reflected anteriorly protecting facial nerve branches. The periosteum over the zygomatic arch was incised, followed by exposure of the ankylotic mass. After exposing the ankylosed joint, the bone was first cut at the lower end of zygomatic arch using electric drill with cutting burr under vision. The angle of the drill was kept in downward direction. After complete transection of the ankylotic bone, the two ends were again drilled slowly to increase the gap between the recontoured glenoid fossa and the mandible to about 0.5 mm so as to pass 0.2 mm ultra-thin silicon sheet of size 5×5 cm easily through the gap to secure it between the two transected bony ends (Fig. 2). Medially, it was anchored with non-absorbable 3-0 nylon suture to medial pterygoid muscle and laterally across the gap, it was sutured to periosteum of zygomatic arch so as to fix the sheet securely and also to cover the two transected bone ends completely. In all cases, around 2.8–3.2 cm mouth opening could be achieved intra-operatively. After achieving haemostasis, the wound was closed with 3-0 nylon suture over a suction drain. The drain was removed on second post-operative day and skin stitches were removed on the 7th post-operative day. From the 2nd post-operative day, all patients were trained for extensive active physiotherapy using custom made acrylic dynamic jaw opener (Fig. 3) for minimum of 1 year and were advised for regular follow-up.

Follow-Up

All the patients were advised for follow-up at monthly intervals for 6 months, then every 3 months for the next

Table 1 Clinical details and the difference between pre-operative and post-operative mouth opening in our patients

Serial no.	Age	Sex	Joint involved (unilateral/bilateral)	Pre-operative mouth opening (in mm)	Intra-operative mouth opening (in cm)	Post-operative mouth opening at 1 year follow-up (in cm)	Post-operative mouth opening at 21/2 years follow-up (in cm)
1	6	Female	Unilateral right	2	3.0	3.0	3.1
2	9	Male	Unilateral right	4	3.2	3.2	3.2
3	12	Male	Unilateral right	1	2.8	2.8	2.8
4	15	Female	Unilateral left	2	3.0	3.0	3.0
5	14	Male	Unilateral right	5	3.2	3.2	3.3
6	11	Male	Unilateral left	3	3.1	3.0	3.1
7	12	Male	Unilateral right	3	3.2	3.2	3.0
8	4	Female	Unilateral right	5	3.0	3.0	3.1
9	6	Male	Unilateral left	3	3.0	3.0	3.2
10	8	Female	Unilateral right	3	3.1	3.2	3.2

Fig. 1 Coronal cut of computed tomography (CT) showing bony ankylosis of left TM joint

Fig. 2 Intra-operative photograph showing placement of ultra-thin silicon sheet between two transected bony ends

6 months and then annually. During each visit, the objective measurement of improvement in mouth opening was noted and patient satisfaction was also assessed. The extensive physiotherapy was continued for at least 1 year in all our cases. There was no incidence of any growth or structural abnormalities during follow-up period in any of our patients after subjecting them to this technique.

Results

All children presented to our tertiary care institute from January, 2008 to June, 2010 with chief complaint of inability to open mouth after trauma were included in our study (Table 1). In all, ten cases were included, six children were male and four patients were female. The age ranged from 4

Fig. 3 Patient using acrylic dynamic jaw exerciser post-operatively

to 15 years. In all our cases, the ankylosis was unilateral. The pre-operative mouth opening in our cases varied from 1 to 5 mm (Fig. 4). The intra-operative mouth opening achieved ranged from 2.8 to 3.2 cm. There was no immediate complication and no incidence of facial nerve injury in any of our cases. There was no extrusion of the implant in immediate and follow-up period in any of our patients. There was no incidence of recurrence of trismus during the follow-up period ranging from 2 to 3 years. Three out of ten patients were followed up for more than 3 years and there was no incidence of extrusion or diminution of function in any of our cases. The mouth opening was more than 2.7 cm in all cases even after 21/2 years of follow-up (Fig. 5).

Discussion

Normal mouth opening in adults is between 40 and 56 mm which varies in children depending upon the age of the

Fig. 4 Pre-operative photograph of a patient who developed trismus after fall from height

Fig. 5 Post-operative photograph showing mouth opening of 3 cm at 1 year follow-up

child. Temporomandibular joint ankylosis may be classified according to the site (intra or extra-articular), type of tissue involved (bony, fibrous or fibro-osseous tissue), and the degree of fusion (complete or incomplete) [5]. The most common etiological factors are trauma and infection [1]. In post-traumatic ankylosis of TMJ, there is displacement or destruction of the meniscal cartilage. As a result, there is bone to bone contact either directly or via blood clot which has a potential for osteogenesis, resulting in extensive fusion at the level of joint [6]. Infection of the TMJ most commonly occurs secondary to contiguous spread from otitis media or mastoiditis or from hematogenous spread of infection. Systemic causes of TMJ ankylosis include ankylosing spondylitis, rheumatoid arthritis, and psoriasis [7]. In our study, the main cause was post-traumatic ankylosis, although one of our patients had congenital TMJ ankylosis.

Temporo-mandibular joint ankylosis protocols throughout the world suggest early surgical intervention, elaborate resection, early mobilization and aggressive physiotherapy for at least 6 months postoperatively [8]. The fundamental aim in the treatment of TMJ ankylosis is the successful surgical resection of ankylotic bone, the prevention of recurrence, and aesthetic improvement by ensuring functional occlusion [9]. Therefore, immediate treatment is necessary to promote proper growth and function of mandible and to facilitate the positive psychological development of the child. A variety of techniques for the treatment of TMJ ankylosis have been described but most frequently reported operations worldwide for TMJ include gap arthroplasty, interpositional arthroplasty and joint reconstruction with autogenous or alloplastic materials [3, 4, 8].

Gap arthroplasty alone, giving rise to a gap between the skull base and residual mandibular ramus, has the advantage of simplicity and short operating time [3]. The disadvantages are generating a pseudo-articulation, with loss of the mandibular height and, in addition, it has high risk of recurrence [3, 4]. The loss of mandibular height increases the facial deformity in children.

Interpositional arthroplasty with autogenous or alloplastic material at the osteotomy site is a mechanism for preventing recurrence [3, 5]. At present, there is no ideal interpositional material [10]. Pedicled temporalis flaps are still the most popular choice as interposition material. The use of autogenous full thickness skin or dermis grafts as interpositional materials has also been published [10]. Even the buccal pad of fat has been used as an interposition material [11]. The problems encountered with these include muscle shrinkage and fibrosis, fascia lacking bulk, cartilage tending to fibrose and calcify, and alloplastic implants under functional load disintegrating and causing foreign body giant cell reactions [1]. All these lead to high recurrence rates.

Temporo-mandibular joint reconstruction may be necessary for patients with extensive osteotomy and consequently insufficient ramus height, and hence can be performed with costochondral grafts, clavicular osteochondral grafts, iliac crest grafts, coronoid process grafts and alloplastic condylar implants [3, 5]. The most widely accepted autogenous technique is a costochondral graft. According to MacIntosh, [12] the advantages of this graft are its biological compatibility, workability and functional adaptability. The growth potential of the costochondral graft makes it the ideal choice in children [3]. Costochondral grafts have been shown to adaptively grow with downward growth of the maxilla and mandible, thus maintaining vertical height. Potential problems include fracture, further ankylosis, donor site morbidity and the variable growth behaviour of the graft [13]. The advantages of the alloplastic material are they are easy to use, have a

short operating time and low cost; however, the disadvantages are foreign body reactions, dislodgement, infection and implant extrusion.

Irrespective of the technique chosen by the surgeon, aggressive resection of the bony or fibrous ankylotic segment is crucial to avoid recurrence. In addition, dissection of the muscles of the mandibular ramus and ipsilateral coronoidectomy must be carried out to prevent inadequate intraoperative interincisal opening, because the coronoid process may be elongated in long-standing cases [3–5, 8]. Temporalis muscle is pedicled and turned 180 degrees to fit into the glenoid fossa. This leads to a significant decrease in the vascular supply of the muscle making it prone to ischemic necrosis, especially when it gets compressed between the two bone ends. Temporalis muscle turned 180 degrees on itself is difficult to suture and retain in the gap. Thus to ensure good anchorage and prevent ischemic necrosis of the muscle, a large chunk of the bone has to be removed which leads to further decrease in the height of the vertical ramus of mandible, which in turn accentuates the facial deformity. Dissecting temporalis muscle leads to scar contracture of the donor site and loss of an important muscle of mastication which may further compromise the jaw movements [14]. Few of our early cases were recurrent ones where the temporalis muscle had already been used. Hence in such recurrent cases, alternate interpositional material option was required. The standard treatment to restore mandibular height in children has been to use a costochondral graft; however, many of the parents especially of girls, in the Indian context were unwilling to subject their child to additional chest surgery and it is in these children and the ones with recurrent diseases, we decided to use ultrathin silicone sheet as interpositional material to maintain as much mandibular height as possible. Moreover, in all techniques for interpositional arthroplasty, no attention is paid to the construction of the articular cartilage, which is always lost due to ankylosis of the TM joint. The role of the articular disc has been stressed upon now and several authors have repositioned the disc to act as a cushion for the condyle [15]. They have stated that this maneuver goes a long way in preventing reankylosis and have demonstrated consistent long-term results in cases of TMJ dysfunction.

We also feel that reconstruction of the articular disc is the most important part of ankylosis correction. The articular disc is a tough and oval pad of dense fibrous connective tissue with an avascular central portion. Any material which can replicate this disc in its size and strength can form a good interpositional material. Silicone, as interpositional material, had been used in earlier times in the form of blocks and balls to replicate the TMJ. However, these had very high extrusion rates due to presence of large amount of foreign material in a very small joint space.

High incidence of foreign body reactions with implant failure and subsequent extrusion were observed. Thus, to overcome the disadvantages of the muscle and the foreign body reactions of silicone, a middle path was devised by us. We have used an ultrathin silicone sheet which replicates all the characteristics of the articular disc (permanent, thin, avascular, tough structure); at the same time, ultrathin sheet limits the amount of foreign material present in the TMJ space. It can be easily sutured onto the adjacent structures and being extremely thin and pliable, does not require big bone gaps.

In our technique of using ultrathin silicon sheet for management of post-traumatic TMJ ankylosis in children, we have used ultrathin silicon sheet of thickness of 0.2 mm to replicate the normal intra-articular disc, which was fixed with sutures so as to completely cover the joint space thus preventing any contact between raw areas (Fig. 2). The silicone sheet is non-absorbable, immune to ischemic necrosis and does not lead to loss of mandibular height. The secure fixation of the sheet to the fascia over the zygoma and the fascia over the medial pterygoid reduces the chances of re-ankylosis due to displacement or extrusion of the implant. We did not come across any case of loss of implant by either extrusion or displacement. Thus, there was no recurrence of trismus in our study.

The advantages of our technique were short operative time of 1½ h, minimal foreign material in the joint space leading to negligible foreign body reactions and as less space was required between the bones to insert such a thin silicon sheet, the chances of increase in height discrepancy between two sides of the mandible was not seen in any of our cases. The follow-up in our cases varied from 24 to 36 months and the initial results are quite encouraging. We did not use costo-chondral graft in any of our cases even if the discrepancy of the length of the condyle was great as we believe that the discrepancy of the mandibular height will get compensated with time in growing children and hence we did not subject our patients to additional procedure of costo-chondral graft insertion. In cases where the height discrepancy would persist even after skeletal maturity, we intend to use distraction osteogenesis to restore facial symmetry along with orthodontic treatment to restore proper occlusion. Our technique of ultra-thin silicon sheet insertion thus has the advantage of reduced intra-operative time, reduced post-operative recovery time and also protecting our patients from undergoing additional procedure of chest surgery without compromising the long-term results.

Another important aspect of the treatment of TMJ ankylosis in children is the role of post-operative physiotherapy. This is essential to prevent adhesion formation and to maintain the mouth opening achieved during surgery. It is extremely difficult to ensure good physiotherapy in

children with conventional techniques like hister's jaw opener and use of wooden spoons. These as we believe, cause passive stretching of the muscles leading to severe pain and poor compliance. We used a custom made dynamic jaw exerciser. This is easy to assemble and can be used in small children as well. It causes active physiotherapy and is relatively pain free, thus ensuring good compliance among children [16]. The use of jaw exerciser, we believe is as important as the surgical procedure in achieving our treatment goals. Aggressive physiotherapy should be recommended in order to disrupt and prevent adhesions, prevent soft-tissue contractions and redevelop normal muscle function [3, 4, 8]. In our cases, we subjected all our patients to active physiotherapy for at least 1 year post-operatively. All patients were made to use custom made acrylic painless dynamic jaw exerciser, (Fig. 3) which was easy to use and compliance of the patients was good as this jaw exerciser did not cause any pain during jaw exercises.

It is recommended that the TMJ ankylosis should be dealt with aggressive surgical approach with minimal resection of bone in vertical height and using silastic interpositional material followed by early mobilization of the joint. It not only results in satisfactory mouth opening and jaw function, but also ensures reduction of subsequent re-ankylosis.

Conclusion

We have described a new technique of using ultra-thin silicon sheet (0.2 mm) between two transected bony ends for TMJ ankylosis in children. The advantages of our technique were short operative time of 11/2 h, less insertion of foreign material in the joint space leading to negligible foreign body reactions and as less space was required between the bones to insert such a thin silicon sheet, the chances of condylar discrepancy between two sides of the mandible was not seen in any of our cases. Thus, our technique is a good alternative to conventional techniques used for TM joint ankylosis with less morbidity and early recovery but more randomized trials are required to assess its effectiveness in comparison to conventional techniques and for universal adoption of this technique.

Conflict of interest Nil.

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