

Cremio–Maxillofacial Surgery

Treatment of temporomandibular joint ankylosis by a modified fossa prosthesis

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SUMMARY. Background and objective: Treatment of temporomandibular joint ankylosis is a challenge and suffers from a high incidence of recurrence. Although treatment of ankylosis has been tried as early as nearly 200 years ago, no single technique produced satisfactory results. An alternative technique and a modified spacer system are described in this paper. Material and methods: Fifteen patients, nine of whom had unilateral and the remaining six had bilateral ankylosis were evaluated. Modified fossa implants were used in all cases. Results: The highest incidence of ankylosis was observed in the 11–20 year age group (nine patients). Falls during childhood was the common aetiological factor. Eight patients had been previously operated upon. Postoperative interincisal opening values were remarkably different from the preoperative ones and the long-term results were satisfactory. Conclusion: With continued research and development in the treatment of ankylosis, temporomandibular joint implants will become more predictable and reliable. This specially designed fossa implant seems to be promising in the treatment of TMJ ankylosis. © 2004 European Association for Cranio-Maxillofacial Surgery.

Keywords: Temporomandibular joint; Ankylosis; Arthroplasty; Fossa implant; Spacer

INTRODUCTION

Temporomandibular joint ankylosis is a disabling condition of the masticatory system and is most commonly due to trauma, infections and some systemic diseases. Hypomobility affects surrounding structures as well as the joint itself. Ankylosis arising in early childhood usually leads to facial asymmetry and in rare cases also to upper airway obstruction or obstructive sleep apnoea. The maxilla is usually affected secondarily, with shortening of the posterior facial height. Thus facial asymmetry is the classic feature in unilateral cases. The chin deviates towards the affected side, and the vertical height of the affected side is reduced when compared with the unaffected side.

Secondary effects on the soft tissues surrounding the mandible occur in the form of shortening of the pterygo-masseteric muscle sling and the ligaments attaching the mandible to the skull base (sphenomandibular and stylomandibular; *El-Sheikh et al.*, 1996).

The masticatory muscles may become hypertrophic as a result of long-standing isometric contractions. Hypertrophy of the temporalis muscle may lead to thickening and elongation of the coronoid process. For this reason, coronoidectomy is required in long-standing cases. The suprahyoid muscles also become shorter and hypertrophic as they try to pull the chin inferiorly and simultaneously posteriorly causing shortening of the chin–hyoid distance, and thus

contributing to partial obstruction of the airway (*El-Sheikh et al.*, 1996).

The degree of recession and asymmetry of the mandible depends on the growth condition and the time of onset of ankylosis. On the other hand, complete limitation of the mouth opening and symmetrical recession of the chin are typical characteristics of bilateral ankylosis. Timing, the type of operation, and the policy of treatment vary from one country to another. However, the main principles include resection of the ankylosed segment, use of interpositional material, plus early, aggressive and persistent postoperative physiotherapy.

According to *Verneuil* (1860), the first arthroplasty was made by *Percy and Barton* in 1826. *Verneuil* was the first to suggest the interposition of muscle and fascia between the bones and many other materials like cartilage (*Kummoona*, 1978), muscle and dermis (*Topazian*, 1966), fat (*Murphy*, 1914), or fascia (*Narang and Dixon*, 1975). Metatarsal (*Stutville and Larfranchi*, 1955) and sternoclavicular joints (*El-Sheikh*, 1996) were proposed for TMJ arthroplasty. Numerous alloplastic materials have been used for partial and total reconstruction of the temporomandibular joint to prevent re-ankylosis. They were either made of silicone, acrylic, polyoxymethylene, ceramic or various metals, (*Cobey*, 1967; *Borçbakan*, 1968; *Christensen*, 1971; *Davis and Jones*, 1971; *Taurus et al.*, 1972; *Kent et al.*, 1983; *Szabo et al.*, 1990).

Variable success rates for TMJ prostheses have been reported. Few reports included short follow-up periods. Failure and success were not clearly defined.

In this paper, the use of a modified fossa implant composed of titanium mesh and acrylic for the treatment of TMJ ankylosis will be described and their long-term consequences will be presented.

PATIENTS AND METHODS

The survey is based on 15 patients who were treated between 1985 and 2000. The factors evaluated were sex, age, cause and type of the ankylosis, preoperative and postoperative maximum interincisal distances (Table 1).

All 15 patients had a history of trauma and the differentiation regarding degree and severity of the ankylotic process was made according to the classification of *Sawhney* (1986, Table 1). Falling during childhood was the most common aetiological factor in this study (10 patients). Two more patients had been injured in traffic accidents and their disorders were attributed to inadequate treatment of maxillo-facial injury after the accident (Table 1). Three more patients were unable to provide details regarding the aetiology of ankylosis.

Surgical technique

Patients were operated upon under general anaesthesia using nasal intubation. Retro- or preauricular incision was used to avoid injury to the superficial temporal vessels and the facial nerve. The dissection proceeded to the zygomatic arch and extended anteriorly and posteriorly to expose the ankylosed TMJ. The periosteum covering the zygomatic arch and ramus was incised and elevated. Following exposure the bone was drilled using a round bur until just thin, thin cortical bone was left in the wound depths. The two segments were gently split to avoid injury to the internal maxillary artery or pterygoid plexus of veins. The irregular edges of the segments were smoothed shaved by a bur and the ramus was completely disconnected from the upper bony block. The coronoid process was resected together with the ankylosed bony mass in long-standing cases (Table 1).

In all unilateral cases, the contralateral TMJ was mobilized effectively immediately after mobilization of the ankylotic side, in spite of having remained almost functionless for many years.

A modified fossa implant composed of a titanium mesh and acrylic was used as a spacer to prevent re-ankylosis (Figs 1 and 2). Data from a 3-D CT was used to create a custom made and well fitted fossa implant. It was shaped using pink wax prior to surgery. The wax model adhered to the titanium mesh bar and was converted into a custom fitting implant using heat cured acrylic applying conventional laboratory techniques. The implant was steam

Table 1 – Characteristics of the patients with TMJ ankylosis before and after surgery.

No	Age (years)	Sex	Type of trauma/ at age (years)	Joint involved	Type/no of previous operations	Type of approach	Pre-op IO (mm)	Immediately postop IO (mm)	Follow-up period years/ IO (mm)	Type of ankylosis (Sawhney)	Coronoidectomy
1	26	F	Fall/2	Unilateral (Rt)	Gap arthroplasty/1	Preauricular	6	42	8/37	4	Unilateral
2	18	F	Fall/2	Unilateral (Rt)	Gap arthroplasty/1 ^a	Preauricular	5	40	8/38	4	No
3	29	F	Fall/?	Unilateral (Lt)	Acrylic spacer/2	Preauricular + intraoral	3	46	7/35	4	Unilateral
4	20	M	?/?	Unilateral (Lt)	—	Auricular	4	45	7/36	3	No
5	22	F	Traffic acc./7	Bilateral	—	Auricular	4	45	7/34	Lt3/Rt3	Bilateral
6	18	M	Fall/3	Unilateral (Lt)	Silastic sheet	Preauricular	5	49	6/40	2	No
7	25	M	Traffic acc./21	Bilateral	—	Auricular + intraoral	4	46	6/35	Lt3/Rt3	Bilateral
8	16	F	?/?	Unilateral (Rt)	—	Auricular	9	50	6/40	2	No
9	20	F	Fall/?	Unilateral (Rt)	Gap arthroplasty/1	Preauricular	4	41	5/39	4	Unilateral
10	19	F	Fall/3	Unilateral (Lt)	—	Auricular + intraoral	7	40	5/36	4	Unilateral
11	16	M	?/?	Bilateral	Gap arthroplasty/1	Preauricular + intraoral	3	40	4/38	Lt3/Rt3	Bilateral
12	13	M	Fall greater height/4	Bilateral	Gap arthroplasty/1	Preauricular + intraoral	4	45	3/39	Lt3/Rt2	Bilateral
13	21	F	Fall/3	Bilateral	Gap arthroplasty/1	Preauricular + intraoral	4	42	3/38	Lt4/Rt4	Bilateral
14	7	M	Fall/4	Bilateral	Gap arthroplasty/1	Auricular	4	45	3/39	Lt4/Rt4	No
15	16	F	Fall/?	Unilateral (Rt)	—	Auricular	8	48	1,5/45	2	No

^aPatient had previous operation (by author) at age of 10. (IO) Interincisal opening; (Rt) Right; (Lt) Left.

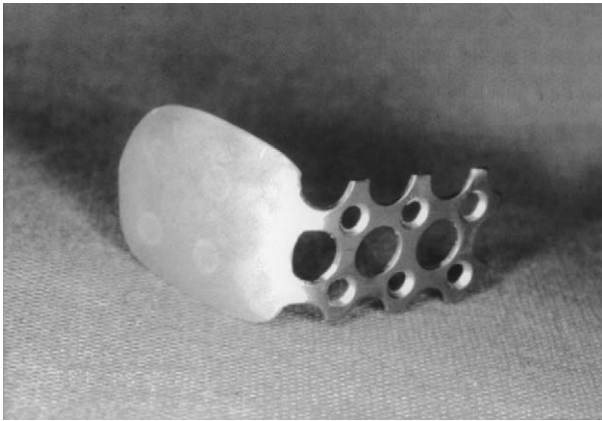
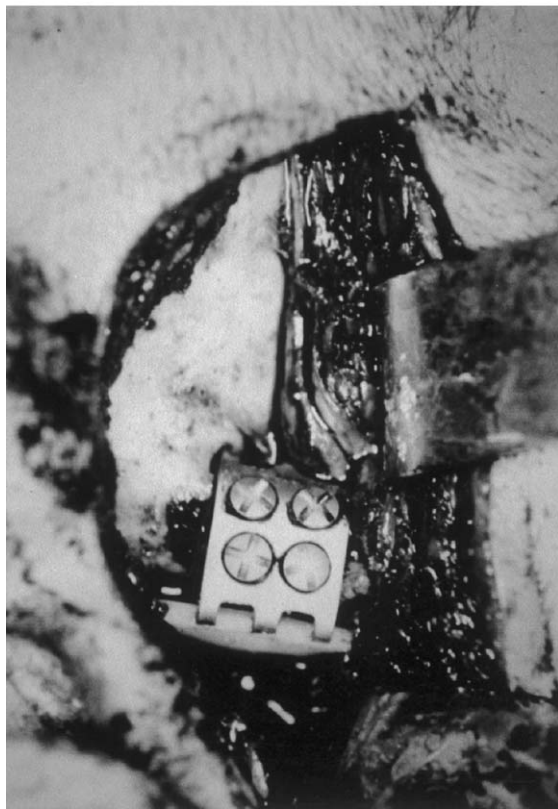


Fig 1 – Fossa implant.



(A)



(B)

Fig 2 – (A) Fixation of the fossa implant. (B) Intraoperative view of the implant.

sterilized and minor adjustments during the operation were easy using a micro motor and pliers. Availability of more than one pre-prepared custom implant of slightly different size reduced the adjustment time during surgery. The acrylic fossa implant was secured to the upper (stable) segment with three or four self-tapping screws after creating a gap (Fig. 2). However, lateral decortication was not necessary to improve the fit of the prosthesis, since it was easy to bend and shape with the titanium plate.

After the operation, patients were encouraged to do vigorous exercises. Although physiotherapy was painful during the first week, most of the patients tolerated the therapy in time. Furthermore, different types of gags were used to increase mouth-opening gradually (Güven, 2000).

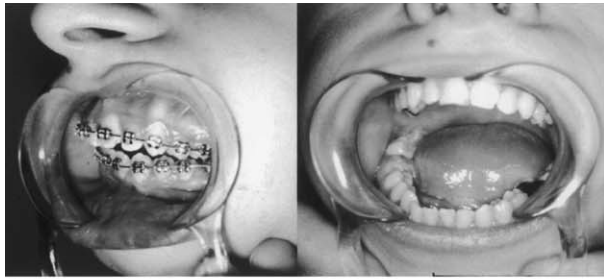
RESULTS

All patients presented gross malocclusions with poor oral hygiene. Nine patients had unilateral and six had bilateral ankylosis. Most patients (8) with ankylosis were in the 11–20 age group; followed by five patients in the 21–30 age group and two patients were under 14. Of the falls during childhood, repeated two suffered an accidental fall at the age of 2, two at the age of 3 and two other patients at the age of 4. Eight patients had been previously operated to release ankylosis. Six of these had been treated by gap arthroplasty. Spherical acrylic spacers (Borçbakan, 1968; Güven, 2000) and silastic sheets were removed in two more patients who had undergone previous surgery. In four patients, the retro-auricular, and in three the preauricular approach was used, the intraoral approach was used in addition in seven patients with severe ankylosis (Table 1). Five patients had bilateral and four had unilateral coronoidectomies as well.

Preoperative and postoperative interincisal distances were remarkably different and satisfactory results were achieved in the long-term follow-up (Figs 3 and 4). However, there were slight differences between the immediate and long-term results (Table 1).

DISCUSSION

Trauma, particularly in childhood is the predominant factor in TMJ ankylosis (Güven, 1992). Up to the second year of life, there are many vascular channels within the condylar head, but they vanish shortly thereafter (Myall, 1994). Active movement of the mandible is particularly important in preventing ankylosis in this highly vascularized and osteogenic environment. There is an enormous potential for regeneration and reshaping in children compared with adults and even adolescents (Murphy, 1914; Güven and Keskin, 2001). According to Raveh et al. (1989), the type of condylar fracture is not very important for the development of TMJ ankylosis,



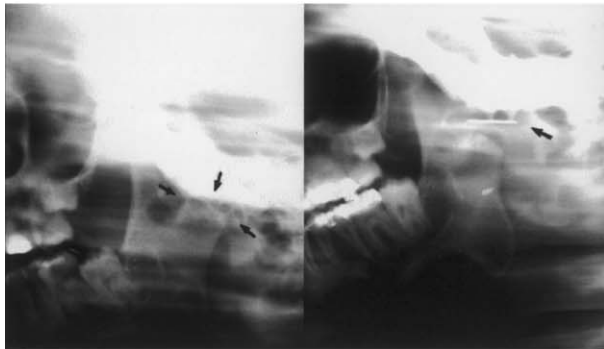
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(B)

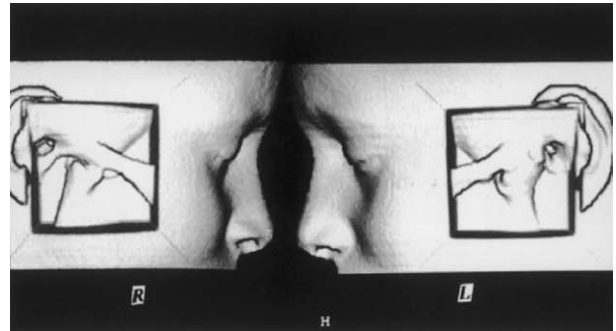


(C)



(D)

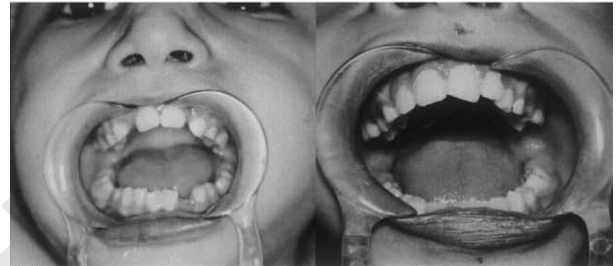
Fig 3 – (A) Preoperative mouth opening of 16 year old girl (Case No: 8) with unilateral ankylosis (left) and mouth opening of the same patient, 6 years postoperatively (right). (B) Preoperative facial frontal view (left) and frontal view at completion of treatment (right). (C) Preoperative (left) and postoperative lateral view at completion of treatment (right). (D) Preoperative (left) and postoperative radiograph of fossa (right).



(A)



(B)



(C)



(D)

Fig 4 – (A) Preoperative CT of 7-years old girl (Case No: 14) with bilateral ankylosis. (B) Fossa implants 6 months postoperatively (orthopantomogram). (C) Postoperative mouth opening after 6 months (left) and 3 years (right). (D) Postoperative frontal view reveals no evidence of abnormal growth.

1 and surgical treatment of condylar fractures is
 2 essential even in childhood. In contrast to the study
 3 by *Raveh et al.* (1989), *Güven* and *Keskin* (2001)
 4 reported successful results achieved by conservative
 5 management of condylar fractures in children. TMJ
 6 ankylosis can be prevented by early diagnosis and
 7 proper early treatment of condylar fractures.

8 Interposition arthroplasty for TMJ ankylosis has
 9 been in use for over 100 years; *Risdon* (1934) used
 10 gold foil. Later, *Eggers* (1946) used tantalum foil,
 11 whilst *Borçbakan* (1968) and *Sawhney* (1986) reported
 12 acrylic spacers for treating ankylosis. The purpose of
 13 using mobile spacers was to enable free movement of
 14 the mandible. But, if an alloplastic prosthesis is not
 15 stable at the time of implantation, it may fail. Poor
 16 fixation of the prosthesis will promote loosening of
 17 the device during function and finally failure (*Mer-*
 18 *curi*, 2000).

19 Some authors concluded that reconstruction with
 20 alloplastic condylar prostheses may lead to a
 21 predictable result in treatment of functionless TMJs.
 22 *Gold* (*Tauras et al.*, 1972), stainless steel (*Spiessl et al.*,
 23 1976), vitallium (*Silver et al.*, 1977), and ticonium
 24 (*Kent et al.*, 1983) were used for this purpose. But the
 25 possibility of glenoid fossa erosion was the major
 26 problem with this type of prosthesis. The use of some
 27 auto-grafts has also been reported for the treatment
 28 of ankylosis (*El-Sheikh* and *Medra*, 1997; *MacIntosh*,
 29 2000). However, the difficulty in fixing the metatarsal
 30 bone to the mandibular fragment, and excessive
 31 growth of costochondral grafts in younger patients
 32 were the disadvantages of these techniques. Accord-
 33 ing to *Mercuri* (2000), placing autogenous grafts
 34 which can grow and remodel makes no sense
 35 particularly in patients with ankylosis. This is why,
 36 in orthopaedic surgery, alloplastic joint reconstruc-
 37 tion is always preferred in similar situations (*Mercuri*,
 38 2000).

39 A total TMJ prosthesis was first described by *Kiehn*
 40 *et al.* (1974). In that paper, they reported a single
 41 case, but in the following years they reported 28
 42 patients treated with total joint prostheses made of
 43 vitallium (*Kiehn et al.*, 1979). *Kent et al.* (1983)
 44 reported on a TMJ prostheses comprising a fossa
 45 made of a fluorinated ethylene propylene and a
 46 chrome-cobalt condyle. However, failure of the
 47 implant became such a problem that manufacturing
 48 ceased (*Vitek*) in 1990 (*Speculand et al.*, 2000). In the
 49 ensuing years, *Mc Bride* (1992), *Cope et al.* (1993) and
 50 *Mercuri* (2000) reported different total TMJ implants
 51 with various success rates.

52 The first reported fossa implant was metallic
 53 (*Christensen*, 1963). Then, *Christensen* (1972) re-
 54 ported almost 160 implants with a 98% success rate.
 55 In the following years, *Besette et al.* (1985) described
 56 silicone fossa implants and then, *Chase et al.* (1995)
 57 reported placement of *Christensen* fossa implants,
 58 made of vitallium, in patients with internal derange-
 59 ment or degenerative joint disease. *Speculand et al.*
 60 (2000) reported their experiences with the *Vitek* VKII
 61 and demonstrated histological evidence of a foreign
 body reaction in four cases.

62 In this study, a fossa implant composed of a
 63 titanium mesh and acrylic was used to prevent re-
 64 ankylosis. Heat cured acrylic and titanium are well
 65 known in maxillofacial surgery having been used
 66 separately for a long time as spacers without any
 67 complication (*Borçbakan*, 1968; *Sawhney*, 1986).
 68 Therefore, a spacer made of titanium mesh and heat
 69 treated acrylic should not cause any foreign body
 70 reaction. *Wolford et al.* (1994), found that the foreign
 71 body giant cell reaction to Proplast-Teflon implants
 72 was proliferative, and worsened in time as more
 73 particles were generated. Abnormalities in lympho-
 74 cyte subset ratios were also found which then
 75 improved towards normal when the Proplast-Teflon
 76 implants were removed and replaced with the
 77 *Techmedica* custom-made total joint prosthesis
 78 (*Speculand et al.*, 2000). It is still not clear whether
 79 the foreign body reactions were caused by the
 80 particulate matter from wear of the artificial articular
 81 surface (*Kent et al.*, 1983; *Speculand et al.*, 2000). One
 82 of the most important considerations for evaluating
 83 any type of implant is failure. In this study group, not
 84 a single immediate or late rejection was encountered,
 85 and none of the implants has had to be removed so
 86 far.

87 Two different approaches were proposed for the
 88 treatment of ankylosis. The meticulous and radical
 89 elimination of the ankylosis was recommended by
 90 *Raveh et al.* (1989) and *Kaban et al.* (1990): An
 91 incomplete removal of the ankylosed bone would
 92 lead to re-ankylosis. The resulting opposing surface
 93 areas of healing bone, therefore, are considerable and
 94 scar tissue may form between them. Radical resection
 95 and complete removal of the ankylosed bone may be
 96 the logical alternative. However, the risk of aggres-
 97 sive surgery is considerable and the advantage gained
 98 is marginal, since complete elimination of the
 99 ankylosed bone still creates an extensive area of
 healing bone where scar tissue inevitably will form
 (*Salins*, 2000).

100 In subankylotic approaches, a pseudoarthrosis is
 101 encouraged below the base of the ankylosed mass.
 102 Therefore in this series, the ankylosed bone was
 103 removed as far as possible, and a generous gap was
 104 created. In long-standing cases the coronoid process
 105 was resected as well. Additional resection of the
 106 contra-lateral coronoid process via the intra-oral
 107 approach improved mouth opening and facilitated
 108 post-operative rehabilitation.

109 Most interpositional, alloplastic grafting techni-
 110 ques provide very limited augmentation of ramus
 111 height. In this study, however, the thickness of the
 112 acrylic parts of the implant was adjusted appropri-
 113 ately during the manufacturing stage in the labora-
 114 tory. More than one pre-prepared, custom-made
 115 implant that slightly differed in size were made
 116 available for the operation.

117 The follow-up period ranged from 18 months to 8
 118 years. Eleven patients have been followed up for 4
 119 years or more. The average interincisal distance was
 120 38 mm with minimum of 34 mm as measured long-
 term (Table 1).

Screws, fixing an implant may loosen with time and function. However, stability of an implant depends not only on fixation but also on adaptation of the implant to the bone to which it is fixed. Clinical experience has shown that the better the adaptation of the fossa implant to the bone, the more stable the implant and the longer the device will survive under function (Swanson and Freeman, 1977).

The effect of TMJ implants on facial growth in childhood is still debated. In this study, there were only two patients under the age of 14 (Table 1). These have been under surveillance for 3 years, but no evidence of abnormal jaw growth has been detected (Fig 4d). The main objective in growing patients with treated ankylosis is to provide normal jaw function following release. This will prevent re-ankylosis and should promote normal growth.

CONCLUSION

The occurrence of TMJ ankylosis is closely related to the cultural and economic environment of the patients. Early onset of ankylosis can be a deterrent to normal mandibular growth. The fossa implant presented is readily available and is not expensive. Titanium mesh is available in most maxillofacial units and to produce a custom made implant of different sizes is not a time consuming process in the laboratory. The implant presented here provides free anterior, posterior and lateral excursions of the mandible. With continued research and development in this field, TMJ implants will become functionally even more stable, predictable and reliable in severe anatomical disorders and disabling conditions of the TMJ.

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