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Original Research

Use of Cortical Bone Screws in Maxillofacial Surgery - A Prospective Study

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Abstract:

Background: The aim of this study is to evaluate the various applications of cortical bone screws in oral and maxillofacial surgery.

Materials & Methods: The study was conducted in a teaching hospital located in, Bangalore, India, on 20 patients. These patients were categorized into three groups depending on the applications of these screws like, for achieving intermaxillary fixation in Group-1, for treatment of simple, undisplaced fractures by "Tension wire" method in Group-2, and further application of these screws were evaluated in Group-3. Different parameters were used to evaluate the efficacy of these screws.

Results: In Group-1(n=12) there was satisfactory occlusion in all the patients with minimal incidence of complications. In Group-2 (n=4) post-operative reduction and fixation was satisfactory and in Group-3 (n=4) the function of these screws was satisfactory when it was used for vestibuloplasty and also as a suspension wiring in treatment of comminuted fracture of zygoma with minimal incidence of complications.

Conclusion: Use of cortical bone screws is a valid alternative for achieving intermaxillary fixation, reduction and fixation of simple, undisplaced or minimally displaced fractures through Tension wire method owing to its simplicity, economy and ease of use, and as a fixation method for apically positioned flap in vestibuloplasty procedure.

Key Words: Cortical bone screws, intermaxillary fixation, self tapping IMF screws

Introduction

For thousands of years mandibular fractures have been treated by stabilization. "Wiring the jaw shut" is a proven method of allowing fracture to heal and ensuring that future occlusion is normal. In the past several decades, the most common method for achieving IMF has been the placement of arch bars on the maxillary and mandibular teeth using interdental wires. These flanged steel bands, though inexpensive have several disadvantages like, placing them is time-consuming, causes periodontal injury, it causes a lot of pain to the patient while placing or removing them, there is an inherent difficulty in maintaining good oral hygiene, and it presents a significant health risk to the practitioner with regard to needle stick injury.[1]

In 1989, Arthur and Berardo suggested an alternative method for intermaxillary fixation. The technique involved the use of self- tapping 2.0 mm titanium bone screws (Bicortical screws, IMF screws, Transalveolar screws) which were placed into the maxilla and the mandible to provide points of fixation and to minimize complications reported with arch bars.[2]

There are a few studies where they had used these cortical bone screws for various purposes other than intermaxillary fixation in treating fracture cases such as, reduction of simple, displaced and / or unstable mandibular fractures using tension wire method,[3] to achieve maxillomandibular fixation in orthognathic surgery,[4] to support arch bar in patients who are partially edentulous or patients with fixed partial denture,[5] fixation of endotracheal tube to the maxilla in patients with burns,[6] for treatment of prolonged bilateral mandibular dislocation,[7] and in cases of vestibuloplasty.[8]

Materials and Methods

The study was conducted on a total of 20 patients who had visited the Department of Oral and Maxillofacial surgery, M.S.Ramaiah Dental College and Hospital, and the Casualty department of M.S.Ramaiah Medical Teaching Hospital. Depending on the application of the screws, the patients were categorized into three groups.

In the first group (n=12) cortical bone screws were used to achieve intermaxillary fixation in treating maxillo-facial fractures. In the second group (n=4), the cortical bone screws were used for open reduction and internal fixation and/ or closed reduction of simple, undisplaced or displaced mandibular fractures and dento-alveolar fractures by "Tension-Wire" method (Tension wire

Figure 1: Cortical Bone screws.

Figure 2: Pre-op Photograph showing Left high condylar fracture.

method is a procedure that uses monocortical screws across the fracture with stainless steel wire for fracture reduction and fixation). In the third group, the further applications of cortical bone screws in maxillofacial surgery were explored. Here, cortical bone screws were used for vestibuloplasty (for the purpose of retaining the apically positioned flap at the desired depth) in 3 patients and in one patient screws were used for suspension wiring in a case of comminuted zygomatic complex fracture.

Inclusion criteria for the study were:

1. Mandibular fractures
2. Dento- alveolar fractures
3. Patients requiring intermaxillary fixation

Exclusion criteria for the study were:

1. Severely comminuted fractures
2. Extensive alveolar bone fractures
3. Medically compromised patients

In all three groups, cortical bone screws measuring about 2 mm in diameter and 10 / 12 mm in length were used. The screw had a pointed tip and, its head had a slot, where in wires or elastics could be placed so as to be held in position (Figure 1).

Patients underwent pre-operative evaluation consisting of a complete case history and general physical examination, routine blood and urine examination, panoromic mandibular X- ray examination, and photographs of occlusion. With the aid of orthopantomograph, the exact site of screw placement was determined taking care that the screws were positioned interdentally.

In the first group (Usage of cortical bone screws to achieve inter-maxillary fixation) prior to placement of screws, occlusion was established after reduction of fracture using standard dental relationships. Local anesthesia (2% Lignocaine) with adrenaline (1: 200,000) was injected into the mucosa at the site of screw placement. In both maxilla and mandible with the help of OPG X-Ray (Figure 2) screws were placed between the roots of canine and premolars and between the roots of 1st molar and 2nd molar at the junction of attached and reflected mucosa. Holes were drilled trans-mucosally using a straight surgical hand piece and straight fissure bur of 2 mm diameter, taking care that the bur enters the alveolar bone at right angles, so as to avoid injuries to the roots. The screws were inserted into previously drilled holes in a clock-wise direction until the flat surface of the screw head fitted snuggly against the buccal mucosa. After ensuring that the screws were secured in the bone, 26-gauge wire / elastic was used to achieve intermaxillary fixation (Figure 3).

Four screws each (1 per quadrant) were placed in 5 cases, while in 7 cases eight screws (2 per quadrant) were placed

Figure 3: Placement of cortical screws and achieving IMF using elastics.

(a total of 80 screws). They were inserted under general anesthesia in 9 patients to obtain intermaxillary fixation intra-operatively followed by open reduction and internal fixation of maxillofacial fractures. Screws were placed under local anesthesia to achieve intermaxillary fixation for closed reduction of sub-condylar fractures.

Figure 4: Postoperative photograph with cortical screws in place.

Figure 5: Pre-operative photograph showing para symphysis fracture.

Post operatively, OPG X-Ray was taken on 2nd or 3rd post-operative day and after removal of screws to assess iatrogenic damage to the teeth (Figure 4). Findings are recorded as follows such as changes in occlusion over a period of one week, complications if any were recorded such as iatrogenic damage to the teeth, mucosal coverage of screws, breakage of screws, loosening of screws and needle stick injuries. Clinically all the patients were asked if they had any tooth pain or sensitivity in relation to site of screw placement and findings recorded.

In Group- 2 (Usage of cortical bone screws to treat fractures by Tension- wire method) in the case of simple, undisplaced fracture of sympysis (Figure 5), after administration of 2% Lignocaine with Adrenaline, the fracture site was exposed through intra-oral incision. After reflecting the mucoperiosteal flap, fracture segments were reduced manually and 2 screw holes were drilled, approximately 4 – 6 mm away from the fracture line at, inferior border and superior border. With the help of screw holder, screws measuring about 2 mm in diameter and 10 mm in length were inserted, until the flat surface of the screw head fitted snugly against the bone, and 26-gauge wire was tightened between the screws producing both reduction and fixation. The incision was closed by means of simple interrupted sutures using 3-0 vicryl.

Figure 6: Post-operative photograph (Tension Wire method).

Post-operatively, OPG X-Ray was taken on the first or second day of operation and after first week to assess reduction and fixation of fracture (Figure 6). Stability of occlusion intra-operatively, immediately on the post-operative day and at the end of 1st week were noted. Complications if any were recorded with respect to mal-union or non-union of fracture site, infection, iatrogenic damage to the teeth, breakage of screws, mucosal coverage of screws.

In Group – 3 (Usage of cortical bone screws for further applications in maxillofacial surgery) in Vestibuloplasty cases, after reflection of supra-periosteal flap (Figure 6), holes were drilled using straight surgical hand- piece and 702 size bur at three points, and flap sutured to the holes of the screws for retaining the apically positioned flap at the desired depth (Figure 7).

Figure 7: Cortical bone screws in place.

Post-operatively in vestibuloplasty cases the desired depth of apically positioned flap achieved with cortical bone

screws is assessed at the time of screw removal. Screw removal was done after 10 days in all the three patients, by giving a stab incision to expose the screw as all the screws had been covered by mucosa.

Figure 8: Preoperative photograph.

In a patient with comminuted fracture of right zygomatic complex with mobility of maxilla in the posterior segment, orbital rim was reduced and fixed with peri-orbita plate. (Figure 8)

Cortical bone screws were placed between 15/16 and 16/17 and suspended to the orbital plate to stabilize the maxillary segment.

Results

Among the 20 patients, depending on the application of screws, 12 patients (60%) patients were categorized under Group-1, 4 patients (20%) under Group-2, and 4 patients (20%) under Group-3. 16 patients were males and 4 patients were females. Among these 20 patients 3 patients were below 20yrs, 11 patients were between 20-40 yrs, 4 patients were between 40-60 yrs and 2 patients were above 60yrs.

Group-1

In all the patients, there was satisfactory occlusion intra-operatively. In 4 patients (33.3%), there was occlusal discrepancy on the first post-operative day. Out of these, 3 patients had mild occlusal discrepancy (Unilateral Sub-condylar fracture) and 1 patient had moderate occlusal discrepancy (Bilateral Subcondylar fracture). In all these 4 patients, post-op elastic traction was given to correct occlusal discrepancy. On the 3rd post-operative day 11 patients (91.6%) had normal occlusion but 1 patient (8.3%) had moderately deranged occlusion (Bilateral Subcondylar fracture). In this patient arch bars had been placed to achieve a more stable intermaxillary fixation. At the end of 1 week, all patients had satisfactory occlusion (Table-1).

There were 80 screws placed in these patients. 2 teeth (2.5%) had iatrogenic damage, there were needle stick injuries in 2 cases (2.5%), 6 screws (7.5%) got loosened at the time of screw removal and mucosal coverage of screws was observed in 2 cases (2.5%). There was no incidence of screw breakage intra-operatively or post-operatively and no clinical evidence of tooth pain / sensitivity in relation to the site of screw placement (Table-2). Mean time taken for placing cortical bone screws and achieving intermaxillary fixation was 16.3 mins.

Group-2

In Group-2 out of 4 patients, 2 patients had Parasymphysis fracture and 2 patients had Dento-alveolar fracture. Post-operative reduction and fixation of fracture

Table 1: Changes in occlusion over a period of 1 week.

Occlusion	1st Day		3rd Day		5th Day		7th Day	
	N	%	N	%	N	%	N	%
Normal	8	66.6	11	91.6	11	91.6	11	91.6
Mild Derangement	3	25	0	0	0	0	0	0
Moderate Derangement	1	8.3	1	8.3				

Table 2: Complications encountered.

Complication	Number	Percentage
Iatrogenic damage to teeth	2	2.5
Mucosal coverage of screws	2	2.5
Breakage of screws	0	0
Loosening of screws	6	7.5
Needle stick injuries	2	2.5
Clinical evidence of tooth Pain / sensitivity	0	0

radiographically was found to be satisfactory in 3 patients and unsatisfactory in 1 patient (mild discrepancy in reduction at the inferior border of fracture site). Occlusal changes over a period of 2 weeks were found to be normal in all the 4 patients. There was incidence of iatrogenic damage to the teeth in 1 patient and loosening of screws in 1 patient at the time of screw removal. There was no incidence of non-union / mal-union of fracture, infection, mucosal coverage of screws and clinically evident tooth pain or sensitivity in relation to the site of screw placement.

Group-3

In vestibuloplasty cases, there was satisfactory depth gained in all the patients at the time of removal of screws. In all the 3 patients cortical bone screws had been covered by mucosa at the time of screw removal and needed a small incision to expose and aid the removal of screws. There was no incidence of loosening of screws, infection or breakage of screws intra-operatively or post-operatively.

In the patient with comminuted Zygomatic complex fracture, the stability of suspension wiring was satisfactory in stabilizing the comminuted fracture, and there were no incidence of complications such as loosening of screws or mucosal coverage of screws.

Discussion

The self tapping intermaxillary screws were first introduced by Arthur and Berardo[5] in 1989 and later modified by Carl Jones[2] with a Capstan shaped head design. He suggested the use of threaded titanium screws of 2mm diameter and 10 to 16 mm in length.[5] He recommended the use of these screws for temporary intra-operative IMF and postoperative elastic traction. The authors used 2mm diameter self-tapping screws of variable length. In our study we used 2 mm diameter self-tapping screws of 10-12 mm length. The use of this method is mainly indicated in single or double mandibular fractures with minimal and moderate displacement, and compound condylar fractures, fractures in edentulous patients if proper dentures are available, and midfacial fractures that requires IMF during and / or after surgery[3]. In our study under Group-1, most of the fractures treated are minimally or moderately displaced single or double mandibular fractures, and few cases of midfacial fractures that required intra-operative IMF. In the present study, the changes in occlusion over a period of 1 week was found to be normal (91.6%) in Group-1, as reported in various studies.

The tension wire method is a procedure that uses cortical bone screws with stainless-steel wire for fracture reduction and fixation in conjunction with intermaxillary fixation. The TWM is an attractive alternative to current methods of mandibular internal reduction and fixation for simple and/ or unstable fractures, with no increased complication rates, low cost, and comparative ease of use. In Group-2 we had used cortical bone screws for fracture reduction and fixation using the same principle. In two patients we had used this principle in dento-alveolar fractures to achieve closed reduction and fixation. In one patient there is slight discrepancy in reduction of the fracture segment radio graphically, but the post-operative occlusion was satisfactory in this patient. There was no incidence of complications such as mal-union/ nonunion, malocclusion, or infection similar to the above study. As the sample size is very small, a longer study with a greater number of patients will allow for better evaluation of this technique.

In Group-3 we tried to explore the various applications of cortical bone screws in maxillofacial surgery other than achieving IMF, and we found the use of screws in two different applications. First application is for the purpose of retaining the apically positioned flap at the desired depth in vestibuloplasty procedure and the second application is to stabilize comminuted ZMC fracture through suspension wiring. There was satisfactory depth gained in all the 3 patients for proper denture support treated by vestibuloplasty. In all 3 patients the screws were covered by mucosa and a stab incision has to be placed for removal of screws, which is disadvantage of these screws. The stability of suspension wiring is satisfactory in stabilizing the fracture, and there was no incidence of complications such as loosening of screws or mucosal coverage of screws.

Conclusion

Considering the advantages of cortical bone screws over arch bar in achieving IMF, and the results revealed in Group-1, use of cortical bone screws to achieve IMF in the treatment of simple, undisplaced or minimally displaced maxillofacial fractures is widely accepted. “Tension wire” method is beneficial in treating simple, undisplaced or minimally displaced mandibular fractures and dento-alveolar fractures either by open reduction and internal fixation or closed reduction owing to its simplicity, economy and ease of use. In exploring the further applications of these cortical bone screws, we found it easy

and safe to use these screws in vestibuloplasty procedure as a fixation method for apical positioned flap. We continue to use these screws in vestibuloplasty procedure. The stability of suspension wiring using these screws was satisfactory in treating zygomatic complex fracture. The main limitation of this study is the small sample size in all the three groups. A longer study with greater number of patients will allow better evaluation of various applications of cortical bone screws in oral and maxiollofacial surgery.

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