Original Article

The use of Synthes MatrixWAVE bone anchored arch bars for closed treatment of multiple concurrent mandibular fractures

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ABSTRACT

Background: Maxillomandibular fixation (MMF) is an important tool in the treatment of facial fractures and bone-anchored arch bar systems have emerged as treatment options. This study illustrates our experience with the Synthes MatrixWAVE MMF system and the novel application in closed treatment of patients with multiple concurrent mandibular fractures.

Methods: We enrolled eight patients with concurrent mandibular fractures and treated them with the MatrixWAVE MMF system. The malleable arch bars were fitted and then secured using 6–8 mm screws. The arch bar was either stretched or compressed to ensure optimal positioning. 24-gauge interdental fixation wiring was placed using the fish loop technique on either side of the fracture to achieve stabilization of the mandible fractures.

Results: All eight patients were retained in MMF until stable occlusion was achieved with clinical evidence of healing, approximately 4–6 weeks. Post-operative Panorex scans did not reveal any evidence of damage to tooth roots. None of the screws became overly embedded in the mucosa secondary to overgrowth; the arch bars were successfully removed in an outpatient setting without local anesthesia. **Conclusions:** The Synthes MatrixWAVE MMF system has unique features such as prominent screw anchor heads and horizontal malleability unique from other bone anchored arch bars. These features allow for completely closed treatment of patients with multiple concurrent mandible fractures.

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1. Introduction

The overall goal in the treatment of mandibular fractures is to restore pre-injury occlusion and this can be achieved with a variety of techniques.¹ Erich arch bars have been the mainstay for maxillomandibular fixation (MMF), but the method can be time consuming and carries a high risk for needle stick injuries. Moreover, arch bars are not suitable in edentulous patients or in the setting of extensive crown or bridgework.^{2,3} This has led to the development of other techniques to achieve MMF. Hybrid systems, such as the Stryker Smartlock[®] Hybrid and the Synthes MatrixWAVE MMF system combine features of traditional arch bars with IMF screws.^{4,5} Synthes MatrixWAVE MMF system is the most recent addition and contains a wave-shaped plate that has unique features such as prominent screw anchor heads and horizontal malleability, which are not seen in other bone anchored

arch bars. Taking advantage of these new features, we have seen success in performing closed treatment of patients with two concurrent mandible fractures, which traditionally may have required open reduction and internal fixation of at least one of their fractures as their treatment modality. This study illustrates our experience with Synthes MatrixWAVE MMF system describing its ease of use, operative time, wire-stick injuries and adequacy of fixation achieved while focusing on the novel application in closed treatment of patients with multiple concurrent mandibular fractures.

2. Patients and methods

2.1. Study design

We conducted a case study on eight consecutive patients with two concurrent mandibular fractures treated with Synthes MatrixWAVE MMF bone anchored arch bar. The institutional review board of Rhode Island Hospital approved the study.

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2.2. Synthes MatrixWAVE MMF system

The Synthes MatrixWAVE is a bone anchored MMF system that consists of a wave shaped titanium bar that attaches to the maxilla and mandible with 6 or 8 mm self-drilling locking screws (Fig. 1). The bar contains 10 holes and can be both stretched and compressed in plane to alter the location of the fixation points. The self-drilling screws are placed through the gingiva and oral mucosa into the supporting bone. The screws sit 1 mm above the bar thereby serving as additional anchors for wires and limit the mucosal overgrowth. The bar is available in two heights (short or tall). The system was released in 2015 and is approved by the U.S. Food and Drug Administration for temporary treatment of mandibular and maxillary fractures and osteotomies in adults and adolescents with permanent teeth.

2.3. Report of cases

Patient 1: a 20-year-old male with no past medical history was transferred from an outside hospital to the Division of Plastic Surgery at Rhode Island Hospital for definitive care of mandibular fractures that he sustained after being assaulted. At the time of presentation, the patient reported pain over his lower face as well as malocclusion. On examination, the patient was noted to have an anterior open bite with early contact on the right. No intraoral lacerations were seen and the patient had excellent dentation. Pre-operative radiographs revealed a mildly displaced right mandibular parasymphseal fracture extending to the alveolar ridge that involved the roots of the canine as well as a mildly displaced left angle fracture that extended to the 3rd molar (Fig. 2).

Patient 2: a 27-year-old male with no past medical history presented with complaints of jaw pain and malocclusion after being assaulted. On gross examination, there were no soft tissue injuries or deficits in sensory or motor function. Intraoral exam was notable for a laceration through the gingiva between the first and second premolars on the right. The patient had an occlusal cant, with early contact on the right and an open bite. Pre-operative radiographs demonstrated a minimally displaced fracture of the right mandibular body between the roots of the first and second premolars as well as a fracture of the left ramus extending through the coronoid process (Fig. 3).

Patient 4: a 23-year-old male with no past medical history presented with complaints of malocclusion. Physical exam revealed a step-off was palpated over the right parasymphysis. A minimally displaced left mandibular and an open right parasymphseal fracture after being assaulted was found. Panorax revealed a left pterygoid plate fracture that extended to the third molar.

2.4. Surgical technique

The risks and benefits of the procedure were explained to the patients, who agreed to proceed with the surgical procedure and gave informed consent. The site was prepped and draped in sterile fashion. Closed reduction of the fractures was performed first to ensure that stable dental occlusion could be achieved. Then, the Synthes MatrixWAVE plate was contoured and cut to fit the maxillary arch. We started on one side and worked toward the other, adjusting the plate as we went. The bar was stretched or compressed to avoid damaging teeth roots and other critical anatomical structures. The plate was gently pressed down as the screws were inserted to avoid premature engagement of the plate and a pickle fork was inserted between the gingiva and the plate to avoid excess pressure on the soft tissue when locking the screw to the plate. The same procedure was then repeated to secure the wave-shaped bar on the mandibular arch with special attention to avoid fracture lines and place screws on each side of the fracture. Typically, 6 mm screws were used in the maxilla and 8 mm screws in the mandible. The hooks and screw heads were used as anchor points to apply the 24-gauge stainless steel wires between the mandible and maxilla and across the mandible fracture line when possible. Care was taken to manipulate mobile mandible segments into normal occlusion, which was confirmed and held in reduction by maximum intercuspation. If fractures could not be reduced nor be stabilized with wires alone, we had discussed open reduction and internal fixation preoperatively. There were no intraoperative wire-stick injuries with insertion of the system.

3. Results

Eight consecutive patients were treated between 2015 and 2016 using the Synthes MatrixWAVE MMF system. The mean age of the patients was 27.3 ± 10.5 years (range 18–51 years). All patients were treated with MMF for mandibular fractures after blunt trauma to the mandible, either through assault or motor vehicle accident. The average duration of treatment was 6 weeks (range 4–8 weeks). None of the patients had any significant medical comorbidities. Clinical evidence of healing was demonstrated by resolution of pain and tenderness over the mandibular fractures. Following removal of wires for MMF, the occlusion was checked and symptoms of pain were assessed. If necessary, guiding elastics were applied for an additional 2 weeks. After this, the remaining wire compressing across mandible fractures were removed and the hardware was removed in the office setting.

There were no major complications associated with the usage of Synthes MatrixWAVE MMF system (Fig. 4). All patients reported restoration of occlusion and clinical exam and post-operative

Fig. 1. Illustrative picture of the Synthes MatrixWAVE system.

Fig. 2. Images taken from a 20-year old male with right mandibular parasymphiseal fracture and a left angle fracture. (A) Axial CT image with bone window. (B) Coronal CT image with bone window. (C) Pre-operative orthopantogram.

radiographs did not demonstrate signs of nonunion or malunion. In addition, post-operative Panorex scans did not reveal any evidence of damage to tooth roots. Lip irritation from the hardware was reported in one patient and was treated with orthodontic wax. None of the patients reported problems with oral hygiene during their treatment. None of the screws became embedded in the mucosa secondary to overgrowth; the arch bars were successfully removed in an outpatient setting without local anesthesia in all of the cases.

4. Discussion

Maxillomandibular fixation (MMF) is the cornerstone in the treatment of maxillofacial trauma and multiple techniques to achieve fixation of the maxillomandibular have been developed.⁶ The available hybrid bars have many similar advantages when it comes to speed of application and decreased risk of injury from wires as discussed in previous studies.⁷ However, key differences distinguish the Synthes MatrixWAVE[®] MMF as a unique treatment option for the closed treatment of patients with multiple concurrent mandible fractures. This study presents eight illustrated examples of the Synthes MatrixWAVE MMF system in this novel treatment approach.

For single and simple mandible fractures, the cost effectiveness over Erich arch bars is still debated due to the high cost of these bone anchored arch bar systems. However with multiple concurrent mandible fractures and often a mobile mandible segment,

previous treatment modalities had required open reduction and internal fixation of one fracture as well as continued MMF postoperatively for the more posterior fracture.⁸ The opportunity to now treat these fractures in a complete closed fashion provides clear benefits to the patient as well as the health care system. First, the patient avoids an intraoral incision with sub-periosteal dissection, risk of further mental nerve injury, and permanently implanted hardware with its associated risks of infection and exposure.^{9,10} Second, the decreased invasiveness of the operation reduces recovery time and postoperative discomfort. Moreover, the time the patient is kept in MMF was unchanged from traditional treatment with Erich arch bars and post treatment results are similar between these approaches.

The use of the Synthes MatrixWAVE system in this described fashion takes advantage of the more prominent screws and horizontal malleability to allow manipulation and reduction of the fractured bones and stabilization with strategic wire placement. Wires are placed between the maxilla and mandible hardware for maxillomandibular fixation, and also between mandible screws flanking the anterior mandible fractures producing some compressive force and more stability in these cases with multiple concurrent mandible fractures. Though the hardware has malleability, it is significantly more rigid than the Erich arch bar system. Ultimately, the Synthes MatrixWAVE functions as a small intraoral external fixator. The system is secured directly to the bone so does not rely on circumferential wires as in the Erich system, which tend to loosen over time and often requires adjustment

Fig. 3. Images taken from a 27-year old male year old male with a right mandibular body fracture and the left coronoid process fracture. (A) 3-D reconstruction. (B) Axial CT image with bone window. (C) Pre-operative orthopantogram.

Fig. 4. Postoperative orthopantogram of a patient placed in MMF using wave shaped bone supported arch bars.

postoperatively to maintain stable MMF. Interdental bridle wire placement surrounding a mandibular fracture has also been used, however forces on these teeth can cause the dentition to shift and lacks the stability of bone-anchored screws. None of the cases demonstrate any laxity or instability of the MMF in the postoperative period.

Overall, the Synthes MatrixWAVE MMF system was easy to use and the plate could be placed quickly in patients with a variety of fracture types, but we find the greatest benefit in its application to treat patients with 2 concurrent mandible fractures. There was no mucosal overgrowth that interfered with the removal of the

bone-anchored screws. This is in contrast to previous studies in which mucosal overgrowth was seen in 38% of patients treated with other hybrid bars.⁷ The Synthes MatrixWAVE[®] bar is held in place by self-drilling screws with heads that sit above the bar, decreasing the incidence of mucosal overgrowth. The hooks of the Synthes MatrixWAVE bar are larger than the Erich arch bars, which may account for one patient developing lip irritation. Otherwise, there were no other minor or major complications associated with the system. All patients reported reestablishment of pre-injury occlusion. The horizontal malleability and the prominent screw design allowed for a completely closed treatment of patients with multiple concurrent mandible fractures. The malleability of the bone anchored arch bar allows for optimal screw placement. Moreover, the self-drilling, locking screws sit above the bar to provide additional anchor points for wires to better approximate fracture segments and exert compression across a mandible fracture for added stability when possible. The Stryker Smartlock[®] Hybrid MMF system is designed to mimic the Erich arch bars in plate and hook design. The bone anchor holes do have limited horizontal adjustability to navigate around tooth roots. The screws used for bone anchoring are locking and low profile, which may be more comfortable, however does not allow for wire placement. This difference is in our opinion critical for the manipulation of the anterior mandible fracture since it allows application of compression around the fracture, giving it added stability of this anterior fracture while in MMF therapy. Consequently, this added stability

allows for the complete closed treatment in these clinical cases of two concurrent mandible fractures.

In our experience, the Synthes MatrixWAVE MMF system minimizes the drawbacks associated with traditional MMF techniques and offers a novel approach for closed treatment of patients with multiple concurrent mandibular fractures. Moreover, the cost efficiencies results in higher value from a socioeconomic perspective. Prospective studies would be needed to determine the long-term outcomes.

Conflicts of interest

The authors have none to declare.

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