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Techniques of maxillary–mandibular fixation

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Maxillary-mandibular fixation (MMF) methods are important in the surgical management of the lower facial skeleton. Various techniques have been described to fixate these bones during treatment of facial trauma, reconstruction, and orthognathic surgery. The utilization and technique of placement for Erich arch bars, Ivy loops, Ernst ligatures, and fixation screws are reviewed.

Maxillary–mandibular fixation (MMF) methods are important techniques to master for the otolaryngologist, plastic surgeon, and oromaxillofacial surgeon who is caring for patients with jaw fractures and reconstruction needs. The concept of MMF has been used for the treatment of jaw and dental issues for more than 2000 years. The first documented use of MMF dates to Hippocrates, who in 460 B.C. described a closed reduction of mandible fractures via external manipulation, with gold wire placement to secure the surrounding teeth in occlusion.[1] During the course of the last 100 years, multiple methods have been developed and some remain in use today.

Purpose

The purpose of MMF is to immobilize the upper and lower jaws in an occlusal relationship by securing them to each other via one of the many accepted fixation methods. Properly applied, the fixation method will maintain the jaws in the desired occlusive relationship. Maxillary–mandibular, or intermaxillary fixation, is used in a variety of clinical situations, including the management of mandible and midface fractures, the maintenance of occlusion during mandible reconstruction, and the maintenance of occlusion after elective orthognathic surgery. Stabilization, immobilization, and maintenance of occlusion are the primary goals accomplished in placing the patient into MMF.

Historically, many different methods have been used to accomplish this immobilization and alignment. Barton dressings, wire arch bars, Essig wiring, Erich arch bars, Ernst ligatures, Ivy loops, IMF fixation screws, bonded dental lugs, and plastic circumdental lugs (Rapid IMF, Synthes, West Chester, PA) are but a few of the fixation methods that have been used. In this article, we will focus on a number of the currently popularized methods.

Principles

There are several key principles guiding the surgeon who is considering the placement of a patient into maxillary-mandibular fixation: (1) occlusion, which is the maintenance or establishment of an optimal occlusive relationship between the upper and lower jaws is the dominant ideal behind and the main goal of MMF. Depending on the clinical situation this may be class I occlusion,[2] or "optimal" may be the patient's less-than-perfect premorbid occlusion; (2) immobilization of fractures, which is the reduction of motion along a bone disruption, whether it is a traumatic fracture or an iatrogenic elective osteotomy, is important to promote timely healing, or union. Motion across a healing bone interface is a key factor in malunion and nonunion[3]; (3) the viability of teeth, which depends on intact vascularity and stability. MMF techniques must support these factors, and not disrupt either through the very placement of the MMF

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materials; and finally; and (4) early functioning. In certain clinical situations, particularly in the case of condylar and condylar neck fractures, provisions for the option of a degree of mobilization should be insured by the MMF technique used. In these circumstances, the period of immobilization should be relatively brief to facilitate successful rehabilitation and minimize the risk of ankylosis of the temporomandibular joint.

Erich arch bars

For many, Erich arch bars represent the most reliable method of placing a patient in MMF. The arch bars themselves provide a semirigid bar scaffold to which each dental arch is wired. The arch bars are then wired together, securing the occlusal relationship. The sequence of application is as follows (Figure 1): (1) the skeleton and dental arch is reduced as well as possible

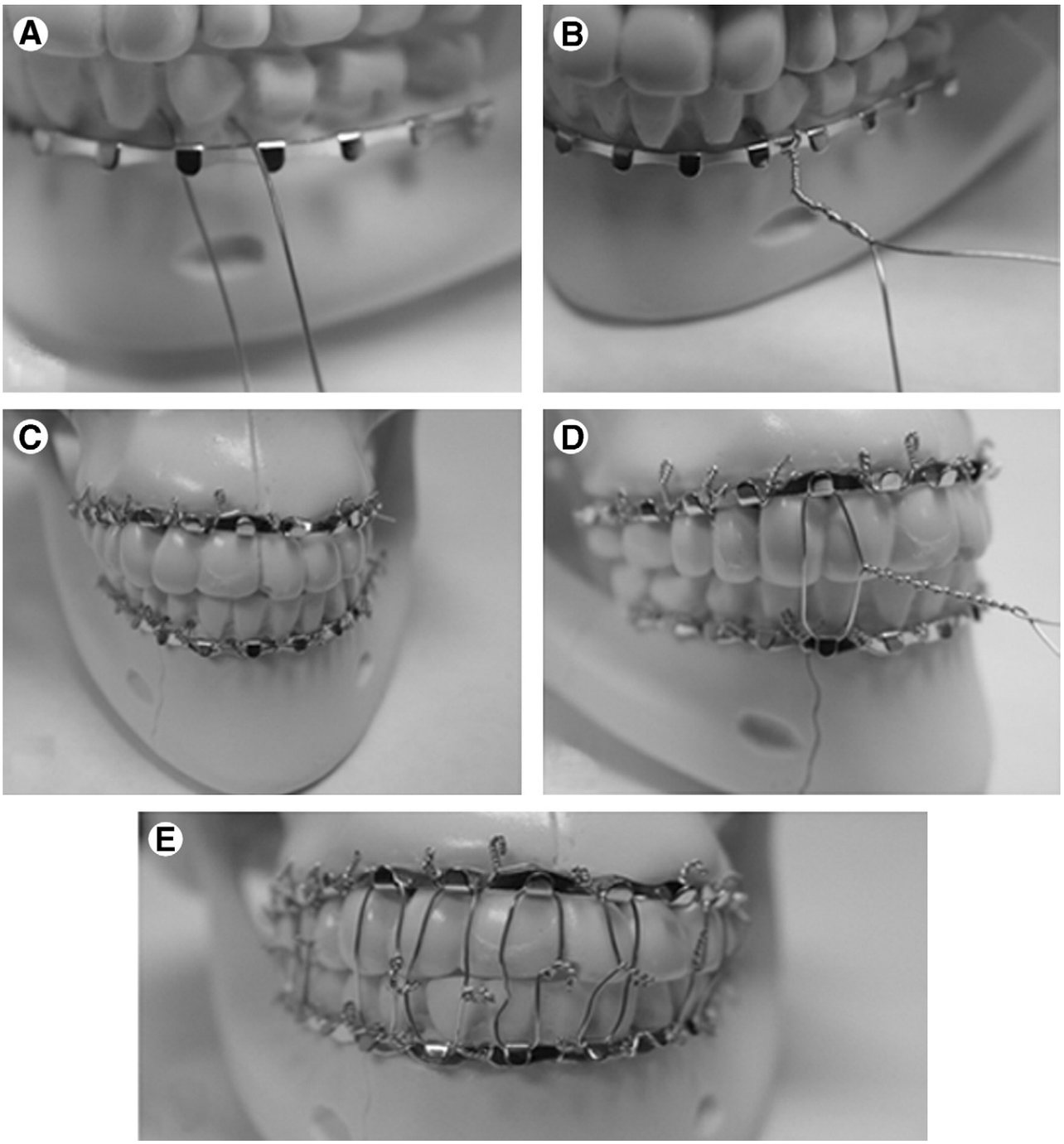

Figure 1 Erich arch bars. (A) After the arch bar material is cut to the length of each dental arch, the bar is placed along the buccal surface of the dental arch, lugs oriented apically. A 24- or 26-gauge wire is passed interdentally around each tooth, such that one end of the wire is positioned occlusal and the other apical of the arch bar. (B) Each wire is twisted clockwise, thus tightening it around the tooth, apical to the crown. (C) The twisted ends are then trimmed and then "rosetted" down toward the gingival, also in a clockwise direction. (D) The patient should be placed into occlusion, and the 2 arch bars secured to each other, either with a wire loops or rubber bands. (E) Arch bars completed.

into the desired position, or occlusion, depending on the clinical situation. (2) The arch bar material is cut to the length of each dental arch. One should avoid extending the arch bar beyond the last tooth to reduce soft tissue injury, or alternatively, one may bend the arch bar around the back of the last tooth. (3) The arch bar is then secured to stable teeth using circumdental 24- or 26-gauge wire, insuring that the lugs of the arch bars are oriented away from the occlusal plane (apically). A wire is placed around each tooth, such that one end of the wire is positioned occlusal and the other apical of the arch bar (Figure 1A). Consistency in wire placement (eg, mesial wire always apical) may be helpful in dealing with these wires during placement and even during the period of MMF. Each wire is twisted clockwise, thus tightening it around the tooth, apical to the contact point or around the base of the crown (Figure 1B). If the jaw on which the surgeon is working contains a fracture, it may be helpful to initially tighten the wires on the greater segment (segment with more teeth) and loosely place the wires on the lesser.

After all wires are in place, the fracture may be reduced and held in reduction, while the lesser segment wires are then tightened. This action may prevent the arch bar placement from interfering with fracture reduction. During tightening, it is important to use a wire push to insure that the circumdental wire is set below the widest portion of the tooth crown, to minimize wire loosening through slippage of the wire occlusally. (4) The twisted ends are then trimmed and then "rosetted" down toward the gingival, also in a clockwise direction (Figure 1C). (5) After both dental arches are completed, the patient should be placed into occlusion, and the two arch bars secured to each other, either with a wire loops or rubber bands (Figure 1D and E). Erich arch bar placement may be difficult if the patient has poor dentition, or if there are multiple avulsed or unstable teeth. Dentoalveolar fractures and comminuted fractures may also make placement more challenging.

Ivy loops

Ivy loops were among the earliest methods used to provide intermaxillary fixation, but they are still frequently used today. Ivy loops allow the patient to be placed in intermaxillary fixation and allow the stabilization of adjacent teeth to one another. Some authors feel they have advantages that allow them to be used in children with mixed and primary dentition.[4] Ivy loops are made and placed as follows (Figure 2): (1) a small loop is created in a 24-gauge wire (Figure 2A); (2) the 2 free ends are placed between 2 stable teeth (Figure 2B); (3) the wire is wrapped around each tooth and the wire fed back through the next dental interspace (Figure 2C); (4) the distal wire is passed through the original loop (Figure 2D) and tightened; (5) the same procedure is performed for the other dental arch, directly opposite the first Ivy loop (Figure 2E); (6) the loops may each be tightened further over the wire to decrease the loop size and length; finally, (7) a second wire should be used through the 2 opposing Ivy loops and tightened clockwise, as in Erich arch bars (Figure 2F). Elastic bands may also be placed over the loops if preferred.

Ernst ligatures

Ernst ligatures are another time-honored method of placing a patient into maxillary-mandibular fixation. There are some

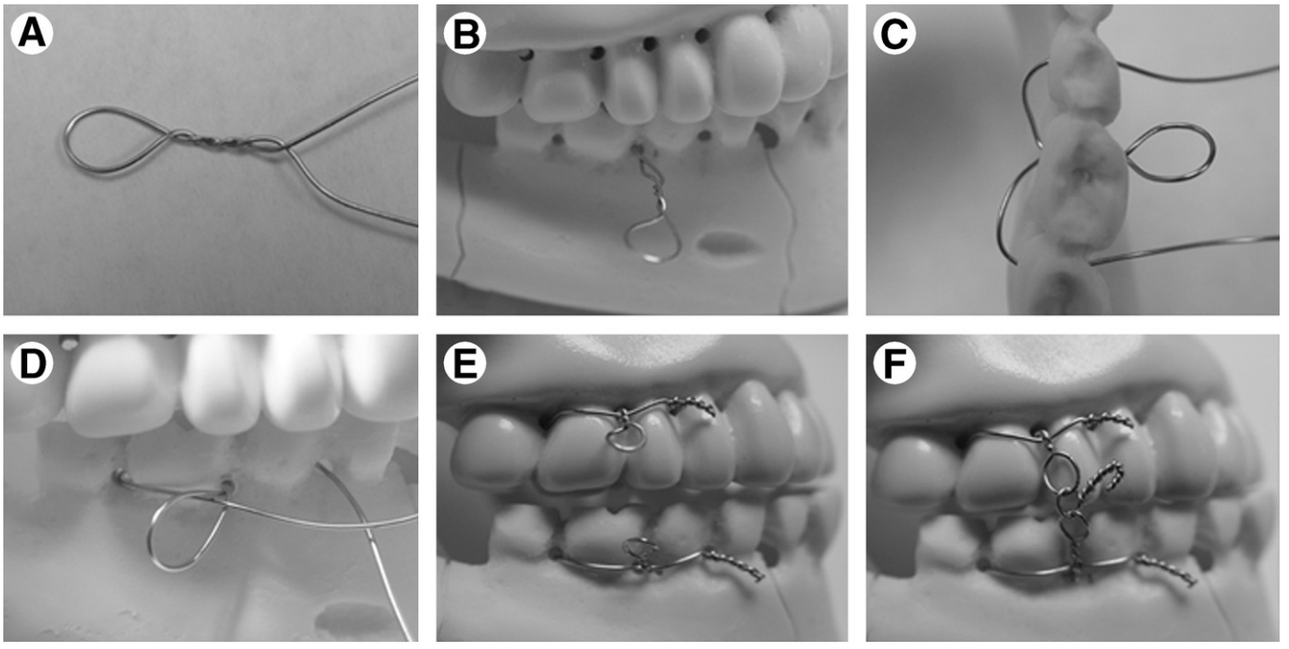

Figure 2 Ivy loops. (A) A small loop is created in a 24-gauge wire. (B) Both free ends are placed between 2 stable teeth. (C) The wire is then passed around the each neighboring tooth and fed back through the next dental interspace. (D) The distal wire is passed through the original loop. (E) The wire ends are twisted together and then the excess if cut off. The same procedure should be performed for the other dental arch, directly opposite the first Ivy loop. Note that the loop can also be further twisted to decrease its size. (F) A second wire is placed through the 2 opposing Ivy loops and tightened clockwise.

similarities to the technique used in the creation and placement of Ivy loops. The Ernst ligatures are best used for temporary fixation and simple fractures. In some clinical situations, such as comminuted or unstable fractures, they may not be sufficient to fully stabilize the fracture segments. The teeth used for the wiring must be secure and not fractured or luxed. The Ernst ligatures are placed as follows (Figure 3): (1) premolar teeth are typically selected for securing the ligature; (2) a 24-gauge wire is placed between the canine and first premolar from a buccal to palatal direction; (3) this wire is then placed in a reverse direction back through the interdental space of the premolars (Figure 3A); (4) the other end of the wire is passed behind the second premolar in a similar fashion (Figure 3B); (5) the second end is also passed back between the premolar interdental space; (6) one end of the wire should be on top and one below the wire loop created on the buccal side of the teeth (Figure 3C); (7) the wire ends are then twisted tight and cut off 4 to 5 cm long (Figure 3D); (8) an identical wire placement is performed on the opposite jaw and a similar pair on the contralateral side (Figure 3E); (9) the ends of these 2 matching pairs are then twisted together after placing the patient in occlusion (Figure 3F); (10) alternatively, the wire ends can be folded over several times creating "hooks," which can then be used for elastics.

Fixation screws

This is one of the more recently introduced techniques for the placement of patients into MMF. Several companies now manufacture specific kits for this technique. The advantages are that it is more rapidly applied than most other techniques. Disadvantages include that it provides no tooth-to-tooth stabilization within the dental arch, and there is notable risk of tooth injury. The mental nerve and infraorbital nerves must be located and preserved with this technique. The technique is probably best applied in short-term situations. In general, the fixation screws are placed as follows (Figure 4): (1) the canine roots are identified on both dental arches, with plans made to place the screws either mesially or distally to the canine root on both dental arches and two points that are 5 mm apical from the dental root are identified. It should be noted that some systems require drilling before screw placement; others are self-drilling, self-tapping screws. Directions should be followed for the set being used. A small cut in the mucosa at the screw placement site may be helpful to minimize mucosa being caught by screw threads and wrapped around the screw as it is placed. (2) The screw should be fully inserted, with a minimum of 2 on the maxilla and 2 on the mandible (Figure 4B). (3) A 24-gauge wire in a loop fashion should be placed (similar to Erich arch bars) over the screw shoulder on each opposing jaw and tightened (Figure 4C). Some screws have through holes on the screw head, through which the wire may also be placed. (4) Cross wires may be placed to create force vectors that can aid in fracture stabilization (Figure 4D). (5) If the patient develops a posterior bite deformity when the wires are tightened, further MMF screws, Ernst ligatures, or Ivy loops may be used posteriorly to correct it. If predesigned MMF screws are not available, short 2.0-mm plates can be used by fixing the plate to the jaw with monocortical 6-mm screws. Wires may then be placed through a plate screw hole after establishing occlusion and tightened.

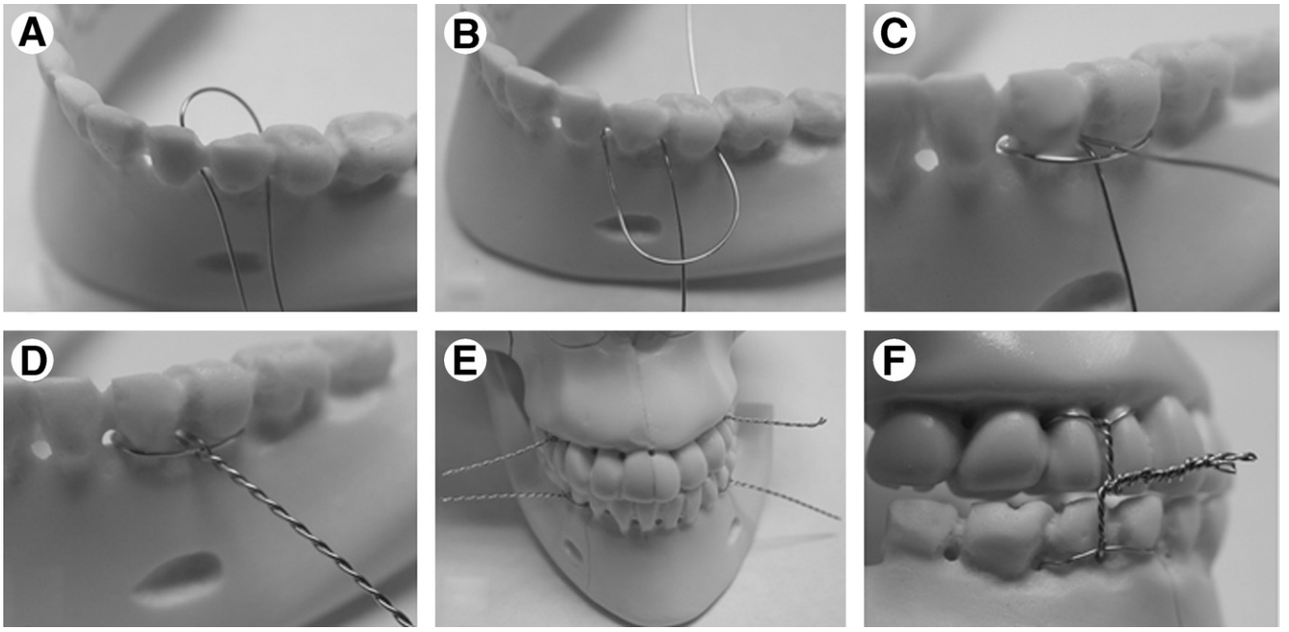

Figure 3 Ernst ligatures. (A) A 24-gauge wire is placed between the canine and first premolar from a buccal to palatal direction and then passed in a reverse direction back through the interdental space of the premolars. (B) The other end of the wire is passed behind the second premolar in a similar fashion. (C) The second end is also passed back between the premolar interdental space, such that one end of the wire should be on top and one below the wire loop created on the buccal side of the teeth. (D) The wire ends are then twisted tight and cut off 4 to 5 cm long. (E) Identical wire placement is performed on the opposite jaw and a similar pair on the contralateral side. (F) The ends of these 2 matching pairs are then twisted together after placing the patient in occlusion.

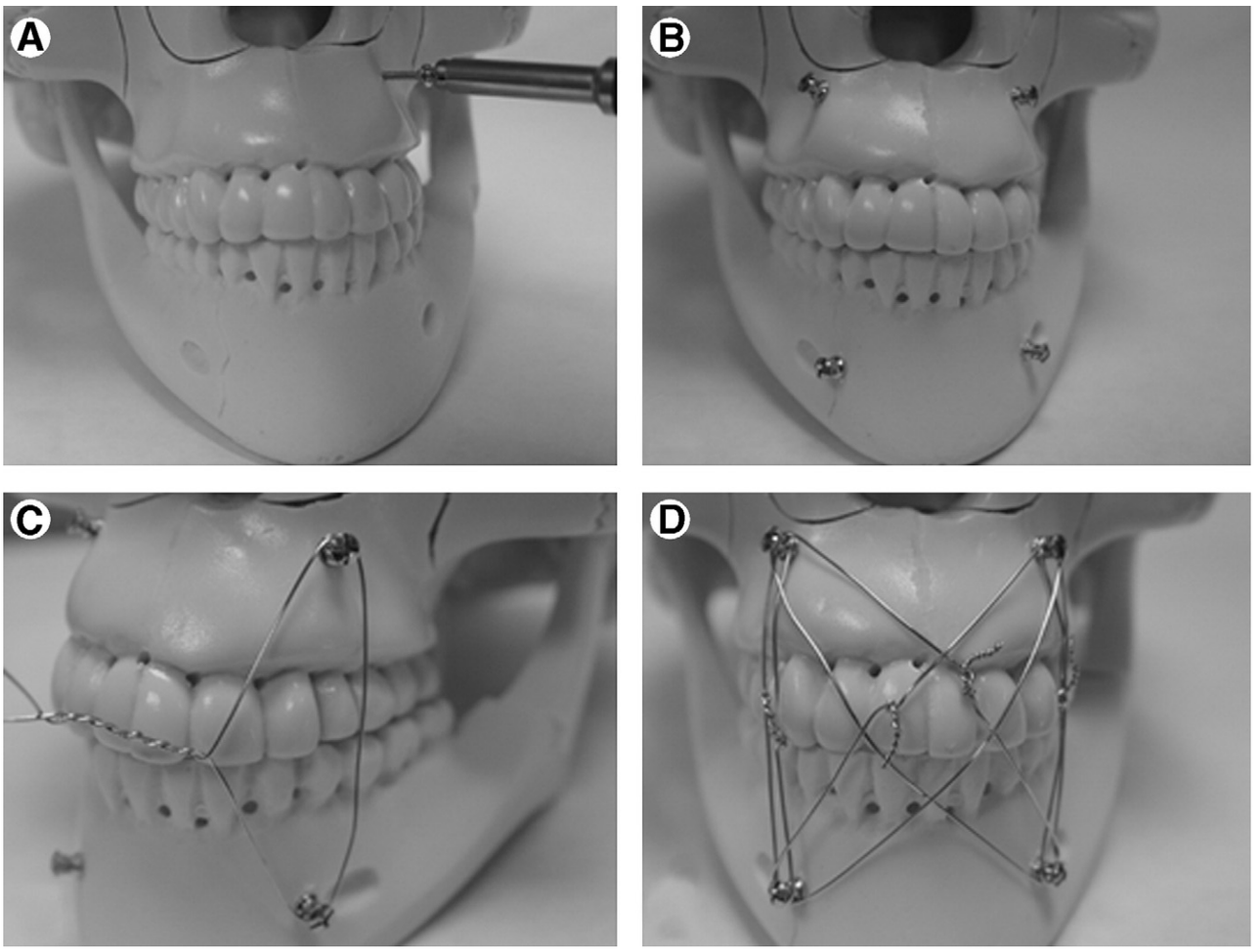

Figure 4 Fixation screws. (A) The canine roots are identified on both dental arches. A screw is placed either mesially or distally to the canine root and 5 mm apical from the dental root. (B) A minimum of 2 screws are secured on the maxilla and two on the mandible. (C) After reducing the patient into desired occlusion, a 24 gauge wire is used to fashion a loop, which is placed over the screw shoulder on each opposing jaw and tightened. (D) Cross wires may be added to create force vectors, which can aid in fracture stabilization.

Other techniques

Some attempts to make placement of MMF less traumatic for the patient, more rapid in placement, and safer for the surgeon (eg, reduced wire sticks) have been made. The primary modification involved in these techniques is the lack of circumdental wires. Bonded dental lugs and Rapid IMF (Synthes Inc, West Chester, PA) are products in which the maxillomandibular fixation is based on lugs either fixed to the enamel of the teeth or by a plastic circumdental device. These techniques are likely best utilized for short term MMF.

Splinting materials can become necessary in the edentulous mandible. These custom acrylic splints are fixed to the mandible and then serve as a "dental arch" for maxillary-mandibular reduction immobilization. In the setting of trauma, the patient's dentures may be used in this fashion if they are intact after the trauma.

Complications and limitations

Dental care becomes an important part of postoperative care. Dental caries may develop if regular dental care with a soft toothbrush and/or water pick device is not used. Caries may still be an issue beneath the arch bars despite good care techniques.

Complications include infection, malunion, nonunion, malocclusion, periodontitis, and tooth-related problems. Many complications are the result of an inability to achieve a stable and appropriate occlusive relationship between the upper and lower jaws or the inability to achieve fracture stability and reduction. Nutritional concerns while the patient is in MMF should be considered. Patients should be given instructions on liquid diets and nutritional counseling to avoid malnutrition, if MMF is to be maintained. Emesis or airway problems may arise in the immediate postoperative period, or in a delayed fashion. Patients who have wires between dental arches should be provided a wire cutter on discharge, with instructions in its use if it should be necessary, as well as instructions to keep the cutters on them at all times. Patients in tight elastic band MMF may benefit from carrying simple scissors to allow for rapid removal of MMF if necessary. Some surgeons may keep a nasogastric tube in place for a short period after MMF placement under general anesthesia, to provide gastric decompression and reduce the risk of emesis postoperatively. The nasogastric tube may also be utilized for enteral feeding if the patient is unable to take oral nutrition. The placement of patient

in MMF provides a closed-method to stabilize the jaw into an occlusive relationship. For the surgeon to use many of the described methods, the patient must have enough stable teeth to apply the fixation apparatus.

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