Management of Comminuted Fractures of the Mandible

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KEYWORDS

• Fractures • Comminuted • Mandible

Comminuted mandible fractures are complex injuries that are generally the result of a significant impact on a localized area of the jaw by either a high-speed collision or a high-speed projectile. Most series of mandibular fractures report 5% to 7% as being comminuted. In a comminuted fracture, the bone is shattered. Most of these fractures are exposed to the mouth or skin. Gunshots are common causes. These complex injuries are difficult to treat and have a high complication rate.

TRADITIONAL MANAGEMENT

The management of comminuted mandibular fractures has evolved. Traditionally, one never opened the comminuted fracture so as to avoid devitalizing the bone fragments, which would ultimately sequester. With few exceptions, these cases were managed with closed techniques based on maxillomandibular fixation (MMF), splints, or both.[1–8] Proximal segment control, when necessary, was accomplished with skeletal pin fixation (**Figs. 1** and **2**). Obviously, if the fracture was secondary to a gunshot injury, there were also blast injury and cavitation considerations in management, depending on the type of firearm and projectiles involved. Most civilian gunshot wounds are secondary to fairly low velocity handguns or shotguns and do not have the cavitation and shock effects of the modern high- and ultra-high–velocity military projectiles. As such, civilian gunshot wounds are usually amenable to more aggressive management.[8]

Traditional management of a gunshot wound of the mandible, following management of any airway or bleeding problems, would be to rule out vascular injury. Once done with neck exploration, and later with carotid angiograms, it is now accomplished with a CT angiogram. Debridement of both hard and soft tissue was based on the type of gunshot wound, but generally involved removal of bone fragments devoid of soft tissue attachment (and thus blood supply), with care being taken not to strip the periosteum from vital fragments. The rule of thumb was to remove only that bone that was flushed out with aggressive irrigation. Any bone still with soft tissue attachment was considered potentially viable. Shattered teeth as well as nonrestorable teeth associated with the fracture were also removed and soft tissue closure of the wound would be attempted. The principles of debridement and closure of these injuries are well established.[9,10] Application of MMF and an external fixater for proximal segment control, or an external fixator alone if the patient was edentulous, provided reduction and fixation of the bone fragments (**Figs. 3** and **4**). Further debridement was often necessary when drainage developed and additional fragments sloughed (see **Fig. 3**). Finally, after drainage ceased and the wound was closed, signifying initial consolidation of the comminuted fragments, reconstruction of any remaining defects was done in one or more stages.[11,12] Rehabilitation of function followed.

Obviously, this type of management was rather prolonged, with a treatment time of months (and sometimes years) rather than weeks. Yet, it was considered the gold standard for 70 years. It is well documented and illustrated by the US Navy

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Fig. 1. Joe Hall Morris appliance for comminuted fracture of the symphysis.

Vietnam War experience.[12] The introduction of rigid fixation techniques which have dramatically shortened the course of treatment, raise the question of which form of treatment is preferable.

CONTEMPORARY MANAGEMENT

Rigid internal fixation with function during convalescence came into general use in Europe in the 1970s.[13–17] As part of this regimen, new techniques evolved for the treatment of comminuted fractures

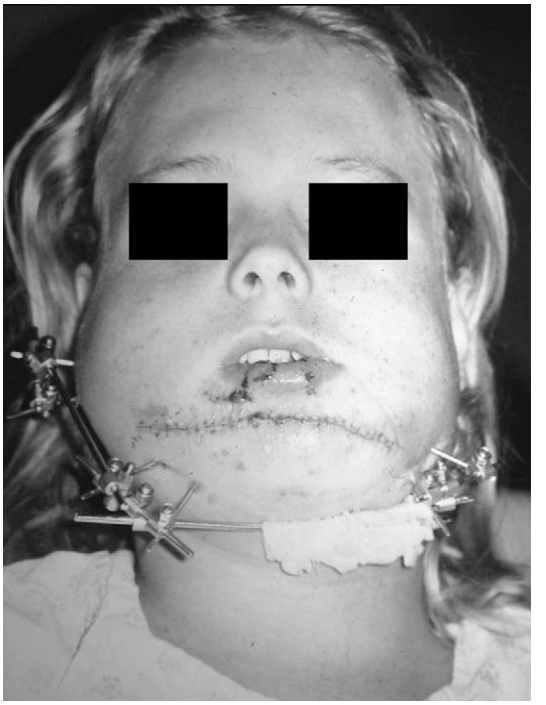

Fig. 2. Roger Anderson appliance controlling multiple comminuted mandibular fractures.

Fig. 3. A 58-year-old edentulous man with gunshot wound to right mandibular body with extensive contamination and comminution managed with external fixation. (*A*) Initial presentation. (*B*) Panoramic radiograph showing the comminuted fracture. (*C*) External fixator adapted to provide maxillomandibular fixation via attachment to the zygoma. (*D*) Sloughing bone fragments. (*E*) Final appearance at 2 months. (*F*) Panoramic radiograph showing final result.

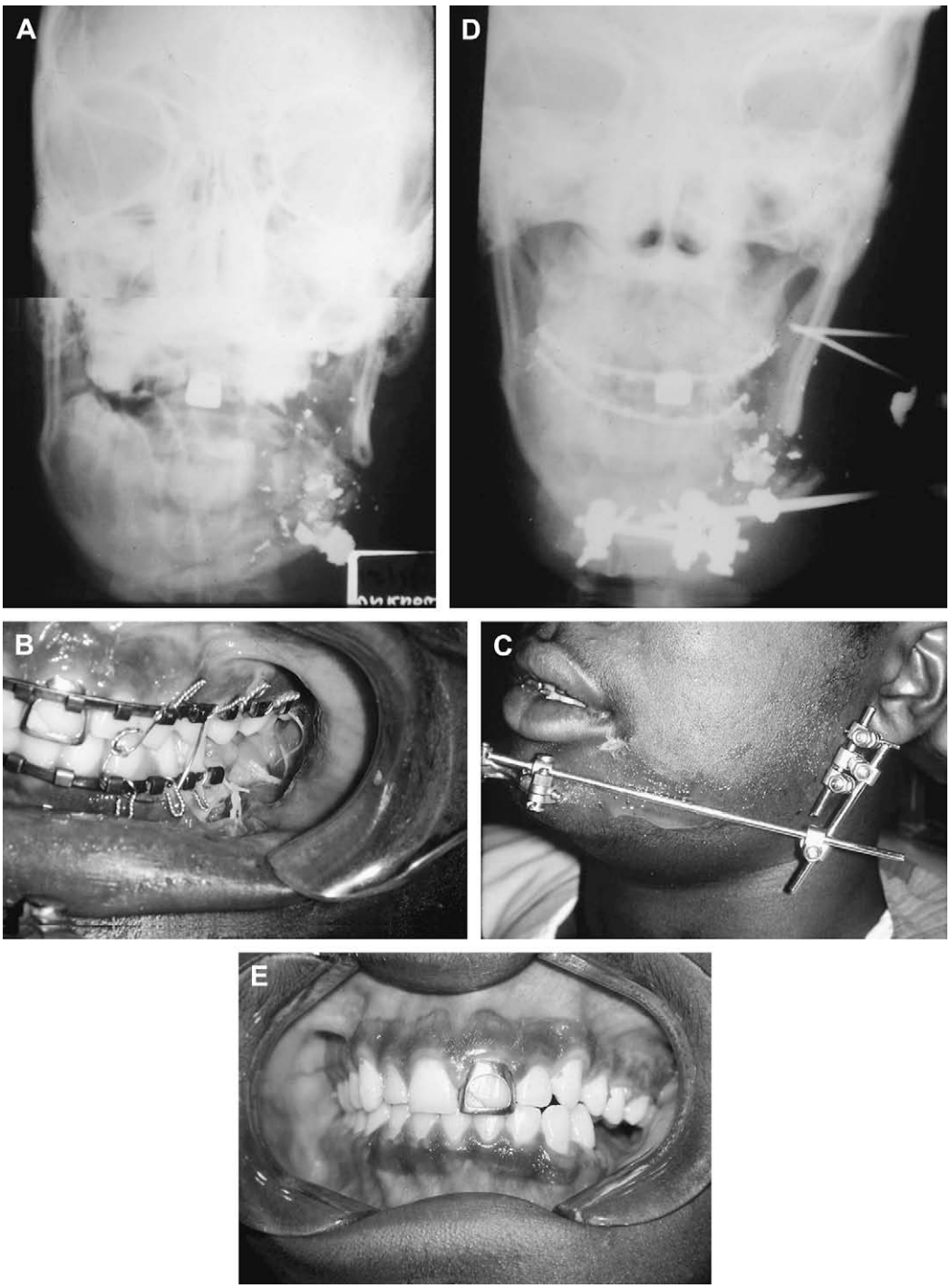

Fig. 4. A 21-year-old man with large-caliber gunshot wound of left mandible managed with intraoral debridement, MMF, and external fixation with a Roger Anderson device. (*A*) Radiograph demonstrating extensive comminution. (*B*) MMF following conservative intraoral debridement of bone and tooth fragments. (*C*) Control of proximal fragment with Roger Anderson appliance. (*D*) Radiograph showing external fixator. (*E*) Final occlusion.

of the mandible. Conceptually, rigid fixation of the fragments minimized sequestration while at the same time allowed postoperative function. The technique came into general use in North America by the late 1980s and various investigators have reported results[18–27] This concept has done much to dramatically shorten the course of treatment for these complex, difficult injuries (**Fig. 5**).

Essentially, an open reduction and internal fixation of the entire comminuted fracture complex is performed using load-bearing osteosynthesis. Any defects are bone grafted, as necessary. In this particular protocol, the plate must be big and strong enough to withstand the functional forces on this area of the mandible. Stabilization by compression or any other form of load-sharing osteosynthesis is obviously contraindicated because small fragments cannot be compressed and are not capable of sharing loads.

Technique Points

Treatment begins with rigid fixation of the teeth in occlusion. This is accomplished with arch bars or wire and acrylic, which stabilize both the teeth and the alveolus. When exposing the fracture (generally extraorally), one needs to maintain the lingual periosteum, if possible. Small fragments are fastened together with miniplates and lag screws, the so-called ''simplification'' of the fracture. The simplified segments are then bridged with a locking reconstruction plate and three or

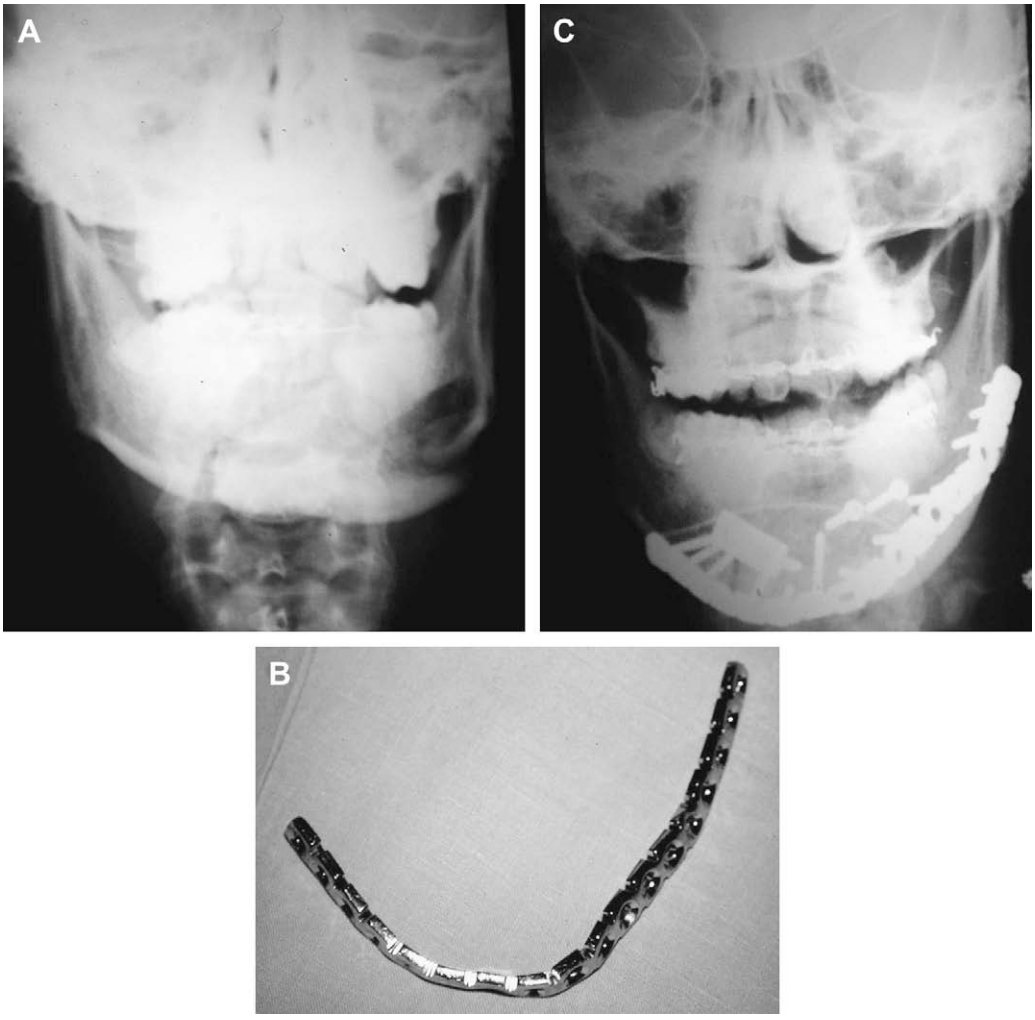

Fig. 5. (*A*) Early example of management of a comminuted mandibular fracture with a stainless steel reconstruction plate and lag screws, allowing postoperative function. Radiograph showing comminuted fracture of mandible. (*B*) Stainless steel 2.7-mm reconstruction plate. (*C*) Radiograph showing results of open reduction and rigid fixation. Note the absence of MMF allowing postoperative function.

four screws on either side of the fracture ends (**Fig. 6**). Most experience has been gained with 2.7-mm reconstruction or 2.4-mm locking plates, but the heavier variety of 2.0-mm locking plate is now becoming popular. It remains to be seen if the latter will offer sufficient strength and stability. MMF is released after plating, allowing at least limited function.

Defect Fractures

Some comminuted fractures result in defects because detached bone fragments were removed. With rigid fixation, there is no micromovement to stimulate callus formation. Therefore, these defects will not fill in with new bone and thus need to be grafted.[15] If the overlying soft tissue is healthy, and wound closure is possible, grafting can take place at the time of initial repair (**Fig. 7**). The preferred graft material is autogenous particulate bone and marrow because of its rapid revascularization and resistance to infection. The preferred donor site is the tibia. If there are other considerations, such as inadequate wound coverage or potential cavitation necrosis, as

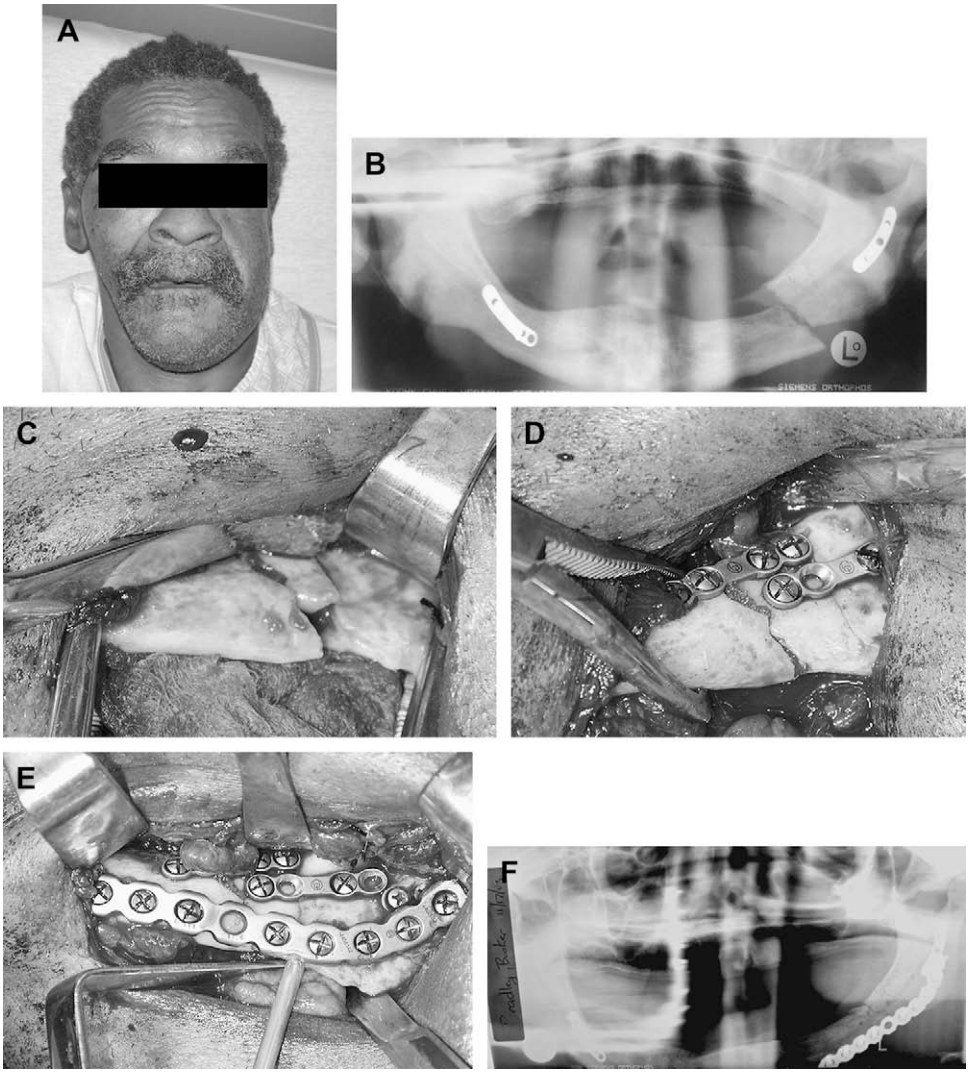

Fig. 6. A 62-year-old man who sustained a comminuted fracture of the left posterior body of the mandible from a beating with a pipe. (*A*) Initial presentation. (*B*) Panoramic radiograph showing plate from treatment of a previous treatment and new fracture of left body. (*C*) Extensive comminution seen when fracture is exposed. (*D*) Reduction of fractures and "simplification" with miniplates. (*E*) Application of locking reconstruction plate. Note at least three screws on either side of the fracture. (*F*) Postoperative radiograph.

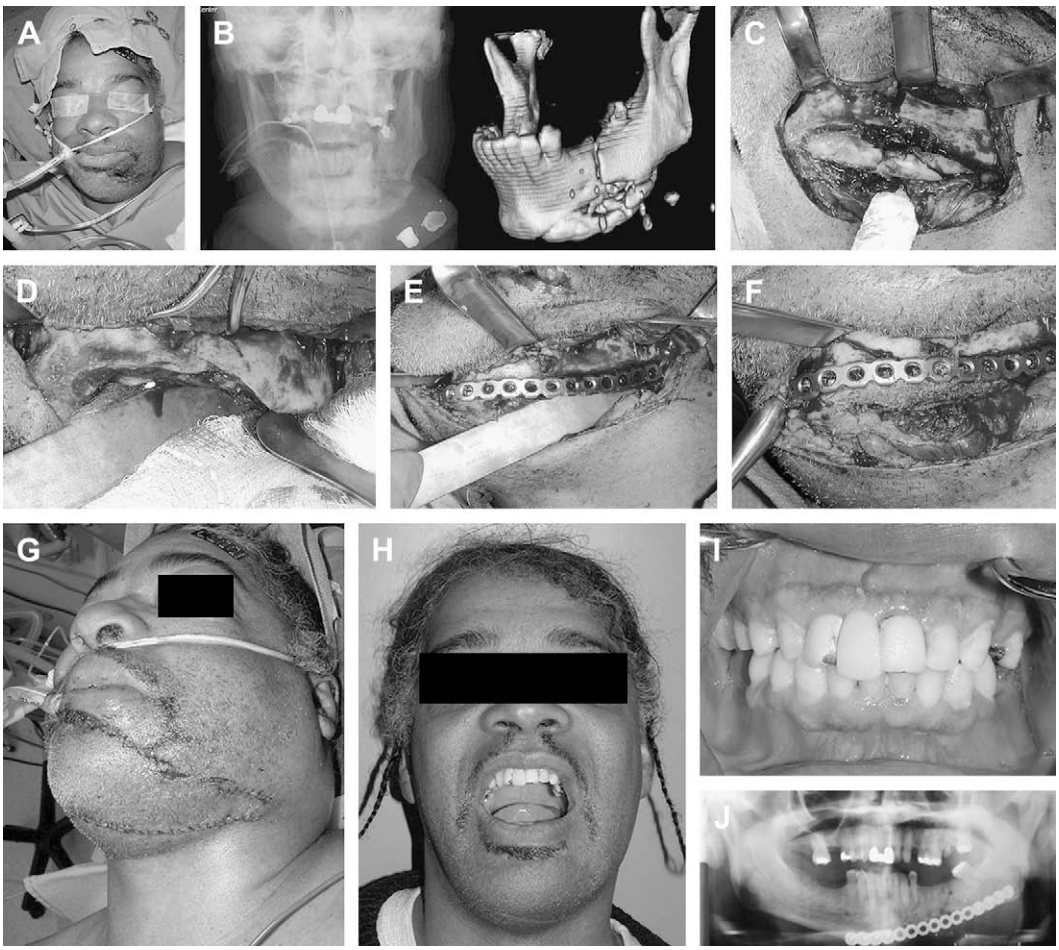

Fig. 7. A 22-year-old man presenting with a gunshot wound to left mandible managed with debridement and primary reconstruction with locking reconstruction plate and a particulate bone and marrow graft. (*A*) Presentation in the operating room. (*B*) Posteroanterior radiograph and three-dimensional CT scan of comminuted fracture of the mandible. (*C*) Exposure of fractures following placement of MMF. (*D*) Debridement of inferior border. (*E*) Application of locking reconstruction plate. (*F*) Reconstruction with tibial bone graft. (*G*) View of wound closure. (*H*) Mouth opening at 2 weeks. (*I*) Final occlusion. (*J*) Postoperative panoramic radiograph.

occurs in some gunshot wounds, the defect can be grafted later.

DISCUSSION

Comminuted fractures of the mandible have long been managed successfully with closed techniques relying on MMF and external devices. The military experience of World War I, World War II, the Korean War, and the Vietnam War not only established, but reinforced and perfected the principles and techniques of closed management.[11,12] Yet, even with ultimate successful outcomes, these closed techniques result in long (months to years) treatment times, with attendant disability.

Properly executed rigid fixation has proven to be a great advance in the management of comminuted fractures of the mandible. The outcomes are improved and the course of treatment is significantly shortened. Elimination of postoperative MMF allows function and does much to minimize the restriction from scarring, which often occurs with conservative closed treatment. Indeed, the patient usually remains functional, even during complications.

However, there is still a place for conservative treatment. When postoperative function or shortening the course of treatment are not an issue, as in a patient with a significant head injury, conservative treatment with closed techniques offers a realistic alternative to a major surgical procedure (**Fig. 8**). Likewise, if the surgical team is not well versed in the nuances of rigid internal fixation, or the necessary equipment is not

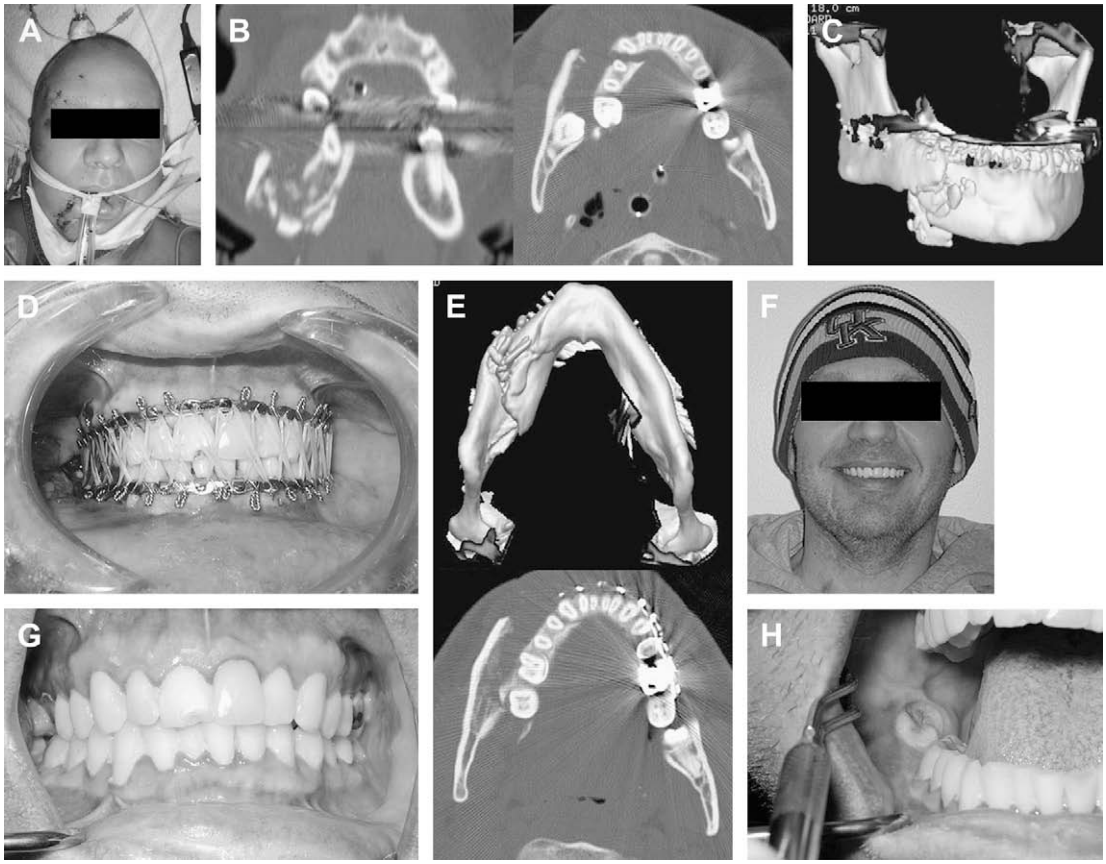

Fig. 8. A 38-year-old police officer involved in an automobile accident in which his car went over a bridge. He sustained severe head injuries and was in the intensive care unit in a vegetative state. Although he had a severely displaced, comminuted fracture of the mandible, only a closed reduction with MMF was permitted 1 month following the injury. He ultimately woke up and was rehabilitated. (*A*) Presentation 1 month after the accident. Note intracranial pressure monitor. (*B*) CT scans showing the displaced, comminuted fractures of the mandible. (*C*) Three-dimensional CT scan showing the fractures. (*D*) Treatment with arch bars and elastics. (*E*) Postreduction regular CT scan and three-dimensional CT scan showing that there is still displacement. (*F*) Appearance of patient 9 months after closed reduction. (*G*) Occlusion at 9 months. (*H*) Mouth opening at 9 months.

available, it is far better to do simple closed treatment. It has stood the test of time and achieves more than adequate results in most cases.

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