Keywords:

Maxillofacial plate, mandibular fractures, cat, toy breed dog

Abstract:

This study shows the successful application of the titanium maxillofacial mini-plate, Compact 1.0, in 12 cats and two toy breed dogs. Miniature fractures, such as mandible or digit fractures, too small for the AO/ASIF mini-plate system are indications for these implants. The self-tapping screws of the maxillofacial system, Compact 1.0, with a core diameter of 0.7 mm, can be used as plate screws or interfragmentarily.

Application of the Maxillofacial Mini-plate Compact 1.0 in the Fracture Repair of 12 Cats and two Dogs

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Summary

This study reports the application of the AO/ASIF maxillofacial mini-plate system, Compact 1.0 [a] (MF mini-plate 1.0), in the repair of fractures in 12 cats and two small sized dogs.

The malleability of these titanium mini-plates allows them to be precisely contoured and positioned to fit onto the most advantages sites of the bone. Self-tapping mini-screws provide an easy application and a time-saving osteosynthesis.

Fractures of miniature bones too small for the regular AO/ASIF mini-implants can be repaired successfully with this MF mini-plate 1.0 implant set.

The special indications reported were the repair of fractures of the angle of the mandible in cats, articular digital fractures in small dogs and the stabilization of small avulsion fractures in cats and dogs.

Introduction

The principle of open reduction and internal fixation has been successfully applied in fracture repair in small animals ranging from 0.5 to almost 100 kg body weight (7). With the introduction of the AO mini-implant set (5) internal fracture fixation in small animal orthopaedic surgery was further improved for animals weighing less than 5 kg. These mini-implants, basically smaller versions of the larger AO/ASIF dynamic compression plates, use 1.5 and 2.0 mm screws for the corresponding plates. They can be applied in long bone fractures in animals under 5 kg, in articular fractures and in small bone fractures in larger dogs (5).

Nevertheless, in some fractures the fragments are too small for the application of either a 1.5 or 2.0 dynamic compression or reconstruction plate.

The application of Martin maxillofacial mini-plates has been described in the repair of mandible fractures in dogs and cats (1). Because these plates and

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screws have the same size as the AO/ASIF mini implants, they offer few advantages for the fracture repair of miniature bones.
Smaller titanium mini-implants have been described for human maxillofacial surgery (8) and are potentially useful in small animal surgery.
With the smallest MF mini-plate system, 1.0, miniature fractures in small dogs and cats can be repaired. Indications include mandible fractures, tarsal and carpal bone fractures or articular and diaphyseal fractures of the digits. Also single screws can be applied interfragmentarily in articular fractures or used to fix avulsed bone fragments in small dogs and in cats. The screw's selftapping design shortens the operating time. Because the screws can be inserted without tapping, the period of time, for temporary fracture reduction is short and therefore associated with fewer intraoperative complications.
The clinical use of the MF mini-plate 1.0 in cats and dogs has, as far as we know, not hitherto been reported. This study describes their successful applications in 14 cases.

Material and Methods

Instrumentation

The MF mini-plate 1.0 used consists of miniature AO/ASIF implants designed originally for human craniofacial surgery. The 1.0 system is composed of a variety of preshaped titanium adaptation plates (8). In this study straight 34-hole cuttable titanium plates (0.7 mm thick) were used (Fig.1). These plates are fixed to the bone by self-tapping screws. Their core diameter is 0.7 mm and their thread diameter 1.0 mm. An emergency screw with a core diameter of 0.9 mm and a thread diameter of 1.2 mm is also available. The length of the screws varies from 2 to 8 mm. Since the head of the screw has a cruciform recess, a special screwdriver, with a corresponding cruciform tip, is required. This screwdriver, with its mini-quick coupling, fits into the handle of the AO mini-plate system screwdriver. The 0.7 mm drill can be used with the mini AO/ASIF air drive because it has the same mini-quick coupling system.

Fig. 1: Mini-maxillofacial titanium plate and screw, Compact 1.0 system, in relation to a matchstick

Since the complete human set is very expensive and was not needed for our purpose, we composed a set configuration for small animal orthopaedic surgery. This set configuration is shown in table 1:

Table 1:

Set for the MF mini-plate system1.0 used for small animal surgery

amount	article
1	34-hole cuttable plate
10	screw: diameter 1.0 mm, length 6,0 mm
10	screw: diameter 1.0 mm, length 8.0 mm
5	screw: diameter 1.2 mm, length 6.0 mm
5	screw: diameter 1.2 mm, length 8.0 mm
2	0.7 mm drill with mini-quick coupling
1	pair of plate-cutting forceps
1	screwdriver with cruciform tip with mini-quick coupling

Patients and Fractures

The MF mini-plate 1.0 was used for the fracture repair of 14 small animals at the Small Animal Surgery Department of the University of Zurich. Miniature fractures which seemed too small to be fixed adequately with conventional implants were selected for the application of these mini implants.

The median age of the animals was three years and the median weight was 4.1 kg. The patients treated were 12 cats (2 female, 5 spayed female, 2 male and 3 castrated male) and 2 dogs (1 male and 1 female).

The following fractures (table 2) were repaired with the MF mini-plate 1.0:

Six mandible fractures were repaired in cats. Five were fractures of the angle and one was a grade III open rostral gunshot fracture. A ventral surgical approach to the mandible was performed (6). We prefered the ventral approach, in comparison to the oral, because it avoids contamination of the surgical wound with oral bacterias. A mini-plate was positioned on the coronoid crest of the angle of the mandible (Fig.2). Additionally fixations used in these fractures were: in two cases a second mini-plate placed ventrally on the mandible (case #4 and case #5 (Fig.3)); two hemicerclages in one case (case #3) and a full cerclage was placed around the rostral mandible in three cats with symphyseal separation (case #1, #3, #5). A feeding tube was placed in five cats with mandible fractures after surgery to provide the patients with nutrition until they started eating voluntarily (table 2).

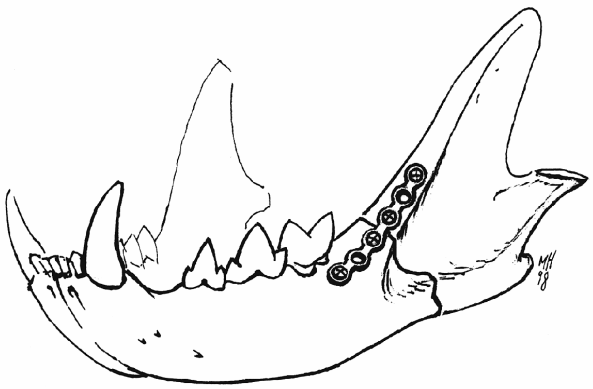

Fig. 2: Front view of the angle of the mandible in a cat, stabilized with the MF mini-plate 1.0 positioned on the coronoid crest

Metatarsal fracture fixation was performed in three cats (case #7, #8, #10) and one dog (case #13). One cat (case #10) had a three months old non-union of metatarsal II - V fractures. In the dog (case #13) an articular component of a distal metatarsal fracture was repaired with one intrafragmentary screw in addition to a mini-plate (Fig. 4). An avulsed lateral collateral ligament of the metatarsal-phalangeal joint of the fifth digit was fixed with a single mini-screw (Fig.4). Another application for the MF mini-plate 1.0 was in a fracture of the first phalanx of the third digit of the forelimb of a cat (case #9). A partial tarsal arthrodesis was performed secondary to an intertarsal instability in a cat (case #12, Fig.5). The fracture of the lateral ridge of the talus in a cat (case #11) and a fracture of accessory carpal bone in a young dog (case #14) were also repaired by single screws. Standard approaches were used in the fracture repair of these fractures (6).

Results

For all 14 fractures a clinical follow-up was performed and radiographs taken to monitor fracture healing. Uncomplicated clinical fracture healing was diagnosed radiographically in 10 cases. Two articular fractures healed with good functional results, but moderate degenerative joint disease developed (cases #1 and #11). In the cat with the bilateral rostral mandible gunshot fracture, a rostral hemi-mandibulectomy had to be performed three weeks post-operatively, secondary to formation of a sequestrum. The mandible fracture on the other side healed without complication. One cat (case #4) with a comminuted mandible fracture developed a functional pseudoarthrosis between the caudal end of the plate and the temporo-mandibular joint due to a fracture that had not been diagnosed pre-operatively. The joint functioned well with a good range of motion. The dental occlusion in all cats with mandible fractures was good.

Discussion

The principles of open reduction and internal fracture fixation are identical in both human and small animal veterinary orthopaedic surgery, but the size of

bones in cats and toy breed dogs is much smaller. Most of these miniature fractures can be successfully repaired with the plates and screws of the veterinary AO/ASIF mini-instrument set (5). However, these plates may still be proportionally too large and be difficult to contour accurately to the anatomically irregular shape of the bones.
We have shown in this study that it is advantageous to use MF mini-plate 1.0 for these fractures as the implants are very small and the plate is malleable (Fig.1). These qualities mean that they can be placed in the biomechanically most advantageous sites on the fractured bone. Indications were mandible fractures in cats, tarsal and carpal fractures and fractures of the digits in toy breed dogs and cats.

In the repair of five mandible fractures in cats the plate was easily contoured and placed along the coronoid crest of the mandible. This is the biomechanically correct position for the plate, as it is the tension side of the fracture (2). Larger plates usually have to be placed ventrally on the compression side of the mandible (9). The application of a second mini-plate on the ventral side of the mandible is described in human surgery (3) to add some stability to the fracture repair. This technique was applied in two mandible fractures in this study.
In orthopaedic surgery, tension free wound closure over conventional bone plates is difficult to achieve in areas with little soft tissue coverage or due to swelling caused by the fracture. Tension on the suture can result in suture dehiscence. MF mini-plates are just 0.7 mm thick, much thinner than any other bone plates, which permits wound closure with the minimal amount of tension. In our study wound healing problems did not occur. Even in a cat with three metatarsal fractures of one hindlimb that had received three mini-plates, the wound was easily sutured.

Screws of the MF mini-plate system (1.0) are thin, have a small thread pitch and are self-tapping. Using screws that are too large in repairing mandibular fractures can cause damage to the roots of the teeth (12, 13). The risk of intraoperative damage to the teeth can be minimized with the MF mini-screws 1.0. They are tiny and can be angled through the mini-plate. No teeth

damage did occur at the operation nor was it seen at the times of re-examination.

In order to create adequate compression with a screw, the thickness of the bone, where the screw is inserted, should be at least twice the thread pitch distance of the screw (4). The thread pitch of the MF mini-screws 1.0 is only 0.25 mm, smaller than in any other bone screw. Even in areas where the bone is only 0.5 mm thin, they produce a reliable compression between the plate and the bone. Positioning of a screw too close to a fracture line can cause stripping of the screw hole. A screw should be placed at least one screw hole diameter away from a fracture line (9). As the screw diameter of the MF mini-screws 1.0 is only 1.0 mm even fragments of only 3 mm can be fixed safely.

Fracture fixation with the Martin maxillofacial mini-plates has been shown to provide good results in mandible and maxillary fracture repair in small animals (1). These implants are easier to contour than AO/ASIF mini-plates. Because the size of the screws are the same as in the AO/ASIF mini-implants (5), they offer few advantages for the repair of miniature fractures.

Screws 6 and 8 mm long were used in this study. The appropriate length was estimated intraoperatively with the help of a skeleton and the radiographs. Applying these screws only monocortically has been shown to provide adequate stabilty in the fracture repair of the human mandible (2). This goes with our experience that in cases were some of the screws in the fracture repair of the mandibles were only placed monocortically, the fracture fixations were yet stable enough to allow bone healing.

Inserting mini-screws without having to measure the depth of the screw hole, and without having to tap, reduces the critical period from temporary fracture reduction to definitive stabilization with bone implants. This is especially advantageous when handling miniature bone fragments and shortens the operation time.

Comminuted fractures of the angle of the mandible in humans have a better prognosis when fixed with semi-rigid plates (11). Semi-rigid plates, such as the maxillofacial mini-plates, stimulate callus formation and accelerate an indirect bone healing.

The costs of an osteosynthesis with the mini-implants described in this paper are similar to those performed with an AO/ASIF mini-implant. The MF mini-screws 1.0 cost more, but the cuttable titanium plate is less expensive.
In conclusion, we think that, in small animal orthopaedic surgery, the MF mini-plate 1.0 represents a good addition to the AO/ASIF mini-instrument and implant set. Many instruments used with this system, such as the handle of mini-screwdriver and the mini air drive, are already available in most veterinary orthopaedic clinics. Once more experience has been gained with the MF mini-plate 1.0, more indications will be found.

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Legends for figures

Fig. 1:

Mini maxillofacial titanium plate and screw, Compact 1.0 system, in relation to a matchstick

Fig. 2:

Front view of the angle of the mandible in a cat, stabilized with the MF mini-plate 1.0 positioned on the coronoid crest

Fig. 3:

Left mandible angle fracture and symphyseal separation in a 4 year old cat (case #5): radiographs a) pre-operative, b) 10 weeks post-operative

Fig. 4:

Articular metatarso-phalangeal fracture IV digit, avulsion of the lateral collateral ligament of the V digit (case #13): a) pre-operative, b) 4 months post-operative radiographs showing clinically good fracture healing

Fig. 5:

Dorsal intertarsal instability in a 6 months old cat (case #12): a) pre-operative, b) 3 weeks post-operative radiographs showing almost completely fused partial tarsal arthrodesis

Legends for tables

Table 1:

Set of the MF mini-plate 1.0 used for small animal surgery

Table 2:

Signalement, type of fracture and kind of repair with the MF mini-plate 1.0

Legend for table 2:

Abbreviations: DSH domestic short hair cat

Footnotes for table 2:

[1] gastric feeding tube

[2] esophageal feeding tube