

Treatment of Orthopaedic Problems with Manuflex® Disposable External Fixator in 15 Dogs and 7 Cats

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Summary

The aim of this study was to use Manuflex® disposable external fixator (MDEF), designed by two Hungarian orthopaedists, one of which is MD and the other is DVM, for treatment of orthopaedic problems, and to present the outcomes in dogs and cats. Cases included fractures of humerus (n=1), tibia (n=4) and radius-ulna (n=4), an angular deformity (with radius-ulna fracture), tibio-tarsal luxations (n=3), a tarso-metatarsal fracture (n=1), mandibular fractures (n=2) in dogs; and fractures of tibia (n=2), radius (n=1) and humerus (n=2), a radio-carpal luxation (n=1), bilateral tibio-tarsal luxation and malleolar tibial fracture (n=1) in cats. Three types of fixators (large, medium and small) has been used according to animal sizes and bone fracture types. All cases had tolerated their apparatus well and did not have any postoperative reactions and they started using the limbs immediately after surgery. Pin tract infections were seen in 2 dogs. Functional outcomes were very good in 10 cases, good in 4 cases and satisfactory in 1 case, in dogs; and very good in 6 cases and satisfactory in 1 case in cats. It was concluded that MDEF can be an alternative system compared to other external fixators, because of its easier application, forming rigid fixation and stability, applying without any complicated equipments and being more economic.

Keywords: External fixator, Dog, Cat, Manuflex®

Ortopedik Problemlerle 15 Köpek ve 7 Kedinin Manuflex® Eksternal Fikzator İle Saęaltımı

Özet

Bu çalıřma, biri beřeri, dięeri veteriner hekim olan iki Macar ortopedist tarafından geliřtirilen Manuflex® eksternal fikzatorün kedi ve köpeklerde karřılařılan ortopedik problemlerin saęaltımında kullanılması ve sonuçların deęerlendirilmesini amaçlamıřtır. Çalıřma materyalini, köpeklerde humerus (n=1), tibia (n=4) ve radius-ulna (n=4) kırığı, angular deformitesi (radius-ulna kırığıyla birlikte), tibio-tarsal lukzasyon (n=3), tarso-metatarsal kırık (n=1) ve çene kırığı (n=2), kedilerde tibia (n=2), radius (n=1) ve humerus (n=2) kırığı, radio-karpal lukzasyon (n=1), çift taraflı tibio-tarsal lukzasyon ve malleolar tibia kırığı (n=1) oluřturmuřtur. Hayvanların büyüklüęüne ve kırık kemik tiplerine göre üç tip fikzator (büyük, orta ve küçük boy) kullanılmıřtır. Operasyon sonrası tüm olgular apareyi iyi tolere etmiř, herhangi bir postoperatif reaksiyon göstermemiř ve hayvanlar uzuvlarını oldukça hızlı kullanmaya bařlamıřlardır. Yalnız iki köpekte pin dibinde enfeksiyon řekillenmiřtir. Fonksiyonel sonuçlar 10 köpekte çok iyi, 4 köpekte iyi ve 1 köpekte yeterli; 6 kedide çok iyi ve 1 kedide yeterli görülmüřtür. MDEF'nin, karmařık ekipmana gereksinim duyulmadan kolay uygulanabilmesi, yeterli fikzasyon ve stabilite oluřturması ve daha ekonomik olması yönlerinden dięer eksternal fikzatorlerle karřılařtırıldıęında alternatif bir sistem olarak kullanılabileceęi sonucuna varılmıřtır.

Anahtar sözcükler: Eksternal fikzator, Köpek, Kedi, Manuflex®

INTRODUCTION

External fixators are used in animals, for emergency or temporary stabilisation of bones, for treatment of fractures,

correction of limb deformities, stabilisation of arthrodeses, treatment of non-unions and osteomyelitis, treatment of



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quadriceps muscle contracture, and in modern trauma management [1-3].

An external fixator is composed of inserting multiple percutaneous transcortical stainless steel pins or wires placed proximal and distal to the fracture or joint. The external frame can be linear (rods or columns) or circular (rings). It is applied using either closed or open reduction. The pins are connected by clamps, acrylic or epoxy putty compounds to an external connecting bar [4,5]. This fixation system is modular and thus can be assembled in numerous construct configurations. External fixation is also used in combination with internal fixation (especially intramedullary Steinmann pins and/or cerclage wires) to provide adjunctive fracture stabilization [6].

Three types of external fixator systems are classified: Type I (a and b) utilizes half pin splintage. Pins pass through both cortices of the bone, clamps and bars are placed on one side of the limb and pins only penetrate one skin surface. Type II utilizes full-pin splintage. Pins pass through both cortices of the bone, clamps and bars are placed on both sides of the limb and pins penetrate opposing skin surfaces. Type III utilizes combination of half-pin and full-pin splintage, type I and II systems are placed at 90 degrees to each other and the frames are interconnected. External fixators can also be classified either uniplanar (pins and bars occupy a single plane) or biplanar (two half-pin splintage fixators are placed at 60 degrees to 90 degrees of axial rotation to each other and the frames are interconnected) [6].

Both in human and veterinary surgery, the bone-pin interface (pin diameter and interference), the components of the fixator and the fixator configuration (how it is assembled on the inserted bone pins) directly influence the contribution to stability by the external fixator. All these forms external fixator biomechanics and directly affect the animal comfort, limb using, fracture and tissue healing [6,7].

The aim of this study was to describe the technique and surgical outcomes of the use of Manuflex^o, the unique disposable external fixator (MDEF) which is not connected by clamps, for treatment of different orthopaedic problems (fractures of the long bones, fragmented fractures of condylar areas, luxations, stabilization of bones, angular deformities and mandible fractures) in cats and dogs.

MATERIAL and METHODS

Animals

This study had been performed in Szent Istvan University, Faculty of Veterinary Medicine, Department of Surgery, Ankara University, Faculty of Veterinary Medicine, Department of Surgery and Veterinary Surgery and Orthopaedic Center. Seven cats and 15 dogs of different

age, sex and breeds, with different orthopaedic problems were assessed for the study. Considering the anamnesis and clinical examinations, plain radiograms were taken in all cases. All radiograms were examined by the same orthopaedists. Before surgery, MDEF configuration was determined from assessment of radiograms of orthopaedic problems. Manuflex type and Kirschner wires in suitable diameters (1.0, 1.2, 1.5 and 2.0 mm) were chosen.

Operations

Surgery was performed under general anesthesia by the same operators. Xylazine 2% (Alfazyn, 2 mg/kg, IM, Egevet, Türkiye) and Ketamine HCl 10% (Alfamine, 10 mg/kg, IM, Egevet, Türkiye) were used for dogs and cats. Also, cefazolin (Sefazol, 20 mg/kg, IV, Mustafa Nevzat, Türkiye) was administered 1 h before the operation. Preoperative analgesia included SC administration of 0.2 mg/kg meloxicam. All animals were treated with MDEF (Trade-Coop, Hungary) which was made of unalloyed aluminium material. MDEF was used also with polymethyl methacrylate (PMMA) in 7 animals (2 cats and 5 dogs). Closed reduction was performed on 7 cases (4 cats and 3 dogs), limited open reduction was performed on 2 cats and open reduction was performed on 13 cases (1 cat and 12 dogs) (Table 1).

Manuflex Apparatus

Three types of device have been used in animals of different sizes and weights, and different bone fractures.

- Large Size Manuflex^o (40.0 cm lengthening of rods, 9.0 mm diameter of rod, 10.0 cm distance without any hole between lower and upper hole, 5.0 mm inner diameter of a hole, 3.0 mm distance between holes)
- Medium Size Manuflex^o (50.0 cm lengthening of rods, 8.0 mm diameter of rods, 3.0 mm inner diameter of a hole, 3.0 mm distance between holes)
- Small Size Manuflex^o (50.0 cm lengthening of rods, 5.0 mm diameter of rods, 2.0 mm inner diameter of a hole, 1.0 mm distance between holes) (Fig. 1)

In open reduction technique, the fracture fragments were exposed surgically by dissecting the tissues and the fragments were reduced. After fracture reduction, pins (K-wires) were placed unicortically or bicortically (according to fracture type and animal weight) with a high torque drill. In this technique, tension band wires and intramedullary pins were also used depending on the animal's weight and fracture type. In close reduction technique, small longitudinal stab incisions were made in the skin over the insertion sites for each pin. Pins were placed through as little soft tissue as possible (Fig. 2). K-wires with different sizes and numbers were placed on the proximal and distal fragments unilaterally or bilaterally. MDEF position was determined by suitable pin insertion points. MDEF has not got a clamp apparatus.

Table 1. Summary of data recorded for 22 cases (15 dogs and 7 cats) managed with MDEF

Tablo 1. MDEF uygulanan 22 olguya (15 köpek ve 7 ked) ait bilgiler

Case No	Signalment	Fracture Type, Localization, and History	Procedure and Apparatus Configuration	Radiologic Consolidation (Days after operation)	Fixator Removal (Days after operation)	Complications	Functional and Cosmetic Results
1	Dog, German Shepherd, 2 years-old, M, 33 kg (AUFVM)	Left tibia; Grade II-Open fragmented fracture on distal 1/3 of diaphyseal region; Vehicular trauma	Closed reduction; Large size Manuflex®; Four K-wires 2.0 mm Ø on the proximal fragment (bilateral); Three K-wires 2.0 mm Ø on the distal fragment (Two of them unilateral, the other bilateral); Two K-wires 2.0 mm Ø on the metacarpus (bilateral); With PMMA	43	55	No complication	Very good
2	Cat, Mix, 11 years-old, M, 5 kg (AUFVM)	Right tibia; Fragmented fracture on distal 1/3 of diaphyseal region; Fall from height	Limited open approach and reduction; Small size Manuflex®; One K-wire 1.5 mm Ø intramedullary pinning; Three K-wires 1.5 mm Ø on the proximal fragment (bilateral); Two K-wires 1.5 mm Ø on the proximal fragment (unilateral); Two K-wires 1.5 mm Ø on the distal fragment (bilateral); With PMMA	38	45	No complication	Very good
3	Dog, Bull Terrier, 2 months-old, F, 5 kg (SIU)	Left radius and ulna; Fragmented fracture on mid 1/3 of diaphyseal region; Compression injury	Closed reduction; Small size Manuflex®; Two K-wires 1.5 and 1.0 mm Ø on the proximal fragment (bilateral, near to fracture line 1.0 mm Ø); Two K-wires 1.5 mm and 1.0 mm Ø on the distal fragment (bilateral, near to fracture line 1.0 mm Ø); Non-PMMA	27	35	No complication	Very good
4	Cat, Siamese, 11 years-old, MN, 4.5 kg (VSOC)	Right radiocarpal luxation; Fall from height	Closed reduction; Small size Manuflex®; Three K-wires 1.5 mm Ø on the radius and ulna (bilateral); One K-wire 1.5 mm Ø on the carpal bones (bilateral); Two K-wires 1.5 mm Ø on the carpal bones (unilateral); With PMMA	25	35	No complication	Very good
5	Dog, Peckinese, 5 years-old, M, 13 kg (SIU)	Right tibio-tarsal stabilization and fracture on Mt IV; Vehicular trauma	Open approaches and arthrodesis; X pinning for tarsal arthrodesis; Medium size Manuflex®; One K-wires 1.5 mm Ø on the tibia (bilateral); One K-wires 1.5 mm Ø on the calcaneus (bilateral); two K-wires 1.5 mm on the metatarsus (bilateral); With PMMA	45	55	Pin tract infection on the postoperative 6 th day	Good
6	Cat, Mix, 4 months-old, F, 2.8 kg (AUFVM)	Left radius; Simple fracture on mid 1/3 of diaphyseal region; Vehicular trauma	Closed reduction; Small size Manuflex®; Two K-wires 1.2 mm and 1.0 mm Ø on the proximal fragment (unilateral, near to fracture line 1.0 mm Ø); Two K-wires 1.2 mm and 1.0 mm Ø on the distal fragment (unilateral, near to fracture line 1.0 mm Ø); Non-PMMA	32	45	No complication	Very good
7	Dog, Mix, 3 years-old, M, 17 kg (VSOC)	Right humerus; Oblique fracture on midline diaphyseal region; Unknown trauma	Open approaches and reduction; Medium size Manuflex®; Two K-wires 2.0 mm on the proximal fragment (unilateral); Two K-wires 2.0 mm on the distal fragment (unilateral); Two K-wires 2.0 mm Ø for intramedullary fixation; Non-PMMA	35	45	No complication	Very good
8	Cat, Mix, 2.5 years-old, FM, 4.5 kg (VSOC)	Right humerus; Fragmented oblique fracture on mid 1/3 of diaphyseal region; Unknown trauma	Open approach and reduction; Small size Manuflex®; Three K-wires 1.5 mm Ø for intramedullary fixation; Collaps of fracture line on postoperative 3 rd week; Second operation; Removal all K-wires, Closed reduction; Three K-wires 1.5 mm Ø on the proximal fragment (unilateral, far to fracture line 2.0 mm Ø threaded pin); Two K-wires 1.5 mm Ø on the distal fragment (unilateral, far to fracture line 2.0 mm Ø threaded pin); With PMMA	30	45	No complication	Very good
9	Cat, Mix, 4 months-old, M, 2.0 kg (SIU)	Left humerus; Fragmented oblique fracture on mid 1/3 of diaphyseal region; Unknown trauma	Limited open approach and reduction; Small size Manuflex®; Two K-wires 1.0 mm Ø for intramedullary fixation; Two K-wires 1.0 mm Ø on the proximal fragment (unilateral); Two K-wires 1.0 mm Ø on the distal fragment (unilateral); Non-PMMA	30	45	No complication	Very good
10	Dog, German Shepherd, 2.5 years-old, M, 42 kg (SIU)	Left tibia; Tibio-tarsal stabilization and shearing injury; Vehicular trauma	Closed reduction; Large size Manuflex®; Four K-wires 2.0 mm Ø on the tibia (bilateral); One K-wire 2.0 mm Ø on the tarsal bones (bilateral); Three K-wires 2.0 mm Ø on the metatarsus (bilateral); With PMMA	21	35	No complication	Good
11	Dog, Jack Russell Terrier, 1 years-old, M, 8.5 kg (AUFVM)	Left radius and ulna; Fracture on distal 1/3 of diaphyseal region Vehicular trauma	Open approaches and reduction; Medium size Manuflex®; Plate fixation (DCP 3.5 mm Ø, 10 holes, 8 cortical screws 3.5 mm Ø); Plate removal on postoperative 3 rd months; Fracture line not enough (protection for refracture); Two K-wires 1.5 mm Ø on the proximal fragment (bilateral); Two K-wires 1.5 mm Ø on the distal fragment (bilateral); Non-PMMA	30	45	No complication	Very good

M: male, F: female, MN: male neutered; AUFVM: Ankara University Faculty of Veterinary Medicine, SIU: Szent Istvan University, VSOC: Veterinary Surgery and Orthopaedic Center

Table 1. Summary of data recorded for 22 cases (15 dogs and 7 cats) managed with MDEF (continued)
Tablo 1. MDEF uygulanan 22 olguya (15 köpek ve 7 kedî) ait bilgiler (devam)

Case No	Signalment	Fracture Type, Localization, and History	Procedure and Apparatus Configuration	Radiologic Consolidation (Days after operation)	Fixator Removal (Days after operation)	Complications	Functional and Cosmetic Results
12	Dog, German shepherd; 1 years-old, M, 31,5 kg; (AUFVM)	Left radius and ulna; Angular deformity; Early closure to distal epiphyseal growth plate of radius; Unknown trauma	Open approaches and wedge osteotomy for radius; simple osteotomy for ulna; Cross pinning for osteotomy line; Large size; Manuflex®; Two K-wires 2.0 mm Ø on the proximal fragment of radius (one of them bilateral, other unilateral); One K-wire 2.0 mm Ø on the distal fragment of radius (bilateral); Two K-wires 2.0 mm Ø on the metacarpus (bilateral); With PMMA	40	55	No complication	Very good
13	Dog, German shepherd, 3 years-old, M, 38 kg (AUFVM)	Left tarso-metatarsal stabilization; Fall from height	First operation; Open approaches and arthrodesis; X pinning and tension band wire for tarso-metatarsal arthrodesis; Large size Manuflex®; Second operation after 3 weeks; One K-wire 2.3 mm Ø on the tibia (bilateral); Two K-wires 2.0 mm Ø on the tarsal bones (bilateral); Three K-wires 1.8 mm on the metatarsus (bilateral); Three angular technique; With PMMA	50	60	No complication	Good
14	Cat, Mix, 2 years-old, M, 3 kg (SIU)	Left tibia; Shearing injury distal 1/3 of diaphyseal region of tibia; Vehicular trauma	Closed reduction; Small size Manuflex®; Two K-wires 1.2 mm Ø on the proximal tibia (bilateral); One K-wire 1.2 mm Ø on the tarsal bones (bilateral); Two K-wires 1.2 mm Ø on the metatarsus (bilateral); With PMMA	21	35	No complication	Very good
15	Cat, Mix, 4 years-old, F, 3 kg (AUFVM)	Left and right tibia; Tibio-tarsal luxation and fracture of malleolar region of tibia (right side is open fracture; Grade II and left side is closed); Fall from height	Closed reduction; Left and right side; Small size Manuflex®; Four K-wires 1.5 mm Ø on the tibia (bilateral); One K-wire 1.0 mm Ø on the tarsal bones (bilateral); Three K-wires 1.0 mm Ø on the metatarsus (bilateral); With PMMA	35	45	No complication	Satisfactory
16	Dog, Mix, 5 months-old, M, 30 kg (SIU)	Left tibia and fibula fracture; Fragmented oblique fracture on mid 1/3 of diaphyseal region; Vehicular trauma	Open reduction; Large size Manuflex®; Two K-wires 2.0 mm Ø on the proximal fragment of tibia (unilateral); Three K-wires 2.0 mm Ø on the distal fragment of tibia (unilateral); Tension band wire on tibial fracture line; With PMMA	30	45	No complication	Very good
17	Dog, Mix, 6 months-old, F, 16 kg (VSOC)	Left tibia; Fragmented oblique fracture on proximal 1/3 of diaphyseal region; Vehicular trauma	Open reduction; Large size Manuflex®; Two K-wires 2.0 mm Ø on the proximal fragment (unilateral); Three K-wires 2.0 mm Ø on the distal fragment (unilateral); Non-PMMA	35	45	No complication	Very good
18	Dog, Mix, 9 months-old, F, 18 kg (AUFVM)	Right radius and ulna + right femur; Fragmented simple fracture on radius; Vehicular trauma	Open reduction; Intramedullary pinning for femur osteosynthesis; Medium size Manuflex®; For tibial fracture; Two K-wires 2.0 mm Ø on the proximal fragment (unilateral); Three K-wires 2.0 mm Ø on the distal fragment (unilateral); Non-PMMA	30	38	No complication	Very good
19	Dog, Mix, 3 months-old, F, 10 kg (SIU)	Right tibio-tarsal stabilization and m. quadriceps contracture; Vehicular trauma	Open reduction; Medium size Manuflex®; Two K-wires 1.5 mm Ø on the femur (unilateral); Four K-wires 1.5 mm Ø on the tibia (unilateral); Two K-wires 1.5 mm on the tarsal bones (unilateral); Non-PMMA	-	21	Pin tract infection on the postoperative 4 th day	Satisfactory
20	Dog, Mix, 8 months-old, F, 20 kg (SIU)	Right tibio-tarsal stabilization and shearing injury; Vehicular trauma	Open reduction; Large size Manuflex®; One K-wire 1.5 mm Ø on the metatarsus (unilateral); Four K-wires 2.0 mm Ø on the tibia (unilateral); One K-wire 2.0 mm on the tarsal bones (unilateral); The second Manuflex® apparatus at the level of the third and fourth wire of tibia; Non-PMMA	-	21	No complication	Good
21	Dog, Mix, 2 years-old, M, 20 kg (AUFVM)	Right mandible multiple fractures; Vehicular trauma	Open reduction; Small size Manuflex®; Two K-wires 1.0 mm Ø on the body of mandible, between the fourth premolar and third molar teeth; Three K-wires 1.0 mm Ø between the third molar tooth and ramus mandible; With PMMA	27	35	No complication	Very good
22	Dog, Labrador retriever, 6 years-old, F, 25 kg (VSOC)	Right mandible simple fracture; Vehicular trauma	Open reduction; Small size Manuflex® Four K-wires 1.5 mm Ø on the body of mandible and ramus mandible; With PMMA	30	40	No complication	Very good

M: male, F: female, MN: male neutered; AUFVM: Ankara University Faculty of Veterinary Medicine, SIU: Szent Istvan University, VSOC: Veterinary Surgery and Orthopaedic Center

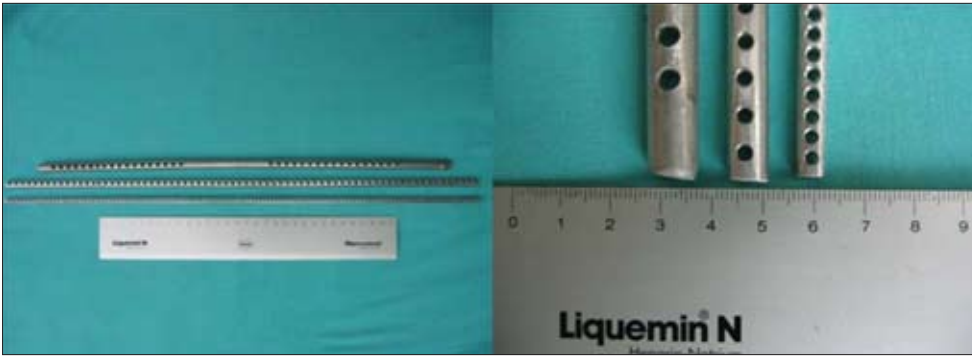


Fig 1. Manuflex Disposable External Fixator types (large, medium and small size)

Şekil 1. Manuflex Eksternal Fiksator çeşitleri (büyük, orta ve küçük boy)

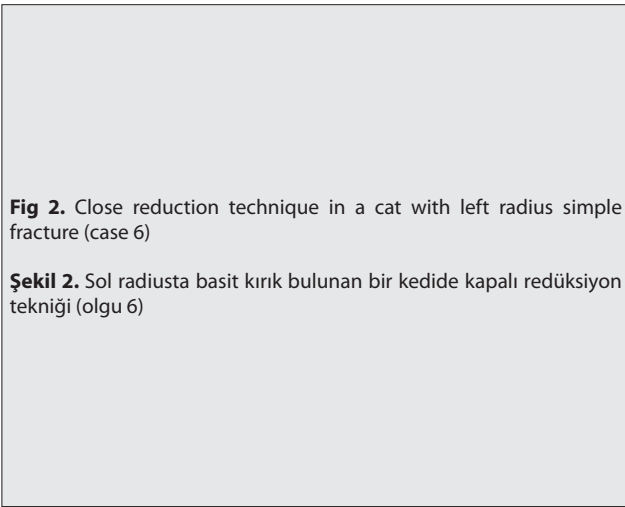


Fig 2. Close reduction technique in a cat with left radius simple fracture (case 6)

Şekil 2. Sol radiusta basit kırık bulunan bir kedide kapalı redüksiyon tekniği (olgu 6)



Fig 3. The application of crimping forceps

Şekil 3. Sıkıştırma forsepsinin uygulanışı



Then pin insertion site within the fixator was compressed by a special crimping forceps (Fig. 3). MDEF is a unique system in all external fixators with clamp system due to crimping issue. In some animals, PMMA was covered on the Manuflex apparatus completely (Fig. 4,b). In 2 dogs with mandibular fractures, Kirschner wires were placed in the mandible and the fragments were transfixed with them. The ends of the pins were incorporated in apparatus laterally. PMMA did not use for both dogs.

Postoperative Follow-up

Radiograms were taken after surgery. In the postoperative period, the owners were warned that cases should be taken to avoid stairs and should not play with other animals for at least 21 days. The skin of the area where the pins exit was cleaned daily with antiseptic solutions and tetracyclin spray was applied to the area. Carprofen

(Rimadyl, 2 mg/kg, bid, orally, Pfizer, USA) was administered for 5 days, amoxicillin-clavulanic acid (Amoklavin forte, 20 mg/kg, bid, orally, Deva, Türkiye) was used as a broad spectrum antibiotic for 7 days. Owners were called for clinical and radiological assessments weekly until fracture healings were complete and the devices were removed. Fixator was removed under sedation using a wire twisting forceps at the suitable time of fixator removal. The area was cleaned with warm povidon iodine antiseptic solutions daily for 7 days.

RESULTS

In the study, mean age of dogs was 2.4 years (range, 2 months-5 years) and cats was 5 years (range, 4 months-11 years). Mean body weight was 21.8 kg for dogs, 3.5 kg for cats. There were 6 female and 9 male dogs, 3 female and



Fig 4. Radius-ulna fragmented fracture on mid 1/3 of diaphyseal region. Preoperative (a1) and immediate postoperative (a2) radiographs, (b) photograph of the dog after application of MDEF, (c) postoperative 35th day radiographs of the dog (case 3) (from SIU)

Şekil 4. Radius ve ulnanın 1/3 diyafizer bölgesinde parçalı kırık. Operasyon öncesi (a1) ve operasyondan hemen sonraki (a2) radyografi görüntüsü, (b) MDEF yerleştirilen köpeğin fotoğraf görüntüsü, (c) köpeğin operasyon sonrası 35. gün radyografisi (olgu 3) (SIU'dan)

4 male cats. Orthopaedic problems included fractures of humerus (n=1) (Fig. 5), tibia (n=4) (Fig. 6) and radius-ulna (n=4), angular deformity (with radius-ulna fracture), tibio-tarsal luxations (n=3), tarso-metatarsal fracture (n=1), mandibular fractures (n=2) in dogs; and fractures of tibia (n=2), radius (n=1) and humerus (n=2), radio-carpal luxation (n=1), bilateral tibio-tarsal luxation with malleolar tibial fracture (n=1) (Fig. 7) in cats. Fractures were caused by vehicular trauma (11 dogs, 2 cats), falling from height (1 dog and 3 cats), compression injury (1 dog) and unknown trauma (2 dogs and 2 cats) (Table 1).

Mean time to fixator removal was 39 days (range, 21-60

days) in dogs, 42 days (range 35-45 days) in cats. Two dogs (case 5 and 19) had pin tract infection as complication on the postoperative period. There were no other complications such as vein or nerve damage, malunion, nonunion or osteomyelitis. In postoperative period, it was observed that all cases had tolerated their apparatus well and could use their limbs immediately, and they did not form any reaction.

DISCUSSION

External skeletal fixation (ESF) has become a well established treatment technique for many traumatic and degenerative orthopaedic problems in dogs and cats.



Fig 5. Humerus oblique fracture. Pre-operative (a1) and immediate postoperative (a2) radiographs. (b) radiographs of the humerus after MDEF removal on the post-operative 45th day (case 7) (from VSOC).

Şekil 5. Humerusta oblik kırık. Operasyon öncesi (a1) ve operasyon sonrası (a2) radyografileri, (b) humerusun operasyon sonrası 45. gün MDEF uzaklaştırıldıktan sonraki radyografisi (olgu 7) (VSOC'dan)

The frame type, configuration, implant size, pin types and numbers are important for the apparatus accommodation to the bone. They can be applied in either open or closed reduction, used alone or combined with internal fixation. Especially the past decades, clinical and experimental studies have led to technological advances and modifications in external fixator design and techniques [4,6]. Considering all these circumstances, as a new external fixator, MDEF has been designed. In this study, in different orthopaedic problems, MDEF was evaluated with its surgical outcomes in dogs and cats.

ESF is commonly used for the long bone fracture repair. All kinds of frames can easily be applied to tibia and radius. Type II frames may be applied for providing rigid stabilization in tibial and radial fractures. Type III frames may be used for fractures in large dogs and for comminuted fractures in which limited exists between the fixator and fragments [5,8,9]. In the study, type I and type II frames were used for tibia and radius fractures both in dogs and cats. All animals either with simple or fragmented fractures could tolerate their MDEF well and they could use their limbs without any problems.



Mandibular fractures are seen less frequently in dogs than in cats. They generally involve the premolar or the molar regions in dogs. Methods of its fixation include

plate fixation, external fixators, transverse pinning and wire sutures. In comminuted fractures of the ramus, the use of an external fixator may be more applicable



Fig 7. (a) Radiograms of bilateral tibio-tarsal luxation and MDEF application in a cat. (b) Photograph of the cat after application of MDEF with PMMA (case 15) (AUFVM)

Şekil 7. (a) Bir kedide bilateral tibio-tarsal luksasyon ve uygulanan MDEF'nin radyografik görünümü. (b) Aynı kedinin PMMA ile birlikte MDEF uygulandıktan sonraki fotoğraf görüntüsü (olgu 15) (AUFVM'dan)

than a plate. Also the shape of the mandible in breeds like brachicephalics may make use of a traditional connecting bar on the fixator difficult. In this situation, the pins or Kirschner wires are driven into the bone fragments and joined on the lateral aspect of the mandible with cement or dental acrylic [10,11]. In this study, MDEF applied to the bone fragments easily and satisfactorily. Because of its lightness, dogs might use their mandibles immediately after the operation. Although there were only two dogs, fixator availability and the absence of any complications after surgery were assessed as the advantage of the apparatus might be in mandibular fractures in dogs.

Close reduction technique is less traumatic to the soft tissues, but can not yield an adequate alignment as open reduction [6]. In this study, reduction technique was chosen according to the bone fractures and also fragments positions.

For external fixation systems, acrylics (methacrylates, epoxy putties) can be used instead of Kirschner clamp. Especially PMMA are available as bone cements and

can be used either as a liquid poured into tubing placed over the fixation pins, or at the dough stage rolled into a cylinder then pressed around the pins [12]. It is lighter, less bulky, can be customized for any size and shape of bone, allows flexibility for pin placement and cheaper than using Kirschner external skeletal fixators. According to studies, when acrylic columns compared to Kirschner external fixators, it is improved more stiff [12-14] especially in cats and small breed or low weighted dogs [15]. MDEF is similar to PMMA in some of its advantages. It is light and can be in any shape and size. It can be adapted for any number and size of pins. Its holes can be pressed and pins are stabilized to the fixator system. In the study, MDEF was used alone or also used with PMMA. Using fixator with or without PMMA was not a standard procedure. But in general PMMA was preferred in operations for increasing frame stiffness, in which large size MDEF was used.

Acrylic external fixator systems include toxic fumes that are produced during polymerization and acrylic can reach high temperatures (range between 50 to 100°C) that can cause bone necrosis. Because of the risk the skin-acrylic column distance must be adjusted [14,15]. PMMA-

MDEF combination did not cause a risk and results were satisfactory.

ESF postoperative complications are generally soft tissue healing problems, pin tract infections and fixator failures [16]. In the study, pin tract infections were seen as a complication in 2 cases (case no. 5 and 19) because of the poor wound hygiene and inconsistent use of antibiotic. It was treated with oral antibiotics and daily pin tract care successfully in these two cases.

In previous studies, premature loosening of the pins is the other most frequent complication due to the stress on the pins both in cats and dogs, especially in heavy animals [17]. In the present study, the appropriate pin size and numbers were selected that would ensure adequate stiffness at the fracture site and prevent fragment motion, to prevent this complication. In general, with large size MDEF, 3-4 pins were applied on each fragment; with small and medium size MDEF, 2-3 pins were applied on each fragment. Secondly, special design fixator Manuflex® allows latitude in fixation pin placement and pins do not need to be aligned in the same longitudinal plane. Manuflex® shape, size and diameter of pin holes could be designed perfectly according to the bone, fracture type and localization.

In the study, high torque drill was used for inserting fixation pins into the bone. This was preferred, because previous studies show that high speed drills (or with low speed and excessive pressure) may cause thermal necrosis in the bones and because of the holes excessive enlargement for the pins resulting in premature loosening [18].

Soft tissue swelling is frequently seen between connecting bar and skin, postoperatively. This is because of the tissue inflammation around the pin-skin contact area. However, increasing the distance between the bone and the connecting bar decreases the strength of the system [7]. In the present study, sufficient distance was left between the bar and skin, so that it was not encountered any consequences.

In conclusion, MDEF can be an alternative system compared to other external fixators, because of its easier and less complicated application, lighter frame weight, benefit of rigid fixation and stability, and being more economic. It can be easily customized to accommodate all fracture types.

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