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RESEARCH ARTICLE

Treatment of Long Bone Fractures with Acrylic External Fixation in Dogs and Cats: Retrospective Study in 30 Cases (2006-2008)

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Summary

The aim of the present study is to assess the use of acrylic external fixation in long bone fractures of dogs and cats. The material of this retrospective study was composed of 22 dogs and 8 cats. Thirty fractures localized in long bones were stabilized using acrylic external fixation with different frame configurations. Configuration of the ESF was unilateral (type I) in 2 (9%), bilateral (type II) in 14 (63.6%), bilateral biplanar (type III) in 3 (13.7%), and free-form in 3 (13.7%) dogs and unilateral (type I) in 2 (25%), and bilateral (type II) in 6 (75%) cats. Mean frame removal duration was 37 days in dogs and 29.5 days in cats. Minor complications like pin tract infection, periosteal reaction, late pin loosening, synostose, and mild interfragmental angulation were observed in 8 cases (26.6%) and major complications like osteomyelitis, nonunion and delayed union in three (10%). One case was euthanasised because of a concomitant vertebral fracture. The final outcome at frame removal was judged as excellent in 19 cases (65.6%), good in 7 (24.2%), fair in 1 (3.4%), and poor in 2 (6.8%). Fixator tolerance and bone healing were better in cats and puppies when compared with adult dogs. It was concluded that with a proper frame configuration, acrylic external fixation can maintain effective stabilization in long bone fractures of dogs and cats. Cost-effectiveness is one of the other advantages of this technique.

Keywords: *Acrylic, Cat, Dog, External fixation, Fracture*

Kedi ve Köpeklerin Uzun Kemik Kırıklarının Akrilik Eksternal Fiksasyonla Sağaltımı: 30 Olguda Retrospektif Çalışma (2006-2008)

Özet

Bu çalışmanın amacı; kedi ve köpeklerin uzun kemik kırıklarının sağaltımında akrilik eksternal fiksasyonun kullanımın değerlendirilmesidir. Bu retrospektif çalışmanın materyalini 22 köpek ve 8 kedi oluşturdu. Uzun kemiklerde lokalize olan otuz değişik kırığın farklı çerçeve konfigürasyonları ile stabilizasyonu yapıldı. Köpeklerdeki fiksatör konfigürasyonu 2 olguda (%9) unilateral (tip I), 14 olguda (%63.6) bilateral (tip II), 3 olguda (%13.7) serbest form iken kedilerde 2 olguda (%25) unilateral (tip I), 6 olguda (%75) ise bilateral (tip II) olarak belirlendi. Ortalama fiksatör uzaklaştırma zamanı köpeklerde 37, kedilerde ise 29,5 gündü. Sekiz olguda (%26,6) pin yolu enfeksiyonu, periosteal reaksiyon, uzun dönem pin gevşemesi, sinostoz ve hafif dereceli interfragmental angulasyon gibi rutin komplikasyonlar; üç olguda (%10) ise osteomyelitis, kaynama gecikmesi ve nonunion gibi ciddi komplikasyonlar gözlendi. Olgulardan birine, eşlik eden vertebra kırığından dolayı ötenazi uygulandı. Fiksatörün uzaklaştırılmasından sonra yapılan değerlendirmede 19 olguda (%65,5) mükemmel, 7 olguda (%24,2) iyi, 1 olguda (%3,4) vasat, 2 olguda (%6,8) ise zayıf sonuçlar elde edildi. Kemik iyileşmesi ve fiksatör toleransı, kedi ve yavru köpeklerde, ergin köpeklerdekine oranla daha iyi olarak belirlendi.Sonuç olarak, uygun bir fiksatör konfigürasyonu oluşturulduğunda, akrilik eksternal fiksasyonun kedi ve köpeklerin uzun kemik kırıklarının stabilizasyonunda etkili bir yöntem olduğu kanısına varıldı. Ucuz olması, tekniğin bir diğer önemli avantajı olarak değerlendirildi.

Anahtar sözcükler: *Akrilik, Eksternal fiksasyon, Kedi, Kırık, Köpek*

INTRODUCTION

Acrylic-pin splints are external fixators in which the connecting clamps and rods are replaced by acrylic columns. They are particulary useful for mandibular fractures and transarticular applications because the acrylic connecting columns are easily contoured to the shape of the body [1-3].

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Application of an external skeletal fixator (ESF) made of light-weight polymethylmethacrylate acrylic connecting bars for fracture repair has been widely used in veterinary orthopedics. Low cost, mechanical strength equivalent to stainless steel connecting bars, greater versatility, reduced operation time, and simplified application techniques have made acrylic external fixators more preferred to both internal - and external fixation techniques [2-4].

In commercially available veterinary ESF systems, the clamp size dictates the pin size, the angle- and direction of pin placement are limited by the clamp and connecting rod and radiographic evaluation of the fracture may be obscured by the appliance where it is a fully independent free-form of acrylic external fixator. Furthermore, acrylic ESF can easily be used in different bones of varios speices without requiring any special instruments except pins and wires [5].

The purpose of the study reported here was to evaluate the use and probable complications of the use of acrylic ESF in dogs and cats.

MATERIAL and METHODS

The material of the study consisted of 22 dogs and 8 cats of different breeds, age, and sex in whom various long bone fractures were diagnosed were brought to surgery clinic between September 2006 and August 2008. Following the initial clinical examination, antero-posterior (A/P) and medio-lateral (M/L) radiographs of the injured extremities were obtained. The plastic tubes into which the liquid acrylic was poured were prepared from electric cable preservers cut to various lengths. Tubes of three different diameters 15, 23, and 30 mm were used and identified as 1, 2 and 3, respectively. Tube numbers 1, 2, and 3 were used in cases where the body weight was<10 kg, between 10 and 20 kg, or >20 kg, respectively *(Table 1-2)*. All cases were premedicated with diazepam (0.1 mg/kg, IV), induced with propofol (6 mg/kg, IV), and maintained with isoflurane (2-3%). Closed application, and limited open approach were adopted according to the type and duration of fracture. The insertions of pins were carried out using low-speed (not more than 150 rpm) power drill. At least two fixation pins of various diameters and types were placed in each fracture arm. All pins were placed perpendicular to the bones and separated from each other by 1 to 2 cm. The pins nearest the fracture gap were placed 0.5 to 1.5 cm from the fracture line. The skin-acrylic column distance was adjusted to be between 1 to 3 cm according to the diameter of the acrylic column, age, and the body weight of individual cases. Liquid acrylic was prepared in a flexible plastic cup in the powder to liquid ratio of 5:2, respectively.

In all cases, clavulanate-potentiated amoxicillin (10-15 mg/kg/day, SC) and carprofen (4 mg/kg/day, SC) were administered by injections immediately before- and for 5 days following surgery. Further, the owners of the animals were advised to use local antibiotic spray for possible pin tract infections during the convalescence period. External coaptation was not used postoperatively in any of the case. The owners were instructed to restrict exercise for a period of eight weeks.

Control radiographs were taken immediately after the operation and every subsequent week until the extraction of the ESF. During postoperative examination, the distance between the acrylic column and skin was controlled for pressure necrosis (especially in young cases), and crusts surrounding pin bottoms were cleaned by sterile saline. Frames are removed with the patient sedated or anesthetized. For removal of the frames; the wires or pins are cut close to the frame, the frame is removed as a whole before the wires or pins are removed.

The outcome evaluation scale was built up from a combination of the McCartney- and Fox evaluation scales [6,7]. Final assessments were graded and defined as excellent (no lameness, clinically normal), good (slight lameness only after extensive exercise), fair (slight to moderate intermittent lameness but consistent weight-bearing) and poor (non-weight-bearing lameness) *(Table 3)*.

RESULTS

Of the cases, 16 were male (73%) and 6 were female (27%) in dogs while 6 were male (75%) and 2 were female (25%) in cats. Their ages were between 2 months and 4 years (mean 13.1 months in dogs; 9.25 months in cats), and their body weights were between 1 and 45 kg (mean 17.05 kg in dogs; 2.93 kg in cats). Distribution of the fractures according to bones were 12 tibia (54.5%) *(Figure 1)*, 5 antebrachium (22.8%), 3 femur (13.7%) *(Figure 2)*, and 2 humerus (9%) *(Figure 3)* in dogs; 4 tibia (50%), 2 antebrachium (25%), and 2 femur (25%) in cats. Of the fractures; 26 were closed (86.7%) while the other 4 were open (13.3%) and located in the tibia (case no: 1, 13, 14, 19). According to the anamnesis, fractures occurred due to motor

Fig 1. Radiographic appearances of case number 16, preoperatively (a,b), at the 3rd week postoperatively (c,d) and after removal of the fixator (e,f) in which closed application performed

Şekil 1. 16 numaralı olgunun preoperatif (a, b), postoperatif 3. hafta (c, d) ve fiksatör çıkarıldıktan sonraki (e, f) radyografik görüntüleri

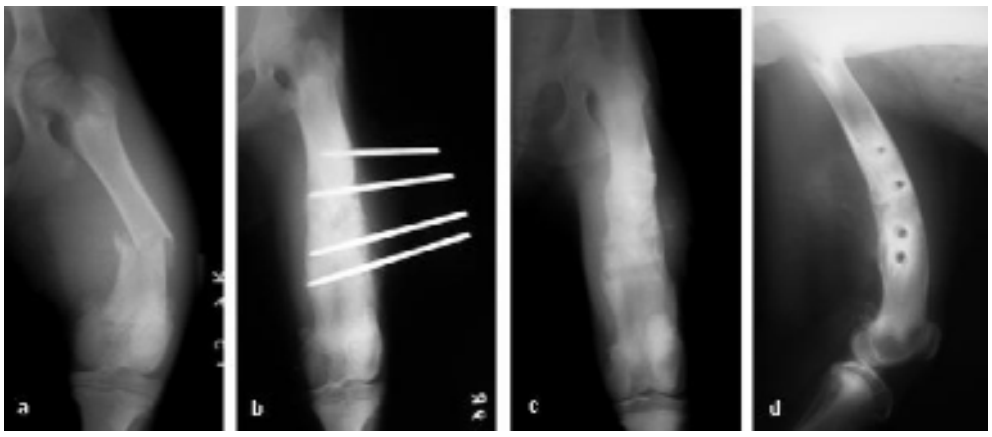

Fig 2. Radiographic appearances of case number 15 pre-operatively (a), at the 5th week postoperatively (b) and after removal of the fixator (c, d)

Şekil 2. 15 numaralı olgunun preoperatif (a), postoperatif 5. hafta (b) ve fiksatör çıkarıldıktan sonraki radyografi görüntüleri (c,d)

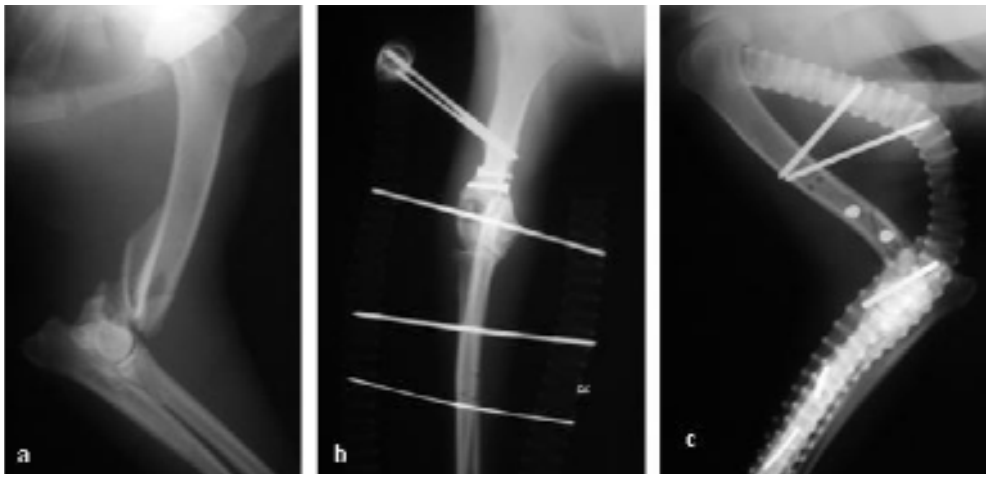

Fig 3. Radiographic appearances of case number 4, pre-operatively (a), and at the 1st week postoperatively (b, c) in which free form acrylic fixation was performed in transarticulary fashion.

Şekil 3. Transartiküler tipte serbest form akrilik eksternal fiksasyon uygulanan 4 numaralı olgunun preoperatif (a) ve postoperatif 1. haftadaki radyografik görüntüleri

vehicle accidents in 18 (60%), high rise syndrome in 11 (36.6%), and gunshot injury in 1 (3%) case.

The surgery protocol was closed in 12 (40%), limited open in 17 (56.7%) and open in 1 (3.3%) case. In 4 cases transarticular pinning was performed for the stabilization of the juxta-articular fractures. Diameters of the plastic tubes used for the acrylic column were 15 mm (tube no: 1) in 9, 23 mm (tube no: 2) in 5, and 30 mm (tube no: 3) in 8 dogs while tube no: 1 was used in all cats. Configuration of the ESF was unilateral (type I) in 2 (9%), bilateral (type II) in 14 (63.6%), bilateral biplanar (type III) in 3 (13.7%), and free-form in 3 (13.7%) dogs and unilateral (type I)

Table 1. *Preoperative and postoperative case details of 22 dogs managed with acrylic external fixation*

Tablo 1. *Akrilik eksternal fiksasyon uygulanan 22 köpeğe ait preoperatif ve postoperatif bilgiler*

Case No	Signalment	Description of fracture	Aetiology	Time elapsed from injury to surgery (days)	Surgical approach	ESF configuration	First use, full weight-bearing (days after surgery)	Complication	Implant removal (days after surgery)	Final assessment of limb function
1	3-year-old, 37 kg, M, Kangal crossbreed	Tibia, open, mid-diaphysis, spiral	Motor vehicle accident	4	Closed application (Biologic fixation)	Bilateral, biplanar, type III P:3X3mm, D:3X3mm P:2X3mm, D1X3mm non-threaded to anterior plane, tube no: 3	6, 37	Mild pin tract infection, moderate periosteal reaction	62	Good
2	3-year-old, 7 kg, F, Terrier	Radius-ulna, closed, mid-diaphysis, transversal	High rise syndrome	5	Limited open approach	Bilateral, type III P:3X2mm, D:3X2mm non-threaded, tube no: 1	3, 18	Slight external rotation of the paw	42	Good
3	7-month-old, 32 kg, M, Kangal	Radius-ulna, closed, mid-diaphysis, oblique	Motor vehicle accident	1	Closed application (Biologic fixation)	Bilateral, type II P:3X3mm, D:3X3mm central-threaded, tube no: 3	FWB	Synostose, mild pin tract infection	46	Good
4	2-year-old, 18 kg, M, Pointer	Humerus, closed, supracondylar, intercondylar, comminuted	Motor vehicle accident	2	Limited open approach (Transarticular pinning)	Radius 2X3mm, humeral condyle 1X2mm bilateral; humerus, 2 lag screws, unilateral 2X3mm non-threaded, tube no: 2 free style	2, 13	Slight interfragmental angulation	31	Good
5	6-month-old, 26 kg, F, Kangal	Femur, closed, mid-diaphysis, transversal	Motor vehicle accident	1	Limited open approach	Unilateral, type I P: 3X3mm, D:3X3mm schanz nail, tube no: 3	1, 19	No complication	40	Good
6	3-month-old, 7 kg, M, Irish Setter	Humerus, closed, supracondylar, oblique	High rise syndrome	1	Limited open approach (Transarticular pinning)	Radius 2X2mm, humeral condyle 1X2mm bilateral non-threaded; humerus, interfragmental K wire, unilateral 2X2mm schanz nail, tube no: 1 free style	1, 4	No complication	23	Excellent
7	8-month-old, 10 kg, M, Terrier	Femur, closed, supracondylar, oblique	Motor vehicle accident	1	Limited open approach (Transarticular pinning)	Tibia 2X3mm, femoral condyle 1X3mm bilateral non-threaded; femur, unilateral 2X3mm schanz nail, tube no: 2 free style	-	Euthanasied because of concomitant L5 vertebral fracture	-	-
8	1-year-old, 34 kg, M, German Shepherd	Radius-ulna, closed, distal-diaphysis, transversal	Motor vehicle accident	2	Limited open approach	Bilateral, type II P:3X3mm, D:1X3mm non-threaded, 2X3mm schanz nail 45°oblique, tube no: 3	FWB	Mild periosteal reaction	47	Excellent
9	3-month-old, 8 kg, F, Crossbreed	Tibia, closed, mid-diaphysis, transversal	Motor vehicle accident	3	Closed application (Biologic fixation)	Bilateral, type II P: 3X2mm, D:3X2mm non-threaded tube no: 1	FWB	No complication	32	Excellent
10	7-month-old, 21 kg, M, Husky	Tibia, closed, mid-diaphysis, transversal	Motor vehicle accident	3	Limited open approach	Bilateral, type II P:3X3mm, D3X3mm non-threaded, tube no: 3	1, 9	No complication	42	Excellent
11	5-month-old, 15 kg, M, Crossbreed	Tibia, closed, proximal diaphysis, long oblique	Motor vehicle accident	1	Limited open approach	Bilateral, biplanar, type III P:2X3mm, D:3X3mm non-threaded, interfragmental lag screw and 1X3mm schanz pin to anterior plane, tube no: 2	2, 6	No complication	45	Excellent

M: male, F: female, P: proximal fracture arm, D: distal fracture arm, Tube no.1: 15mm, no.2: 23mm, no.3: 30mm, DSH:domestic short hair, FWB: full weight-bearing immediately after the operation

Table 1. *(Continued)*
Tablo 1. *(Devam)*

Case No	Signalment	Description of fracture	Aetiology	Time elapsed from injury to surgery (days)	Surgical approach	ESF configuration	First use, full weight-bearing (days after surgery)	Complication	Implant removal (days after surgery)	Final assessment of limb function
12	1-year-old, 6 kg, F, Terrier	Tibia, closed, distal diaphysis, transversal	High rise syndrome	40, nonunion	Limited open approach (Transarticular pinning)	Bilateral, type II tibia P:3X2mm, D:1X2mm, talus 1X2mm non-threaded, tube no: 1	21, -	Nonunion	39	Poor
13	2-year-old, 19 kg, M, Crossbreed	Tibia, open, mid-diaphysis, comminuted	Motor vehicle accident	16, osteomyelitis	Closed application (Biologic fixation)	Bilateral, type II P:3X3mm, D:3X2mm non-threaded, tube no: 2	17, -	Osteomyelitis, nonunion	55	Poor
14	4-year-old, 45 kg, M, Kangal	Tibia, open, mid-diaphysis, comminuted	Gunshot injury	2	Closed application (Biologic fixation)	Bilateral, biplanar, type III P:3X4mm,D:2X4mm non-threaded, P:1X4mm, D:1X4mm schanz pins to anterior plane , tube no: 3	6, 75	Delayed union	112	Fair
15	3-month-old, 10 kg, M, Husky	Femur, closed, distal diaphyseal, oblique	High rise syndrome	1	Limited open approach	Unilateral, type I P:2X3mm, D:2X3mm schanz pins, tube no: 2	1, 9	Mild pin tract infection, late pin loosening	46	Excellent
16	7-month-old, 27 kg, M, German Shepherd	Tibia, closed, mid-diaphysis, oblique	Motor vehicle accident	3	Closed application (Biologic fixation)	Bilateral, type II P:3X3mm, D:3X3mm, centrally threaded pins, tube no: 3	FWB	No complication	32	Excellent
17	2-month-old, 3 kg, M, Irish Setter	Tibia, closed, mid-diaphysis, spiral	High rise syndrome	2	Limited open approach	Bilateral, type II P:2X1mm, D:2X1mm non-threaded, tube no: 1	FWB	No complication	21	Excellent
18	2-month-old, 7 kg, F, Kangal	Tibia, closed, mid-diaphysis, spiral	Motor vehicle accident	1	Limited open approach	Bilateral, type II P:3X2mm, D:3X2mm non-threaded, tube no: 1	3, 7	No complication	25	Excellent
19	3-month-old, 5 kg, F, Crossbreed	Tibia, open, mid-diaphysis, comminuted	Motor vehicle accident	2	Open approach	Bilateral, type II P:2X2mm, D:2X2mm non-threaded, tube no: 1	3, 12	Mild pin tract infection	28	Excellent
20	4-month-old, 8 kg, M, German Shepherd	Tibia, closed, mid-diaphysis, transversal	Motor vehicle accident	1	Closed application (Biologic fixation)	Bilateral, type II P:3X2mm, D:3X2mm non-threaded, tube no: 1	FWB	No complication	31	Excellent
21	2-year-old, 8 kg, M, Terrier	Tibia, closed, mid-diaphysis, transversal	Motor vehicle accident	2	Closed application (Biologic fixation)	Bilateral, type II P:3X2mm, D:3X2mm non-threaded, tube no: 1	FWB	No complication	37	Excellent
22	1-year-old, 22 kg, M,	Radius-ulna, closed, distal-diaphysis, communited	Motor vehicle accident	2	Limited open approach	Bilateral, type II P:3X3mm, D:3X3mm non-threaded, tube no: 2	2, 9	Synostose, mild pin tract infection	47	Good

M: male, F: female, P: proximal fracture arm, D: distal fracture arm, Tube no.1: 15mm, no.2: 23mm, no.3: 30mm, DSH:domestic short hair, FWB: full weight-bearing immediately after the operation

Table 2. *Preoperative and postoperative case details of 8 cats managed with acrylic external fixation*
Tablo 2. *Akrilik eksternal fiksasyon uygulanan 8 kediye ait preoperatif ve postoperatif bilgiler*

Case No	Signalment	Description of fracture	Aetiology	Time elapsed from injury to surgery (days)	Surgical approach	ESF configuration	First use, full weight-bearing (days after surgery)	Complication	Implant removal (days after surgery)	Final assessment of limb function
1	8-month-old, 3 kg, M, DSH	Tibia, closed, mid-diaphysis, transversal	High rise syndrome	2	Limited open approach	Bilateral, type II P:3X2,5mm, D:3X2,5mm non-threaded, tube no: 1	FWB	No complication	21	Excellent
2	3-month-old, 1 kg, F, DSH	Tibia, closed, mid-diaphysis, oblique	High rise syndrome	1	Closed application (Biologic fixation)	Bilateral, type II P:2X1mm, D:2X1mm non-threaded, tube no: 1	1, 2	No complication	17	Excellent
3	7-month-old, 3 kg, M, DSH	Tibia, closed, mid-diaphysis, impact	High rise syndrome	1	Closed application (Biologic fixation)	Bilateral, type II P:2X2mm, D:2X2mm non-threaded, tube no:1	FWB	No complication	37	Excellent
4	4-month-old, 1.5 kg, M, DSH	Femur, closed, distal diaphyseal, green stick	High rise syndrome	2	Limited open approach	Unilateral, type I P:2X2 mm, D:2X2mm threaded, tube no: 1	FWB	No complication	33	Excellent
5	2-year-old, 4 kg, M, Turkish Van	Femur, closed, distal diaphyseal, spiral	Motor vehicle accident	1	Limited open approach	Unilateral, type I P:3X2,5mm, D:2X2,5mm threaded, tube no: 1	1, 3	No complication	32	Excellent
6	1-year-old, 5 kg, M, Turkish Angora	Radius-ulna, closed, distal diaphyseal, comminuted	High rise syndrome	2	Closed application (Biologic fixation)	Bilateral, type II P:2X2 mm, D:2X2mm non-threaded, tube no: 1	1, 5	No complication	33	Good
7	6-month-old, 2.5 kg, F, DSH	Radius-ulna, closed, mid-diaphysis,	High rise syndrome	1	Limited open approach	Bilateral, type II P:3X2 mm, D:2X2mm non-threaded, tube no: 1	1, 4	Synostose	27	Excellent
8	10-month-old, 3.5 kg, M, DSH	Tibia, closed, distal diaphyseal, oblique	Motor vehicle accident	2	Closed application (Biologic fixation)	Bilateral, type II P:3X2mm, D:2X2mm non-threaded, tube no: 1	FWB	No complication	36	Excellent

M: male, F: female, P: proximal fracture arm, D: distal fracture arm, Tube no.1: 15mm, no.2: 23mm, no.3: 30mm, DSH:domestic short hair, FWB: full weight-bearing immediately after the operation

Table 3. *Outcome evaluation scale of the study cases.*
Tablo 3. *Çalışma olgularının sonuçlarının değerlendirme skalası*

Excellent	no lameness, clinically normal
Good	slight lameness only after extensive exercise
Fair	slight to moderate intermittent lameness but consistent weight-bearing
Poor	non-weight-bearing lameness

in 2 (25%), and bilateral (type II) in 6 (75%) cats. Transarticular pinning was performed in 4 cases (case no: 4, 6, 7, 12) *(Figure 3)*. In 11 cases (case no: 3, 8, 9, 16, 17, 20, 21, 23, 25, 26, 30) functional use of the limb with full weight-bearing was observed immediately after recovery from anesthesia.

Mean frame removal time was 42 days in dogs and 29.5 days in cats. According to the McCartney and Fox evaluation scale, results were excellent in 19 (12 dogs, 7 cats) (65.6%), good in 7 (6 dogs, 1 cat) (24.2%), fair in 1 (3.4%), and poor in 2 (6.8%) cases. Preoperative and postoperative case details of dogs and cats are listed in *Table 1* and *Table 2* respectively.

DISCUSSION

Complications associated with ESF can affect bone and soft tissue healing and often require changes in treatment protocol. Complications arising from ESF can be classified as pin tract infections, fixator problems and impalement of neurovascular/muscular tissues. Excessive movement of the pin directly contributes to infection. Slight, serous drainage and minimal tissue inflamation around the pin-skin contact point can usually be seen in all types of ESF applications. Some clinicians prefer to allow this cutaneous drainage to form a sterile crust and provide a possible barrier to infection [8,9]. Others prefer to clean the pin sites daily with various solutions to permit external drainage and so avoid or relieve infection [10-13]. In present study no significant pin tract infection was observed in any of the cases where weekly cleaning and daily antibiotic spray applications were performed regularly as prescribed. The causes of the pin tract infection in 5 cases were irregular usage of the spray and neglect of the wound by the owners besides the factors noted in the literature [8,9,13].

Pin tract infection can be minimized by reducing skin tension around the pin, avoiding thermal necrosis of bone during pin insertion and limiting pin-bone and pin-skin movement [8,10,12-15]. Pin-bone movement is also reduced if bone necrosis is avoided by proper pin insertion. In ESF applications using a power-drill (not more than 150 rpm) prevents excessive tilting, shortens the duration of the operation, reduces anesthesia intake, decreases risk of infection, and allows increased concentration by surgeon during the operation. Although predrilling with a bit smaller in diameter than the pins is advised to limit bone necrosis [14], in the present study self-tapping schanz pins and sharp pointed wires were used with low speed drilling and did not observe any complication correlated with bone necrosis.

Non-threaded fixation pins have significantly lower resistance to axial extraction in cortical bone when compared with partially threaded fixation pins [16,17]. Therefore, non-threaded fixation pins are prone to loosening during the convalescence period, resulting in pin tract drainage and patient discomfort [14]. In the present study, threaded pins were used in the unilateral fixation of femur- and humerus fractures or in heavy dogs which necessitated stronger ESF configuration. In the rest of the cases, stabilization achieved using non-threaded pins was found to be sufficient except case no: 14 in which delayed union was occured due to early failure in pin-bone interface as the result of pin tract infection.

Acrylic ESF have some superiorities over other types of ESFs. The most important one being its cost. A type-I acrylic ESF that uses six 3.2 mm fixation pins costs approximately 75% less than an equivalent Kirschner ESF. Also, the use of acrylic columns affords the surgeon greater latitude in placement of fixation pins because then the pins do not have to be aligned in a single longitudinal plane. In addition, fixation pins of any diameter may be used, and are not restricted to only those that can be accommodated by a connecting clamp. The acrylic column is also light in weight, which may be conducive to an earlier return of the limb to its normal function. Last but not least, most acrylics are radiolucent, which property facilitates better postoperative assessment of fracture reduction and healing [1,5,18,19]. Because of this advantage, in acrylic ESF a misdirected pin can be accommodated by changing the shape of the acrylic column. Not only the thickness and the composition of the plastic tube material but also the sharpness of the pin ends influence the continuity of the reduction at the time of pin-column connection. Because, the excessive force that may have been applied at the time of impaling can impede the reduction. In the present study, we used trochar pins pointed at both ends and sharp-ended schanz pins with an acrylic tube made of flexible, thin-walled plastic to ensure secure connection. If the pin ends stay sharp especially in the medial column, they can injure the contralateral limb. In order not to give room for such a complication, the surgeon needs to be careful not to perforate the lateral wall of the plastic tube. If this is noticed after hardening of the acrylic, these sharp ends of the pins have to be coated with small acrylic beads.

Dynamic changes in the external fixator caused by

the staged disassembly of very stiff frames leads to bone loading and the promotion of callus formation [15]. Increased bone loading in the later stages of fracture healing leads to more rapid healing [19]. A progressive disassembly (dynamization) of the frame may positively influence fracture healing. In an experimental study of canine tibial osteotomy and linear fixation, frame dynamization after 6 weeks had positive effects, but dynamization after 1 to 4 weeks had negative effects and at 12 weeks had no effect when compared to continuous rigid fixation [20]. In the present study, because mean frame removal time was 37 days in dogs and 29.5 days in cats, frame dynamization was not necessitated.

Polymethylmethacrylates are a group of acrylics that undergo an exothermic reaction during the polymerization phase of hardening and can reach temperatures ranging between 50 to 100°C [21,22]. In a study in which dissipation of heat during polymerization of acrylics used for ESF connecting bars was investigated, all thermistors placed 5 mm from the acrylic columns had mean Tmax greater than 50°C, which is enough to cause bone necrosis in dogs [4,23]. Because of such a risk, we adjusted the skin-acrylic column distance between 1 to 3 cm according to the age and the body weight of the individual cases. Although direct cooling of the acrylic columns during polymerization process was believed to impair the mechanical strength of the acrylic [24] we did not encounter any problem relating to strength in any of the cases that were directly cooled.

The finding of the present study was that by designing appropriate frame configurations, acrylic ESF can successfully be used in long bone fractures of dogs and cats. System is found to be more successful and convenient in cats and small breed or low weighted dogs. Result were better with early intervention and less invasive application.

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