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Treatment of Radius and Ulna Fractures in Toy and Miniature Breed Dogs (22 Cases)

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Abstract

Radial and ulnar fractures are common in small animals. Especially toy and miniature breed dogs are at high risk of incidence. Although there are plenty of studies on the treatment of radius and ulna fractures in small animals, studies related to the radius and ulna fractures in toy and miniature breed dogs are limited. The objective of this study was to report the diagnostic information and treatment outcome of radial and ulnar fracture treatment in toy and miniature breed dogs. Radius and ulna fractured 22 toy and miniature breed dogs were included in the study. Clinical findings, radiographic images, treatment applications, prognosis and outcomes were evaluated. As a treatment method, external coaptation in 5 extremities and surgical reduction and osteosynthesis in 17 extremities were performed. Out of 5 dogs who underwent external coaptation, 4 had good outcome and 1 had malunion. Out of 17 patients which underwent surgical treatment, 13 had a good outcome, 2 had nonunion, 1 had surgical site infection, and 1 had malunion and implant failure. As a result, original data on the etiology, diagnosis, treatment, prognosis evaluations, and surgical outcomes of radius and ulna fractures of toy and miniature breed dogs were presented. External coaptation considered could be successful in closed and undislocated radius and ulna fractures of toy and miniature breed dogs. However, the surgical approach and osteosynthesis performing are considered essential in dislocated, comminuted, complicated fractures, or open fractures. Further prospective studies are needed to compare specific surgical treatment methods.

Keywords: Canine, extremity, orthopedics, small animal, surgery.

INTRODUCTION

Radial and ulnar fractures are common in small animals. Especially toy and miniature breed dogs are at high risk of incidence (Lappin et al.,1983; Larsen et al. 1999; Brianza et al. 2006; Gibert et al. 2015; Ramírez and Macías 2016; Nelson et al. 2017). Radius and ulna fractures generally constitute 18% of all fractures (Boudrieau, 2001; Karabağlı 2019). Although the most common causes are motor vehicle accidents and high falls, it can occur for many different reasons (Şen et al. 2015; Altuğ et al. 2017). While minor traumas and falls can cause fractures in small dog breeds, high falls and motor vehicle accidents are more common in large dog breeds and cats (Wallace ve ark., 2009, Karabağlı 2019).

Radius and ulna fractures mostly occur together. Conservative treatment can be preferred in cases without dislocation in which only one of these two bones are fractured. In conservative treatment, external coaptation can be performed by using support materials such as a cast or splint to stabilize fractures and prevent dislocations. In cases where the radius and ulna are fractured together or dislocated, the bones should be reduced and stabilized by a surgical approach (Altuğ et al., 2017). External coaptation is not recommended due to the high risk of fracture healing complications, although it is not dislocated in case of both are fractured of the radius and ulna (Piras et al., 2011; Nelson et al., 2017).

Open reduction and internal fixation techniques are frequently used in surgical treatment, but external fixation applications may also be preferred occasionally (Fossum 2013; Şen et al., 2015; Altuğ et al., 2017). Treatment of radius and ulna fractures with casts, intramedullary pins, external fixators, and bone plates in toy and miniature breed dogs has been reported (Lappin et al., 1983; Waters et al., 1993; Larsen et al., 1999). Bone plates for the radius and intramedullary pin support for the ulna are the most preferred methods among internal fixation techniques in small animals (Larsen et al., 1999; Piras et al., 2011; Nelson et al., 2017; Karabağlı 2019). Bone plates and screws, orthopedic wire (cerclage), lag screws, and percutaneous fixation methods can be used occasionally depending on the characteristics of the patient and fractured bones (Fossum 2013; Altuğ et al., 2017). In the planning of surgical or conservative treatment methods, components such as the characteristics of the patient and the fracture, the experience and preference of the surgeon, and the approach of the patient are decisive (Sağlıyan ve Han 2016; Altuğ et al., 2017).

Although there are plenty of studies on the treatment of radius and ulna fractures in small animals, studies related to the radius and ulna fractures in toy and miniature breed dogs are limited. The objective of this study was to report the information and outcome of radial and ulnar fracture treatment in toy and miniature breed dogs.

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MATERIALS AND METHODS

Toy and miniature breed dogs with radius and ulna fractures from patients brought to Hatay Mustafa Kemal University Veterinary Health Practice and Research Hospital Surgery Clinic between 2017-2021 were included in the study. Demographic and diagnostic information, preoperative and perioperative procedures, treatments applied, postoperative procedures, and prognosis information of the cases were examined. Radial and ulnar fractures in other animal species or dogs of other breeds were excluded from the study.

Collection of Demographic and Diagnostic Information

The patient's description and detailed anamnesis (race, age, gender, the cause of the fracture, etc.) were examined. Clinical findings, radiographic images, treatment applications, and prognosis were evaluated. In the clinical examination, the soft tissue integrity of the extremity, function, and the general condition of the patient was examined. For radiographic examination, radiographs including the radius and ulna region were examined in the mediolateral (ML) and craniocaudal (CrCa) positions (Intermedical, Basic 100-30®, Italy). In the radiographic examination, the location of the fracture (proximal, diaphysis, distal), and the type and configuration of the fracture (transverse, short oblique, long oblique, simple, comminuted) were determined.

Preoperative and Perioperative Administration

The surgical site of the patients was prepared in accordance with the rules of asepsis and antisepsis. Cefazolin sodium (25 mg/kg, IM, Sefazol, Mustafa Nevzat A.Ş., Istanbul, Türkiye) and metamizole sodium (15 mg/kg, IV, Andolor, İbrahim Ethem Ulagay İlaç Sanayi Türk A.Ş., Istanbul, Türkiye) was applied. General anesthesia induction was achieved with xylazine HCl (2 mg/kg Alfazyne 2%, Egevet, Türkiye) and ketamine HCl (10 mg/kg, Alfamine 10%, Egevet, Türkiye). General anesthesia was maintained with 2-3% isoflurane (Isoflurane - USP, Adeka İlaç Sanayi ve Ticaret A.Ş., Samsun, Türkiye) inhalation anesthesia.

Treatment Process

The treatment method to be applied in the patients was determined according to the location of the radius and ulna fractures and whether the fracture fragments were dislocated. Conservative treatment was recommended and performed in only one case. In cases where both radius and ulna were fractured together, surgery was recommended whether it was dislocated or not. Although the surgery was needed, conservative treatment was applied in 4 cases because the owners refused surgery. For conservative treatment, external coaptation and movement restriction were applied at least for three weeks. Internal fixation osteosynthesis was performed with open reduction with a surgical approach in those who accepted the surgery. External fixation was performed in only one case because the comminuted and complicated fracture was not suitable for internal fixation.

Radial and ulna fractures were accessed with a craniolateral surgical approach in cases treated with a surgical approach with internal fixation. In 2 cases of ulna fractures, Kirschner wire with a thickness (Ø 1 - 2 mm) to fill 50-75% of the bone medulla was applied intramedullary with the retrograde fashion. Mini titanium plates (1.6 – 2.4 mm) and screws (1.6 – 2 mm) were used for radius fractures (Table 1). Cross pins were applied only in one radius fracture because the localization was very distal and the distal fragment was very small. Of the operated radius fractures, 1.6 mm mini titanium locking plate was used in 4 cases, 2.0 mm mini titanium locking plate in 7 cases, 2.4 mm mini titanium DCP plates in 4 cases, cross pins in 1 case and external fixator (Type 1a) in 1 case. Intramedullary K-wires were used in only two cases for ulnar fractures. Muscles, subcutaneous tissues, and skin were sutured by simple continuous and simple interrupted suturing with 4-0 or 3-0 (depending on the case) absorbable sutures (Polyglycolic Acid P.G.A., Çetin Kimya Saglik Ara. Gereçleri San. ve Tic. Ltd. Sti., Adana, Türkiye).

Postoperative Administration

In the postoperative period, cefazolin sodium (25 mg/kg, q12 hours, IM) was administered for 7 days for antibiotic purposes. Carprofen (4 mg/kg, q24 hours, PO, Rimadyl tablet, Zoetis Animal Health Ltd. Şti., Ümraniye/Istanbul, Türkiye) was administered for 5 days for analgesic purposes. Postoperative control examinations were routinely performed on days 7 and 21. Additional follow-ups were repeated every 3-4 weeks.

RESULTS

Demographic and Diagnostic Results

In the age distribution of toy and miniature breed dogs diagnosed with radius and ulna fractures, 13 cats were <1 year, 5 cats 1 year, 3 cats 2-7 years old, 1 cat older than 7 years (range 0.4-8, mean 1.45, median 0.85). The gender distribution of the cases was 13 (59%) males and 9 (41%) females. Body weights were determined in the range of 1.5 – 4.5 kg (mean 2.91, median 2.5 kg). The breed distribution was Yorkshire Terrier (8), Pomeranian (7), Chihuahua (4), Miniature Pincher (2), and Jack Russell (1). In the etiology of radius and ulna fractures, fall (14), motor vehicle accident (4), postoperative complication (2), high fall (1) and dog bite (1) were determined. Falls from small heights, such as a sofa or the owner's lap, were defined as "fall", and falls from a height such as the 1st floor of an apartment building were described as "high fall". In clinical examination results, lameness, local pain, and tenderness were present in all cases. Demographic, radiographic, treatment, and prognostic findings of all cases are summarized in Table 1.

The localization of radius and ulna fractures in a total of 39 fractured bones in 22 extremities were presented (Tables 2 and 3). The most common fracture types were determined as transverse (12), short oblique (8), and long oblique (2), respectively. Simple fractures (16) and comminuted fractures (6) were determined. It was determined that the radius and ulna were fractured together in 17 of 22 toy or miniature breed dogs, and only the radius was fractured in 5 of them. In the follow-up examinations, the clinical findings and radiographic images were examined and fracture healing was evaluated in the cases.

Table 1. Demographic, diagnostic, treatment and outcome information of the cases

Case No	Breed	Gn	Age (year)	W (kg)	Cause	Localization	Type	FC	Treatment/Implant Used	O
1	Yorkshire T.	Ma	2	3.5	MVT	Diaphysis R - U	S	T	R: 2.4 mm DCP; U: K-wire Intramedullary	G
2	Yorkshire T.	Ma	0.4	2	Fall	Proximal R - U	S	T	R: MTLP 1.6mm	G
3	Chihuahua	Fe	8	2.5	Fall	Proximal R	S	T	EC (ORS)	G
4	Yorkshire T.	Ma	0.4	3.5	High fall	Distal R	S	SO	R: DCP 2.4 mm	G
5	Juck Russel	Ma	2	5.5	MVT	Distal R	S	T	EC	G
6	Yorkshire T.	Ma	0.7	4.5	Fall	Diaphysis R - U	S	T	R: DCP 2.4 mm	G
7	Pomeranian	Ma	0.6	2.5	Fall	Diaphysis R - U	S	LO	EC (ORS)	M
8	Chihuahua	Ma	0.8	2.5	Fall	Distal R - U	S	T	R: Cross pins	G
9	M. Pincher	Ma	1	3.5	Fall	Distal R - U	C	SO	R: MTLP 1.6 mm	G
10	Yorkshire T.	Fe	0.5	4.5	MVT	Diaphysis R - U	C	LO	R: MTLP 2 mm; U: K-wire Intramedullary	G
11	Chihuahua	Ma	0.7	1.5	Cm	Distal R - U	C	SO	EF	N
12	Pomeranian	Ma	1	2.5	Cm	Diaphysis R - U	C	SO	R: MTLTP 1.6 mm	N
13	Pomeranian	Fe	1	2	Fall	Distal R - U	S	T	EC (ORS)	G
14	Pomeranian	Fe	1	2.5	Fall	Distal R	S	T	R: MTLP 2 mm	Cm
15	Pomeranian	Fe	1	2.5	Fall	Distal R	S	T	R: MTLTP 1.6 mm	G
16	Pomeranian	Fe	0.9	3	Fall	Diaphysis R - U	S	T	R: MTLP 2 mm	G
17	Yorkshire T.	Ma	0.8	2	Fall	Diaphysis R - U	C	SO	R: MTLP 2 mm	M and ImFa
18	Yorkshire T.	Fe	0.8	2.5	Fall	Distal R - U	S	SO	R: MTLTP 1.6 mm	G
19	Yorkshire T.	Fe	0.6	2	Fall	Distal R - U	S	SO	EC (ORS)	G
20	Pomeranian	Fe	0,6	2.5	Fall	Diaphysis R - U	S	T	R: MTLP 2 mm	G
21	M. Pincher	Ma	2	3.5	MVT	Diaphysis R - U	S	T	R: MTLP 2 mm	G
22	Chihuahua	Ma	5	3	Dog Bite	Diaphysis R - U	C	SO	R: MTBHLP 2.4 mm	G

T: terrier,M.: Miniature, Ma: Male, Fe: Female, MVT: Motor Vehicle Trauma, R: Radius, U: Ulna, S: Simple, C: Comminuted, FC: Fracture Configuration, T: Transverse, SO: Short oblique, LO: Long oblique, EC: External coaptation, ORS: Owner rejected surgery, DCP: Dynamic compression plate, MTLP: Mini titanium locking plate, MTBHLP: Mini titanium biological healing locking plate, O: Outcome, G: Good, N: Nonunion, M: Malunion, ImFa: Implant failure, Cm: Contamination

Table 2. Summary of the fracture localization

Localization	Radius	Ulna
Proximal	2	1
Diaphysis	10	10
Distal	10	6
Total	22	17

Table 3. Summary of the fracture type and configuration

Fracture Type	Simple	16
	Comminuted	6
Fracture Configuration	Transverse	12
	Short Oblique	8
	Long Oblique	2

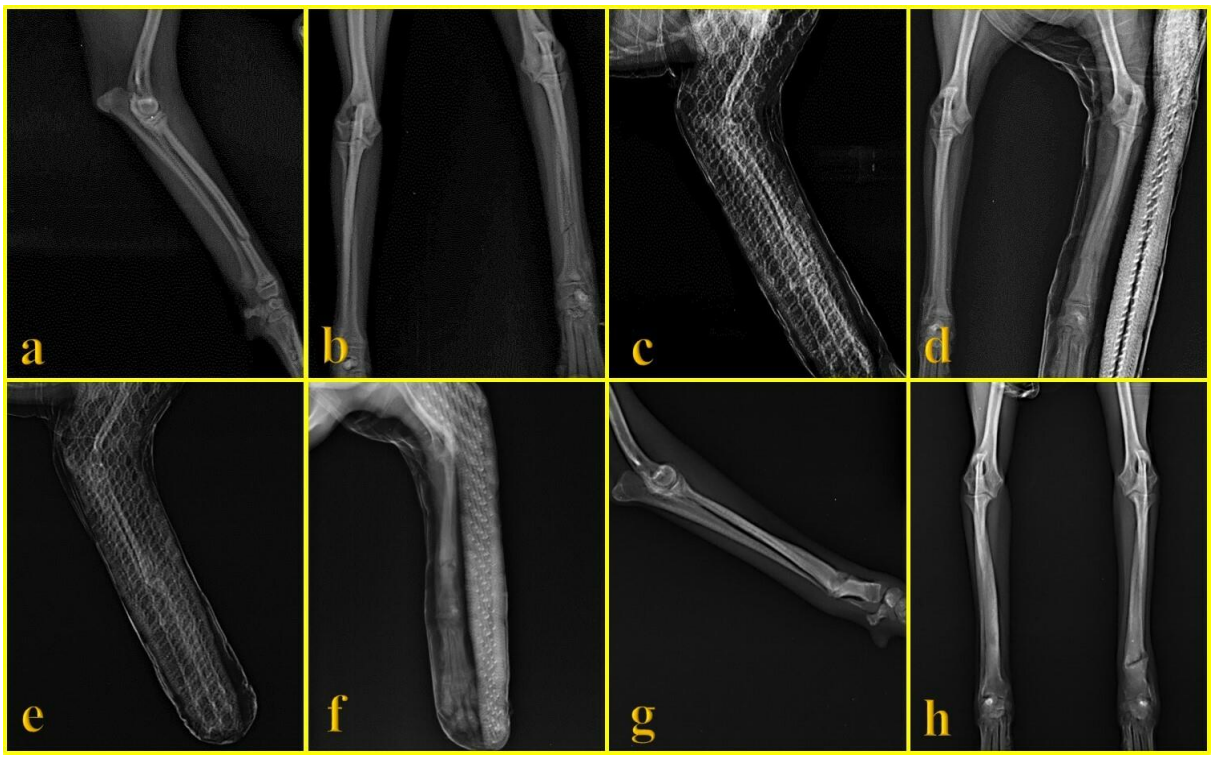

Figure 1. Before bandage (a, b) and after the bandage (c, d : seven days later, e,f : 3 weeks later, g,h : 3 months later) radiographs of radial and ulnar fracture in a Yorkshire Terrier breed dog.

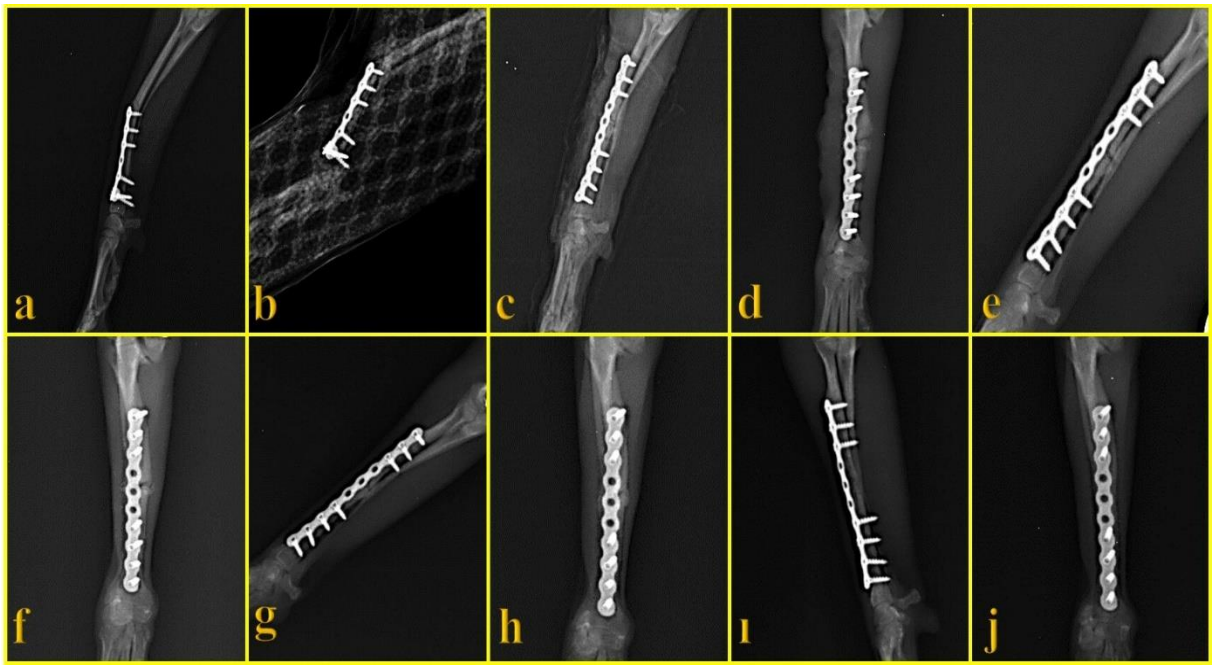

Figure 2. Preoperative (a, b) and postoperative (c, d: first day, e,f: 1 months later, g,h: 2 months later, ı,j: 6 months later) radiographs of radial and ulnar fracture in a Pomeranian breed dog.

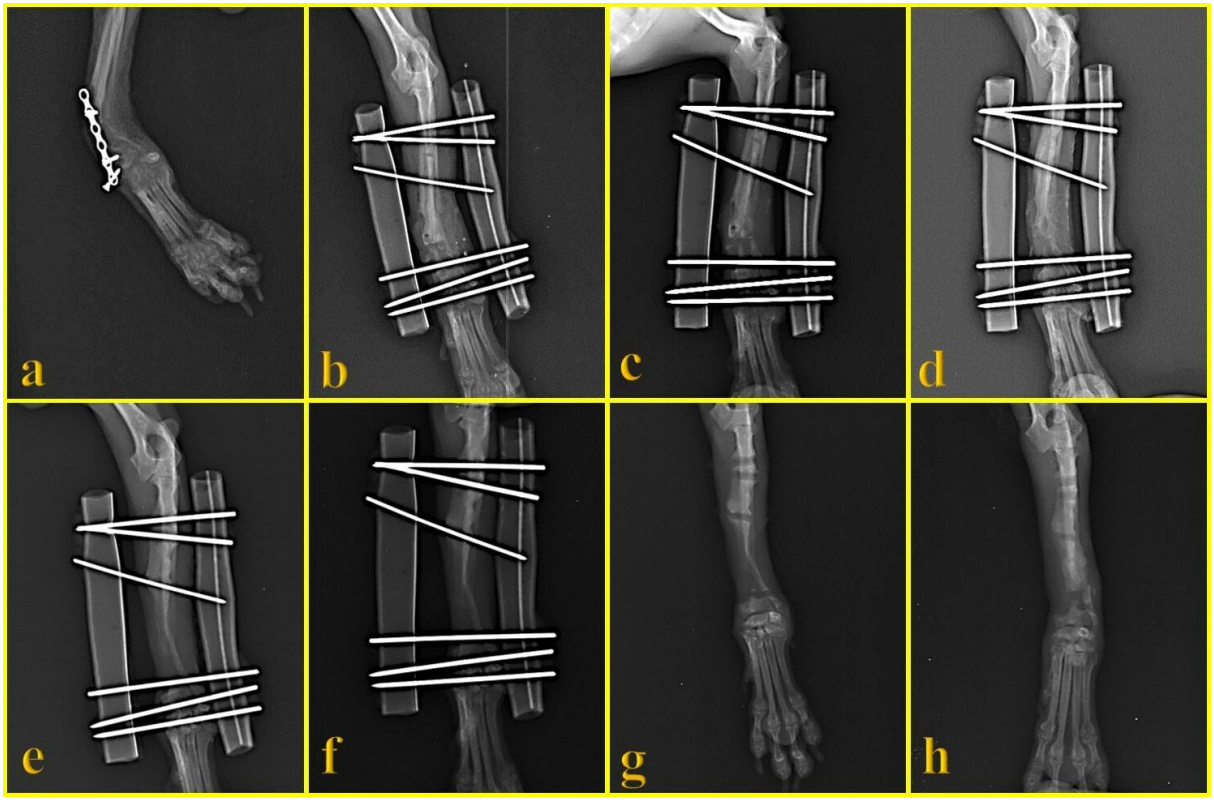

Figure 3. Preoperative (a) and postoperative (b: first day, c: seven days later d: 3 weeks later, e: 2 months later, f: 3 months later, g: 3.5 months later, h: 4 months later) radiographs of radial and ulnar fracture in a Chihuahua breed dog.

Outcome and Prognosis

As a treatment method, external coaptation in 5 extremities and surgical reduction and osteosynthesis in 17 extremities were performed. Out of 5 dogs who underwent external coaptation, 4 had good outcome and 1 had malunion. Out of 17 patients which underwent surgical treatment, 13 had a good outcome, 2 had nonunion, 1 had surgical site infection, and 1 had malunion and implant failure. The dogs with remaining nonunion and malunion have been suggested for revision surgery, but couldn't make it since the owners refused or didn't come to scheduled surgeries. Treatment and prognosis information of all patients are available in Table 1.

DISCUSSION AND CONCLUSION

Studies on fracture treatments in many regions in dogs have been carried out continuously from the past to the present. Thus, data that will guide veterinary surgeons on treatment methods and success are presented (Baroncelli et al., 2012; Minar et al., 2013; Pozzi et al., 2013; Libardoni et al., 2018). It has been reported that the risk of fracture healing complications is high in radius and ulna fractures of toy and miniature breed dogs due to reasons such as weak muscle covering of the distal and diaphyseal bone segment, and weak vascular support in the metaphyseal-diaphyseal transition line (Pozzi et al., 2013; Karabağlı 2019). In addition, it is stated that periosteal blood supply ceases in dogs with complete growth (Karabağlı 2019). For these reasons, studies on the treatment methods and results of radius and ulna fractures, especially in toy and miniature breed dogs, make an important contribution to the benefit of specialists and practitioners working in this field (Piras et al., 2011; Nelson et al., 2017). In this study, original data about the diagnosis, treatment methods and results of radius and ulna fractures in toy and miniature breed dogs are provided. Thus, guiding results and evaluations are presented both in the treatment practices of veterinarians and in the planning of new studies.

Locking plates are useful for both human and veterinary fracture repair. They resist shear forces better than conventional plates, able to withstand higher axial loads, and usually do not fail by screw pull-out (Cronier et al. 2010; Nelson et al. 2017). Locking plates do not rely on compression of the plate to the bone. Therefore, further preservation of the blood supply more likely to be achieved (Wagner 2003; Nelson et al., 2017). It is considered important especially in small breed dogs, because of their decreased vascular density at the distal diaphyseal–metaphyseal part of the antebrachium (Welch et al., 1997; Nelson et al., 2017). The toy or miniature breeds with the small size of the bone fragment was one of the most challenging in stabilizing proximal or distal fractures of the radius and ulna. In case of the short fragments, use of the mini T-plate has been recommended in order to perform the screws in at least four cortices (Hamilton and Langley Hobbs 2005). It's known a minimum of six cortices on each fracture fragment is classically recommended to distribute the stress along the plate (Fossum 2013). However, bone plating guidelines are difficult to follow in some fractures with small fragments. Therefore, it has been suggested that with locking fixation, two screws on each side of the fracture should be sufficient to achieve stability (Stoffel et al., 2003). The locking T-plates are useful for the shorter distal bone fragments which allows the placement of two locking screws in the same level of the bone fragment. For these reasons, when possible, locking plates and screws of

various properties were used for internal fixation in our study. Cross pins were used in only one case and an external fixator was used in one case for reasons that made plate application impossible. Therefore, we mostly used bone plating and didn't use intramedullary pins alone because of its anti rotational inadequacy disadvantage. In one case, the reason for applying cross pins is that the radius fracture is very distal and with a small bone fragment. The reason for using an external fixator in one case is that internal fixation was performed in a private clinic before and complications were formed and it was not possible to apply a plate. External coaptation was recommended directly in 1 out of 5 cases who underwent external coaptation. In the other 4 cases, external coaptation was performed because the owner refused surgery for economic or personal reasons, although surgery was actually required.

A number of studies report different fixation techniques for treatment of radial and ulnar fractures in toy and miniature breed dogs. Internal fixation of small breed radial and ulnar fractures has been reported with the success rate of 70-95% (Larsen et al., 1999; Hamilton and Langley Hobbs 2005; Parent et al., 2017). The overall complication rates has been reported up to 68% of repaired fractures (Nelson et al., 2017; Watrous and Moens 2017). The return to full function has been reported with an 89% incidence for bone-plate fixation in small dogs with an 18% rate of major complication. Implant failures, non-union, malunion, delayed union, re-fracture, and other complications are possible (Larsen et al., 1999; Baltzer et al., 2015; Altuğ et al., 2017). Bone healing rates were reported 93% for external skeletal fixation, 50% for intramedullary pins, and 43% for external coaptation (Lappin et al.,1983; Waters et al. 1993; Larsen et al. 1999; Haas et al., 2003; Piras et al., 2011). Internal fixation complications in our study were found to be reasonable, since the risk of complications in radius and ulna fractures was reported to be high, especially in toy and miniature breed dogs. The inability to get a good result in the case where an external fixator was applied is due to the inability to correct the previous complication. In our study, a higher treatment success was obtained in cases with external coaptation than the rates reported in other studies. Nelson et al. (2017) reported all complications of their study occurred in short oblique fracture configurations. In our study, although most of the cases with complications were in short oblique fractures, complications occurred in one long oblique and one transverse fracture. Based on these, it can be suggested that short oblique fractures are considered at a higher risk of complication.

Limitations of this study were the use of various shaped locking plates, multiple surgeons involved, and limited case numbers. Despite of the limitations, this study provides useful clinical information to the small animal surgeon in determining which fixation method to decide for a particular fracture in toy and miniature dog breeds. Further studies would focus on specific plate-screw systems and carried out multi-institutional to provide further details on the reliability and limitations of these treatments.

As a result of this study, original data on the etiology, diagnosis, treatment, prognosis evaluations, and surgical outcomes of radius and ulna fractures of toy and miniature breed dogs were presented. It was considered that conservative treatment by external coaptation could be successful in closed and undislocated radius and ulna fractures. However, it was stated that the surgical approach and osteosynthesis performing are essential in dislocated, comminuted, complicated fractures, or open fractures. It was determined that further prospective studies are needed to compare specific surgical treatment methods.

Conflict of Interest

The authors declare that they have no competing interests.

Authorship contributions

Concept: M.Z.Y.D., M.E.A., C.T.I., Design: M.Z.Y.D., M.E.A., C.T.I., Z.Y., Data Collection or Processing: H.A., I.A., O.K., N.O., Z.N.A., Analysis or Interpretation: M.Z.Y.D., C.T.I., Literature Search: M.Z.Y.D., O.K., I.A., H.A., Writing: M.Z.Y.D., C.T.I.

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Ethical Approvel

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