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## Fractures in young, single-humped camels (*Camelus dromedarius*)

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**Abstract:** The objectives were to study the frequencies and classification of fractures in young camels and to evaluate the clinical relevance of external fixation as a method of treatment. Cases of fractures (n = 75) in young camels (less than 2 years old) were studied. On admission, the cause, site, classification, and radiography of the fractures as well as the methods of treatment were investigated. Factors affecting fracture healing after treatment were investigated and analyzed. The frequencies of fracture were affected by breed (P = 0.001) and age (P = 0.01) but not sex. Trauma was the most common cause of fractures (P = 0.001). Tibial fracture was the most common. Treatment was performed either by plaster of paris bandage alone (82.1%) or in combination with polyvinylchloride (PVC) splints (70.6%), interdental wiring (14.8%), or 2 Steinmann pins (1.9%). Satisfactory healing was recorded in 81.5% of the treated cases. In conclusion, breed and age affected the frequencies of fracture. There was a significant effect of camel age on the cause of fracture. Moreover, there was a significant effect of camel age on the fractured bone. External fixation using plaster of paris bandage with/without PVC splints and interdental wiring are successful treatment methods of fractures in young camels.

**Key words:** Fracture, classification, treatment, young camels

### Introduction

Although fractures are common affections in large animals (1), the available literature lacks detailed data about prevalence and classification of fractures in camels. Detailed descriptions of mandibular fractures and their treatments in camels have been cited (2,3). Other bone fractures were cited briefly, especially in young camels (2,3). Similarly, there are few reports on the incidence of fractures in camels (4,5). Long bone fractures in the new world camelids are also reported (6-8). Theoretically, any of the fixation techniques practiced in other domestic animals are applicable in appropriate situations in camelids (9,10). External fixation was

used successfully for the treatment of comminuted fracture in a juvenile camel (11).

Camel orthopedics is poorly understood so far because of a lack of comprehensive studies on fracture healing (2). Constraints of camel orthopedics are numerous; hence, the principles of bovine and equine orthopedics cannot be applied on camels in absolute terms (12). On the other hand, Camelids are known to tolerate well orthopedic surgery and the application of various orthopedic devices (13). Therefore, selection of a particular procedure should be dependent upon the bone involved and the nature of the fracture, available anesthesia, equipment and instrumentation, and the skill and experience of the surgeon (13).

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The objectives of this study were to investigate the frequencies and classification of fractures in young camels and to evaluate the clinical relevance of external fixations as methods of treatment. The effect of camel breed, sex and age, history, cause and type of fracture, fractured bone, and method of treatment on fracture healing were determined and analyzed statistically.

## Materials and methods

### Animals

Clinical cases of fractured single-humped camels were investigated during the period from August 2008 to December 2009. These animals were presented to the Veterinary Teaching Hospital, College of Agriculture and Veterinary Medicine, Qassim University. Cases of fractures in young camels (less than 2 years old) were studied with special interest to record the camel breed, age, and sex. Cause and freshness of the fracture (time elapsed between the occurrence of the fracture and presentation to the clinic) were also recorded. Fractured bone, seat, and classification of fractures were described according to clinical and radiological examinations.

### Procedures

Methods of treatment when indicated were external fixation by plaster of paris bandage alone or in combination with splints of polyvinylchloride (PVC), when relatively heavy young camels were fractured. The interdental wiring (IDW) technique was used in cases of mandibular fracture. Immobilization was performed after closed reduction with deep sedation of the camel by xylazine HCl (0.3 mg/kg body weight, intravenously, Rompun 2%; Bayer, Turkey). The camel was positioned in a lateral recumbency and the fractured limb was kept upward. Traction and counter traction was then applied using a cotton rope around the axilla (in the forelimb) or groin (in the hind limb), medial to the thigh, and tied to a fixed object. The counter traction was then applied by tying a rope around the pastern region, while keeping the knot of the rope on the posterior aspect of the foot. The foot region was well padded using cotton before the application of counter traction. The free ends of the rope were kept pulled by a ratchet tie down. Manual handling at the fracture site helped in the reduction.

After reduction, a layer of cotton, as soft padding, was applied around the fractured bone, including the joint above and the joint below. A layer of gauze bandage was then applied followed by 5 to 7 layers of plaster of paris bandages. When 2 PVC splints were used, they were cut at suitable lengths and added just after the cotton layer.

Compound fractures were treated with local and systemic antibiotics (penicillin-streptomycin at a dose of 30,000 IU/kg of penicillin and 10 mg/kg of streptomycin, Pen & strep, Norbrook Laboratories, UK) with a window on the wound through the cast. The cast was reinspected after 2 weeks. Follow up of the cases was done by a phone call to the camel's owners. The cast was removed after the fracture healed. The healed fracture was defined as a clinically acceptable fracture union without deformity and effect on gait, while no healing was defined as an unacceptable fracture union with deformity affecting the gait or no union at all (14).

IDW was applied by inserting a 0.8 mm diameter stainless steel wire between the first and second mandibular cheek teeth. The wire was then passed between the central incisors and the 2 branches of the wire were tied together using pliers. Excess wire was cut by using wire cutters, and the end was twisted towards the roots of the incisors. The same technique was repeated at the other side of the mandibular fracture.

Using an electric drill, 2 Steinmann pins (3.2 mm in diameter) were inserted through the rostral fragment to the horizontal ramus of the mandible, to treat a case (15 day-old male camel) of mandibular fracture. The excess wire was cut and bent using wire cutters and pliers.

### Statistical analysis

Data were analyzed for the effect of breed, sex, and age on the frequency of fractures in young camels. The effect of camel breed, age, sex, history, cause, type of fracture, fractured bone, and method of treatment, as well as their interaction on fracture healing was also studied. The differences in percentages were evaluated by the chi-square test. The level of significance was tested at  $P < 0.05$ . A statistical program (SPSS: Copyright © SPSS for Windows, Version 16.0. SPSS Inc., 2007) was used to perform the statistical analysis.

## Results

The camel breeds were Wadeh (white colored camels, n = 43, 57.3%), Mejhem (brown to black colored camels, n = 20, 26.7%), Asfar (light brown colored camels, n = 7, 9.3%), and Ashaal (reddish-brown colored camels, n = 5, 6.7%), P = 0.001. The fractured bones were recorded in females (n = 41, 54.7%) and males (n = 34, 45%). The median age of the fractures in the young camels was 30 days (range = 1-600 days). Fractures were more frequent at an age less than 180 days (n = 56, 74.7%) than those of 181-365 days (n = 14, 18.7%), and those of age 366-600 days (n = 5, 6.6%), P = 0.01. The time elapsed between the occurrence of fracture to presentation to the clinic (freshness of fracture) ranged from 1 day to 6 months.

The causes of the fractures in young camels were trauma (n = 36, 48%), stepped on by the mother or other camels (n = 29, 38.7%), falling down a hill (n = 3, 4%), camel bites (n = 2, 2.7%), trapping of a limb in a rope (n = 2, 2.7%), car accidents (n = 2, 2.7%), and stick trauma (n = 1, 1.3%), P = 0.001.

Fractures of the head and neck, forelimbs, and hind limbs were noticed in 11 (14.7%), 19 (25.3%), and 45 (60%) cases, respectively, P = 0.001. Left side fractures were observed in 34 cases (53.1%) and right side fractures were observed in 30 (46.9%) cases. The fractured bones were right tibia (n = 16, 21.3%, Figure 1A), left tibia (n = 14, 18.7%, Figure 1C), left radius (n = 10, 13.3%, Figure 1F), mandible (n = 9,

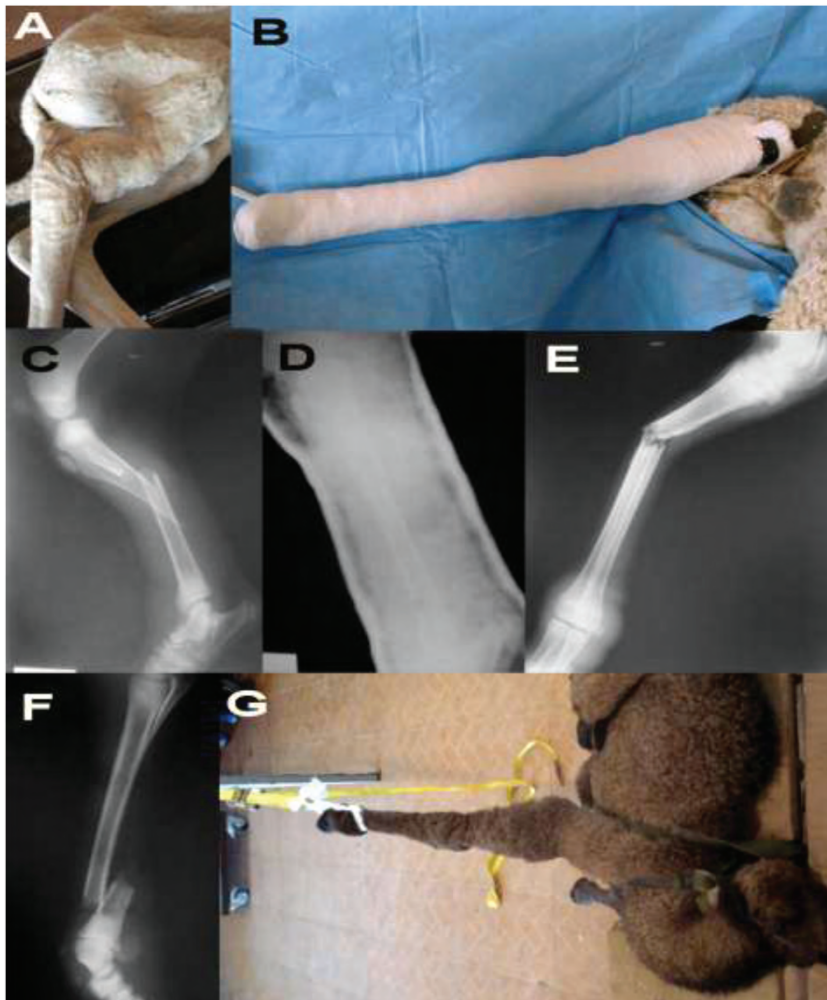


Figure 1. Young camel with closed tibial fracture (A), a cast of plaster of Paris bandage with 2 PVC splints for a tibial fracture (B), lateral radiographs of an oblique tibial fracture before treatment (C) and after treatment by plaster of Paris cast (D), lateral radiographs of metatarsal (E) and radial (F), and the use of the ratchet tie down for closed reduction of radial fracture in a young camel (G).



12%, Figure 2), right metatarsal bones (n = 5, 6.7%, Figure 1E), left metatarsal bones (n = 5, 6.7%), right radius (n = 4, 5.3%, Figure 1G), right metacarpal bones (n = 3, 4%), left femur (n = 2, 2.7%), neck (n = 2, 2.7%), right femur (n = 1, 1.3%), left metacarpal bones (n = 1, 1.3%), lateral first phalanx (n = 1, 1.3%), medial first phalanx (n = 1, 1.3%), and left humerus (n = 1, 1.3%).

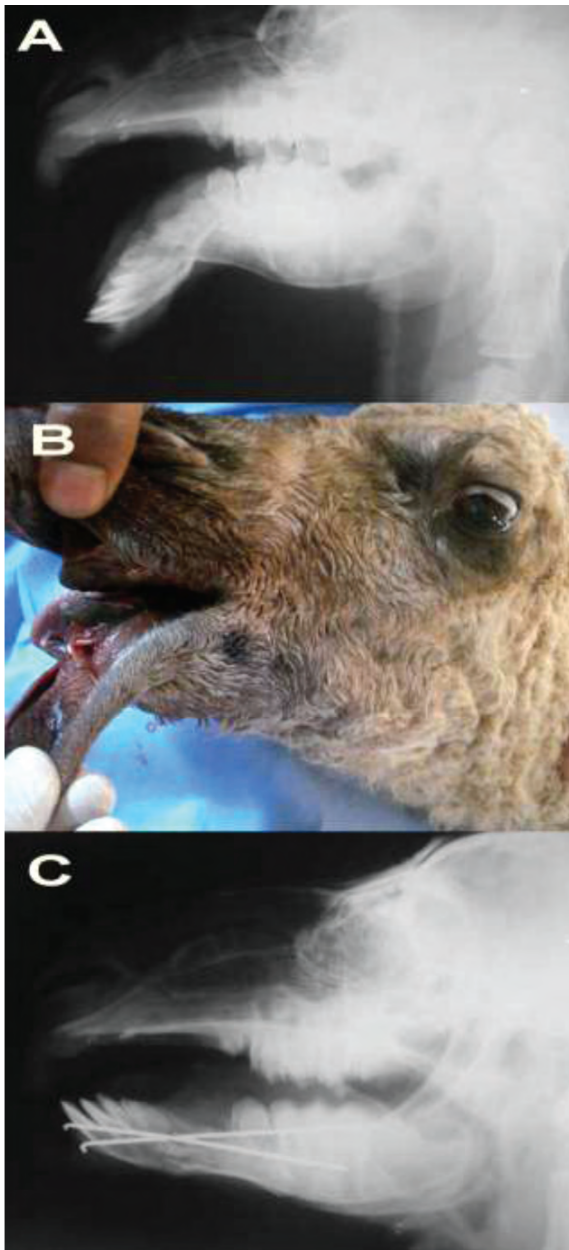


Figure 2. Lateral radiographs of mandibular fracture in a 15-day-old camel (A) and after fixation by 2 Steinmann pins (C), and a photo of the same case after treatment (B).

Closed and open fractures were recorded in 41 (54.7%) and 34 (45.3%) cases, respectively. Single fractures were frequent and represented 51 cases (68%) and multiple and comminuted fractures represented 24 (32%) cases,  $P = 0.01$ . In long bone fractures, diaphyseal fractures (n = 45/60, 75%) were more frequent than metaphyseal (n = 15/60, 25%) fractures,  $P = 0.001$ .

Amputation of the fractured limb was performed as a temporary treatment in 7/75 camels (9.3%). Slaughtering was recommended for 14 (18.7%) cases. Treatment was performed on the remaining 54 cases by either a plaster of paris bandage cast alone (n = 28, 51.9%, Figure 1D), plaster of paris bandage with polyvinylchloride (PVC) splints (n = 17, 31.5%, Figure 1B), by IDW (n = 8, 14.8%), or 2 Steinmann pins (n = 1, 1.9%, Figure 2).

Satisfactory healing was recorded in 44 (81.5%) cases and no healing was recorded in 10 (18.5%) cases. Plaster of paris bandage alone resulted in the healing of 23 (82.1%) out of 28 cases. Plaster of paris bandage together with splints of PVC resulted in the healing of 12 (70.6%) out of 17 cases. There were a few pressure sores in the skin after removal of the plaster cast with the PVC splints in 5 cases. IDW resulted in healing of mandibular fractures in 6 (75%) out of 8 cases. Healing time was from 6 to 9 weeks. Fixation by 2 Steinmann pins resulted in the healing of the case of a mandibular fracture.

Statistically, there were no significant effects of breed, sex, age, cause, fractured bone, or seat of fracture treatment method on the fracture healing. There was a tendency of single fractures to be healed more than multiple and comminuted fractures ( $P = 0.07$ ) (Table 1). There was a significant effect ( $P = 0.01$ ) of camel age on the cause of fracture (Table 2). Furthermore, there was a significant effect ( $P = 0.001$ ) of camel age on the fractured bone (Table 3).

## Discussion

Fractures in young camels are frequent in the Wadeh breed and in age less than 180 days. There was a significant effect of camel age on the cause of the fracture. Moreover, there was a significant effect of camel age on the fractured bone. External fixation using plaster of paris bandage with/without PVC

Table 1. Factors affecting fracture healing in young camels (n = 54).

Factor	Item	Healed (%)	No healing (%)	Total	P value
Breed	Wadeh	23 (76.7)	7 (23.3)	30	0.5
	Mejhem	15 (88.2)	2 (11.8)	17	
	Asfar	4 (100)	0 (0)	4	
	Ashaal	2 (66.7)	1 (33.3)	3	
Sex	Male	18 (81.8)	4 (18.2)	22	0.6
	Female	26 (81.3)	6 (18.7)	32	
Age (days)	0-180	31 (81.6)	7 (18.4)	38	0.9
	181-365	10 (83.3)	2 (16.7)	12	
	366-600	3 (75)	1 (25)	4	
History of fracture (days)	0-3	27 (84.4)	5 (15.6)	32	0.6
	4-7	13 (81.3)	3 (18.7)	16	
	>7	4 (66.7)	2 (33.3)	6	
Cause of fracture	Trauma	18 (75)	6 (25)	24	0.6
	Stepped on	18 (90)	2 (10)	20	
	Fall down	2 (66.7)	1 (33.3)	3	
	Trapped in rope	1 (50)	1 (50)	2	
	Car accident	2 (100)	0 (0)	2	
	Bite	2 (100)	0 (0)	2	
Fractured bone	Stick trauma	1 (100)	0 (0)	1	0.2
	Tibia	18 (78.3)	5 (21.7)	23	
	Mandible	9 (100)	0 (0)	9	
	Metatarsus	6 (100)	0 (0)	6	
	Metacarpus	3 (75)	1 (25)	4	
	Radius	6 (75)	2 (25)	8	
	Femur	0 (0)	1 (100)	1	
Seat of fracture	1st Phalanx	2 (100)	0 (0)	2	0.4
	Diaphyseal	25 (72.8)	8 (24.2)	33	
Single/multiple	Metaphyseal	7 (87.5)	1 (12.5)	8	0.07
	Single	35 (87.5)	5 (12.5)	40	
Closed/open	Multiple	9 (64.3)	5 (35.7)	14	0.3
	Closed	28 (77.8)	8 (22.2)	36	
Treatment method	Open	16 (88.9)	2 (11.1)	18	0.2
	Plaster of paris cast	23 (82.1)	5 (17.9)	28	
	Plaster of paris + PVC	12 (70.6)	5 (29.4)	17	
	IDW	8 (100)	0 (0)	8	
	Steinmann pins	1	0 (0)	1	

Table 2. Effect of camel age on the cause of fracture (n = 75).

Age (days)	Trauma (%)	Stepped on (%)	Fall down (%)	Trapped in rope (%)	Car accident (%)	Camel bites (%)	Stick trauma (%)	Total
0-180	22 <sup>a</sup> (39.3%)	27 <sup>a</sup> (48.1%)	3 <sup>a</sup> (5.4%)	1 <sup>a</sup> (1.8%)	2 <sup>a</sup> (3.6%)	0 <sup>a</sup> (0%)	1 <sup>a</sup> (1.8%)	56
181-365	10 <sup>b</sup> (71.4%)	2 <sup>b</sup> (14.3%)	0 <sup>a</sup> (0%)	0 <sup>a</sup> (0%)	0 <sup>a</sup> (0%)	2 <sup>a</sup> (14.3%)	0 <sup>a</sup> (0%)	14
366-600	4 <sup>b</sup> (80%)	0 <sup>b</sup> (0%)	0 <sup>a</sup> (0%)	1 <sup>a</sup> (20%)	0 <sup>a</sup> (0%)	0 <sup>a</sup> (0%)	0 <sup>a</sup> (0%)	5
<b>Total</b>	<b>36</b>	<b>29</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>75</b>

<sup>a,b</sup> Values with different superscripts in the same column are significant (P < 0.05).

Table 3. Effect of camel age on the fractured bone (n = 72).

Age (days)	Tibia (%)	Mandible (%)	Meta-tarsus (%)	Meta-carpus (%)	Radius (%)	Femur (%)	Phalanx (%)	Total
0-180	25 <sup>a</sup> (47.2%)	2 <sup>a</sup> (3.8%)	7 <sup>a</sup> (13.2%)	3 <sup>a</sup> (5.7%)	13 <sup>a</sup> (24.5%)	3 <sup>a</sup> (5.7%)	0 <sup>a</sup> (0%)	53
181-365	3 <sup>b</sup> (21.4%)	6 <sup>b</sup> (42.9%)	1 <sup>a</sup> (7.1%)	1 <sup>a</sup> (7.1%)	1 <sup>a</sup> (7.1%)	0 <sup>a</sup> (0%)	2 <sup>a</sup> (14.3%)	14
366-600	2 <sup>a</sup> (40%)	1 <sup>b</sup> (20%)	2 <sup>a</sup> (40%)	0 <sup>a</sup> (0%)	0 <sup>a</sup> (0%)	0 <sup>a</sup> (0%)	0 <sup>a</sup> (0%)	5
<b>Total</b>	<b>30</b>	<b>9</b>	<b>10</b>	<b>4</b>	<b>14</b>	<b>3</b>	<b>2</b>	<b>72</b>

<sup>a,b</sup> Values with different superscripts in the same column are significant (P < 0.05).

splints and IDW wiring were successful treatment methods of fractures in young camels.

The increase in the frequency of fractures in Wadeh breed of camel in this study might be due to the high population of this breed in the geographic area of study.

The vast majority of fractures in the current study were in camels of an age less than 180 days. Camels are reared in groups of tens to hundreds in the desert, and she-camels and young camels live together with 1 or 2 camel bulls (for every 50 she-camels), which are used for breeding (15). This kind of management makes young camels more prone to fracture inducing

causes. Fractures of the appendicular skeleton in another study were higher in animals under 4 years old (4).

Moreover, fractures of the head and neck were less common than the appendicular skeleton fractures, if compared to the results of another study (4). In the current study fractures of the hind limbs were prevalent. It seems that the difference arises because the other study (4) was carried out on adult and young camels.

Trauma was the most frequent cause of fractures. Causes of trauma were faulty steps due to uneven soil or stepping on holes in the ground (2), trauma

from another camel, and stepping on of the young camel by its mother or another camel while sleeping. Furthermore, as camels have longer bones than other domestic animals, they might be highly subjected to fractures as a result of trauma. All of these together with the anatomical location of the bones could be fracture predisposing factors (16).

External fixation techniques were used in the present study and were selected because the camels were young, with relatively small soft tissue masses surrounding bones, and the simplicity of the techniques. Moreover, treatment by external fixation was established only when the case was a good candidate for such treatment. Lack of availability and sustainability of suitable implants for internal fixation of the fractured long bones of long-legged animal is also an analogue constraint of camel orthopedics as compared to bovine orthopedics (2).

Treatment techniques differed from those used for appendicular fractures to those used for mandibular fractures. A plaster of paris bandage cast alone or in combination with 2 PVC splints resulted in healing of most of the treated cases of appendicular fractures in the current study. A plaster of paris bandage with 4 wooden or metal splints was used for treatment of fractures of the metacarpus, metatarsus, radius, and ulna of young camels (4). Internal fixation by 2 Steinman pins was used successfully in a case of mandibular fracture in the present study. It was reported that the prognosis of fractures is favorable in most of young camels where fusion of the epiphyseal plate has not taken place as compared to adult camels (2). Moreover, fixation type (internal, external) did not have any significant effect on complications involving

fracture healing, infection, soft tissue structures, or chronic lameness (17). Camelids with open fractures were more likely to have complications associated with fracture healing, repair, and infection (17).

There was a significant effect of camel age on the cause of fracture in the current study. Trauma was found to be the most common cause of fracture in camels more than 6 months of age. On the other hand, being stepped on by the mother or another camel was the most frequent cause in camels less than 6 months of age. This may be explained by the nature of camel rearing in free range desert conditions without separation of the young camels from the mature ones. A fractured tibia was found to be more frequent in camels less than 6 months of age, while mandibular fracture was observed to be more frequent in camels more than 6 months old.

In conclusion, frequencies of fracture in young camels were affected by breed and age. External fixation of fractures by means of plaster of paris bandage alone or with PVC splints and IDW are successful methods of treatment in young camels. There was a significant effect of camel age on the cause of fracture. Furthermore, there was a significant effect of camel age on the fractured bone.

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