

## Operative treatment of splint bone fractures in horses

Mehmet SAĞLAM<sup>1,a,✉</sup>, Cenk YARDIMCI<sup>2,b</sup>

<sup>1</sup>Aksaray University, Faculty of Veterinary Medicine, Department of Surgery, Aksaray, Türkiye; <sup>2</sup>Ondokuz Mayıs University, Faculty of Veterinary Medicine, Department of Surgery, Samsun, Türkiye  
<sup>a</sup>ORCID: 0000-0001-8934-8529; <sup>b</sup>ORCID: 0000-0001-6126-3603

✉Corresponding author: saglam45@gmail.com

Received date: 24.12.2020 - Accepted date: 21.08.2021

**Abstract:** In this study; it is aimed to present the operative treatment and results, which are indicated for the continue of their racing life in splint bone fractures which are frequently occurred in race horses. The 2<sup>nd</sup> and 4<sup>th</sup> metacarpal (Mc-II and Mc-IV) and metatarsal bones (Mt-II and Mt-IV) of the horse are accessory structures that support the carpus and tarsus. Fractures of these bones in horses are called “splint bone fractures”. Splint bone fractures are relatively common in horses and usually seen in forelimbs. Fractures of the proximal part are rarer and represent 2.7-5% of all splint bone fractures, but challenging to manage. In the present study, 5 cases of splint bone fractures in different horses were evaluated. The distribution of the fractures were Mc-II in three, Mc-IV and Mt-IV in one each. Localization of the fractures were distal 1/3 in 4 and diaphyseal in 1 horse. For the management of these fractures, surgical removal of the fractured fragments were performed under general anaesthesia. Functional limb usage was achieved following the 30<sup>th</sup> day postoperatively in all cases.

**Keywords:** Fracture, horse, metacarpus, metatarsus, splint bone.

### Atlarda splint kemik kırıklarının operatif sağaltımı

**Özet:** Bu çalışmada; yarış atlarında sıklıkla karşılaşılan splint kemik kırıklarında, yarış hayatlarını sürdürebilmeleri için endike olan operatif sağaltım ve sonuçlarının aktarılması amaçlanmıştır. İkinci ve dördüncü metakarpal (Mc-II ve Mc-IV) ve metatarsal kemikler (Mt-II ve Mt-IV) karpus ve tarsusu destekleyen aksesuar yapılardır. Atlarda bu kemiklerin kırıkları “splint kemik kırıkları” olarak adlandırılır. Splint kemik kırıkları atlarda sık ve özellikle de ön ekstremitede yerleşim gösterirler. Proksimal bölge kırıkları daha nadir olup, tüm splint kemik kırıkları içerisinde %2,7-5’lik bir orana sahiptir. Bu çalışmada farklı atlardaki 5 splint kemik kırığı değerlendirildi. Kırıkların dağılımı, üç olguda Mc-II, birer olguda da Mc-IV ve Mt-IV olarak belirlenirken, lokalizasyonu ise dört olguda distal 1/3, bir olguda diafiz bölge olarak tespit edildi. Bu kırıkların sağaltımında, distal kırık fragmentleri genel anestezi altında operatif olarak uzaklaştırıldı. Olguların tümünde postoperatif 30. günde ilgili bacağın fonksiyonel olarak kullanıldığı gözlemlendi.

**Anahtar sözcükler:** At, kırık, metakarpus, metatarsus, splint kemik.

### Introduction

In horses, metacarpus (Mc) / metatarsus (Mt) II-IV, also known as “splint bones” which anatomically localized caudo-lateral surface of the Mc-II both laterally and medially (1, 3). These bones take an important role in structures of the carpo-metacarpal and tarso-metatarsal joints (1, 3, 7, 18-21, 23, 24).

Splint bone fractures are mostly seen in forelimbs. Mc-II articulates with second carpal bones proximally and supports the load of this bone (1, 3, 5, 7). Mc-IV articulates with the fourth carpal bone proximally, but the load comes from the carpal bone both supported by Mc-III and Mc-IV (23, 24). An interosseous ligament spans the proximal two-thirds of the splint bone and maintains its attachment to Mc-III (21).

Small metacarpal bones fractures are relatively common in horses and may occur as a result external trauma, hyperextension of the metacarpophalangeal (MCP) joint, or as sequela to localized osteomyelitis caused by penetrating wounds (19, 20). In racehorses, these fractures may occur from acute overload (18-21).

Fracture of the small metacarpal bones can occur in proximal, middle, or distal third, and can be open or closed, and simple or comminuted. These fractures can be managed surgically or conservatively, depending on the location of the fracture along the bone, and whether it is open, closed, simple, or comminuted (2, 5, 16-18). Sequestration rarely occurs with closed fractures, even when multiple fragments are present. Osteomyelitis at the site and sequestration of the fracture fragments commonly

occur when fractures are open or caused by penetrating objects. Culture of the contaminated site often yields *Escherichia coli* or *Streptococcus spp.*; less frequently, *Staphylococci spp.* and *Pseudomonas spp.* are encountered (21, 23, 24).

Clinical signs of uncomplicated proximal and distal Mc-II or Mc-IV fractures include lameness, swelling at the fractures site, pain on digital palpation, and often, concurrent suspensory desmitis (9, 15). Chronic splint bone fractures can develop a subperiosteal exostosis as the fracture attempts to heal. Impingement by the exostosis on the suspensory ligament may limit the horse's return to athletic fitness and necessitate the removal of the exostosis to achieve soundness (5, 17).

The definitive diagnosis of a splint bone fracture is based on clinical signs and radiographic evidence of a fracture. MRI, which is one of the advanced diagnostic methods, is also effective in diagnosis (4). Diagnostic nerve blocks may be necessary to rule out other causes of lameness and to determine whether or not the fracture is responsible for the observed lameness. Associated suspensory desmitis is diagnosed by detecting enlargement and tenderness of the body and/or branches of the suspensory ligament (19, 21, 22).

**Distal fractures:** Fractures of the distal third of the splint bone is the most common type observed (1, 3, 7, 15). Thoroughbreds and forelimbs are more frequently affected than hind limbs (18-21). Horses 6 to 8 years old are more frequently affected with fractures of distal splint bone. In the previous studies distal splint bone fractures were concluded as fatigue fractures caused by the pulling of the interosseous ligament, which creates an increased force on the splint bone, especially during hyperextension of the MCP joint (23, 24).

Amputation of the fractured distal splint bone is the treatment of choice for both complicated and uncomplicated fractures (2, 5, 16). Although many splint bone fractures heal with rest and topical therapy alone, nonunion or formation of a large callus is common. A large callus may impinge on the suspensory ligament and cause lameness. Surgery hastens convalescence, prevents the formation of a large callus, and for open fractures, allows aggressive debridement of infected soft tissue. The horse should be confined to a stall for 30 days and hand walked 30 minutes twice daily. The limb should remain bandaged for 21 days. Following 30 days of confinement, the horse can be allowed to exercise in a small paddock or pasture for 3 to 6 months before training is resumed (1-3, 5, 7).

**Proximal fractures:** Proximal splint bone fractures can be closed or open and have been classified as comminuted, articular oblique, associated with osteomyelitis or chronic nonunion fractures (1-3, 5, 7). Subsequent exostosis and callus production following

proximal splint bone fractures are most commonly associated with direct external trauma such as kicks from other horses, interference during work, or self-inflicted trauma. Amputation of more than two-thirds of the splint bone can result in excessive motion of the remaining segment during weight-bearing (5, 7, 9). This instability may lead to comminution or displacement of the remaining bone, periosteal reaction at the osteotomy site and chronic lameness. Chronic lameness can also result from interosseous desmitis and degenerative joint disease of the carpometacarpal joint due to articular instability.

The aim of this study is to share the clinical and surgical experience of five cases of splint bone fractures that been unreported before in our country.

## Materials and Methods

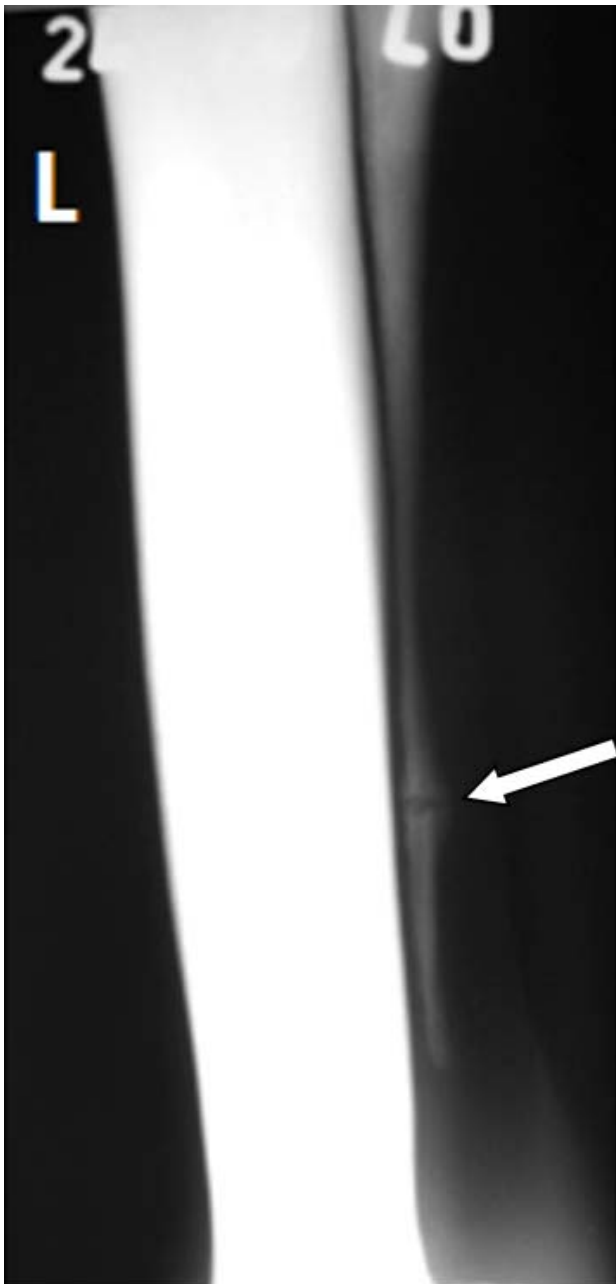
Horses with complaints of lameness after trauma and diagnosed with splint bone fracture with clinical and radiographic examinations were included in the study. For each horse; age, sex, breed, localization and type of fractures were recorded. As a result of detailed clinical and radiographic examinations, it was determined whether the fracture was open, there was an open wound or there was a fracture complication. At least two-sided radiographs of all patients were obtained (Figure 1). A temporary elastic bandage was applied to the legs with splint bone fractures until the operation. For general anesthesia, following premedication with acepromazine (0.04 mg/kg, IV) injection, horses were sedated with xylazine %2 (0.6 mg/kg, IV) and inducted with ketamine %10 (2 mg/kg, IV). After lying down the ground, horses intubated and connected to anesthesia machine and anesthesia was continued with isoflurane. Caudo-medial approach for Mc-II and caudo-lateral approach for Mc-IV was performed under general anesthesia on lateral recumbence. Flunixin meglumine (1 mg/kg, IV) injections were performed on all horses for 3 to 5 days following surgery. Conservative bandages were done to the horses for 7 to 14 days. The recovery period was determined as the period of time in which the horses could trot in a healthy way after they were put in stall rest following the operation.

## Results

Study materials were composed of 4 Thoroughbreds and 1 Arabian horse of different ages and sexes. The mean age of the horses was 4.5 (ranged between 3-7 years). Four of the cases were male (80%) and the resting one was female (20%). Fractures were occurred related to kicks in 3 (case 2, 4, 5) cases and aetiology was unknown in 2 (case 1, 3). Fractures were localized to the distal part of the bone in 4 cases (case 1-4) and diaphysis in one case (case 5) (Figure 2). All of the distal fragments were surgically removed with the limited open approach.

**Table 1.** Clinical data of cases in this study.

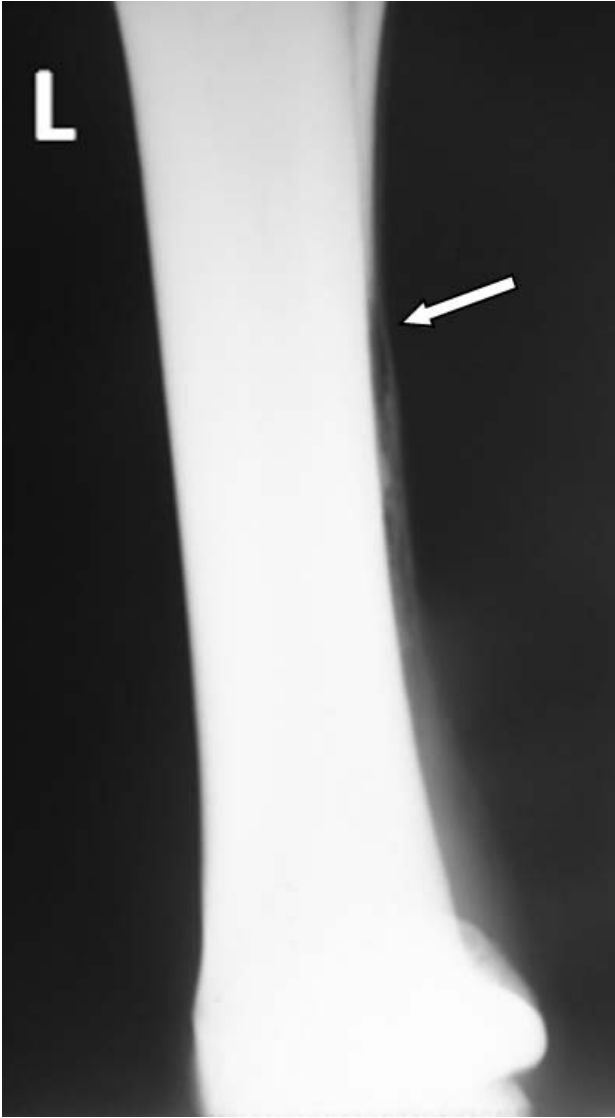
Case no.	Breed	Age/Gender	Bone	Localization
1	Thoroughbred	3/male	Mc II	Distal 1/3
2	Thoroughbred	3.5/male	Mc IV	Distal 1/3
3	Thoroughbred	7/male (castrated)	Mt IV	Distal 1/3
4	Thoroughbred	5/female	Mc II	Distal 1/3
5	Arabian	4/male	MC II	Diaphyseal



**Figure 1.** Preoperative oblique radiography of case 1. The white arrow: Fracture side of splint bone and a callus formation observed in chronic period.



**Figure 2.** Preoperative lateral radiography of case 5. The white arrow: A callus formation observed in chronic period.



**Figure 3.** Postoperative oblique radiography of case 1.



**Figure 4.** Postoperative lateral radiography of case 5. The white arrow: Blunted end of proximal fragment.

In clinical examination, all cases were lame when walking and reluctant to run. The pain was observed in palpation and nerve block was carried out for the differential diagnosis of distal region problems. The mean lameness score of the horses was 2 over 5 (1 to 3). Because all fractures were acute, there was no exuberant callus interfered with the suspensory ligament.

Because the surgical approach to the splint bones is safe and no obvious bleeding was observed during and after surgical removal of the fractured bones. Following removal of the fragments, sharp ends of the remaining bones were blunted with roungeurs in all cases. Closure of the skin and subcuticular tissues were done routinely. After the removal of the fragment (Figure 3, 4), exercise restriction and soft padded bandage applications were performed for two weeks postoperatively. After 20 days postoperatively, controlled walking exercises were

performed twice daily and at the end of the first-month functional limb activities were observed in all of the horses. In the final clinical follow-ups no observable pain or lameness was achieved any of the cases. According to long-term telephone questionnaires made 6 months after discharge, all clients were satisfied with the results.

### Discussion and Conclusion

Splint bone fractures are usually seen in forelimbs (1-3, 5, 7, 9, 15-17) and Mc-II, because Mc-II directly supports the load of the second carpal bone. Eighty percent of the fracture cases in present study were seen in metacarpals which support the previous reports. However, there are studies reporting that metatarsal fractures, especially Mt-IV, are observed more frequently (6, 23). Therefore, it would not be right to talk about a special predisposition.

The main cause of the splint bones is direct trauma and hyperextension injuries but in racehorses, acute overload takes an important role in the etiology (2, 5, 18-21). The most common type of fracture is the fractures localized to the distal region. In this study, distal splint bone fractures constituted 80% of the cases. Although most reported etiology for these fractures is external trauma such as kicking, usually uncomplicated closed fractures are encountered.

Two types of treatment options have been reported for distal fractures which are conservative and surgical treatments, respectively (8, 10, 12-14). Different fractures of forearm bones in foals can be treated with modified Thomas splint applications (11). Suspensor desmitis risk is mentioned as a complication after both treatment options. In addition, in cases where a comminuted fracture is formed in the splint bone, exuberant callus formation caused by excessive movement in the fracture line are also mentioned (8, 10, 12-14). In the long-term, excessive exuberant callus compresses the surrounding soft tissues and results with local pain and lameness. In the distal region fractures, because the bone is not thick enough to allow internal fixation, bone plating is not possible as in proximal fractures. Therefore, the best option for distal fractures is to remove the free distal fragment with a minimal invasive limited open surgical approach (8, 13, 14). Considering the risks mentioned above, we performed the amputation of the free distal fragment in all cases and did not encounter complications such as suspensory desmitis or exuberant callus formation due to early admission to the clinic. In this study, complications such as osteomyelitis or sequestration were not encountered since all fractures in this study were closed fractures and the patients were brought to the clinic in a short time following the formation of the fractures.

Open fractures are most frequently observed in the proximal region and osteomyelitis is inevitable in cases that early intervention is not performed. After the bone infection takes shape, both the treatment to be performed is more difficult and the possibility of the patient regaining his old athletic performance decreases (8, 9, 19, 23, 24). Long-term administration of antibiotics following sequesterectomy may not always result in a successful recovery. Therefore, open fracture cases should be intervened as soon as possible. Meticulous lavage is a must after shaving, asepsis and antisepsis of the area. After each application, the area should be taken into wet dressing in order to protect it from external factors, and the patient owners should be informed that the treatment period may be prolonged (6, 8, 13, 20).

In conclusion, splint bone fractures, especially in the distal region, can be successfully treated with early intervention and minimally invasive surgery. In cases where conservative treatment will be tried, possible

suspensor ligament desmitis and the risk of exuberant sequestration should always be considered.

### Finacial Support

This research received no grant from any funding agency/sector.

### Ethical Statement

This study does not present any ethical concerns.

### Conflict of Interest

The authors declared that there is no conflict of interest.

### References

1. **Alan JN** (1996): *Equine Fracture Repair*. W.B. Saunders Company, Philadelphia.
2. **Allen D, White N** (1987): *Management of fractures and exostosis of the metacarpals and metatarsals II and IV in 25 horses*. *Equine Vet J*, **19**, 326–330.
3. **Auer JA** (1992): *Equine Surgery*. W.B. Saunders Company, Philadelphia.
4. **Barrett MF, Manchon PT, Hersman J, et al** (2018): *Magnetic resonance imaging findings of the proximal metacarpus in Quarter Horses used for cutting: retrospective analysis of 32 horses 2009–2012*. *Equine Vet J*, **50**, 172-178.
5. **Bowman K, Fackelman G** (1982): *Surgical treatment of complicated fractures of the splint bones in the horse*. *Vet Surg*, **11**, 121–124.
6. **Derrungs SB, Fürst AE, Hassig M, et al** (2004): *Frequency, consequences and clinical outcome of kick injuries in horses: 256 cases (1992-2000)*. *Wien Tierarzts Mschr*, **91**, 114-119.
7. **Dietz O, Wiesner E** (1984): *Diseases of the Horse: A Handbook for Science and Practice Part 2/II*. Karger, Basel.
8. **Jackson M, Fürst A, Hassig M, et al** (2007): *Splint bone fractures in the horse: a retrospective study 1992-2001*. *Eq Vet Edu*, **19**, 329-335.
9. **Jenson PW, Gaughan EM, Lillich JD, et al** (2003): *Splint bone disorders in horses*. *Comp Cont Educ Pract Vet*, **25**, 383–389.
10. **Jenson PW, Gaughan EM, Lillich JD, et al** (2004): *Segmental ostectomy of the second and fourth metacarpal and metatarsal bones in horses: 17 cases (1993-2002)*. *J Am Vet Med Assoc*, **2**, 271-274.
11. **Ladefoged S, Grulke S, Busoni V, et al** (2017): *Modified Thomas Splint-cast combination for the management of limb fractures in small equids*. *Vet Surg*, **46**, 381-388.
12. **Lutter DJ, Cary JA, Stephens RR, et al** (2015): *Relative stiffness of 3 bandage/splint constructs for stabilization of equine midmetacarpal fractures*. *J Vet Emerg Crit Care*, **25**, 379-387.
13. **Mageed M, Steinberg T, Drumm N, et al** (2018): *Internal fixation of proximal fractures of the 2nd and 4th metacarpal and metatarsal bones using bioabsorbable screws*. *Aust Vet J*, **96**, 76-81.
14. **Mudge MC, Bramlage LR** (2007): *Field fracture management*. *Vet Clin North Am Equine Pract*, **23**, 117-133.

15. **Nixon AJ** (1996): Equine Fracture Repair. W.B. Saunders Company, Philadelphia.
16. **Peterson PR, Pascoe JR, Wheat JD** (1987): *Surgical management of proximal splint bone fractures in the horse*. Vet Surg, **16**, 367–372.
17. **Preez P** (1994): *Fractures of the small metacarpal and metatarsal bones (splint-bones)*. Equine Vet Educ, **6**, 279–282.
18. **Richardson DW** (1990): Fractures of the small metacarpal and metatarsal bones. In: White C, (Ed). Current practice in equine surgery. JB Lippincott, Philadelphia, pp: 636–641.
19. **Ross MW, Dyson SJ** (2003): Diagnosis and Management of Lameness in the Horse. Elsevier Science, St. Louis.
20. **Ruben JR, David RH** (2000): Manual of Equine Practice. Second Edition. W.B. Saunders Company, London.
21. **Ruben JR, David RH** (2007): Klinik Pratikte At Hekimliđi. Editör: Arda SANCAK ve Mehmet SAĐLAM, Medipres. Malatya.
22. **Seabaugh KA, Hubert JD, Kawcak C, et al** (2012): *Effect of sequential removal of parts of the second metacarpal bone on the biomechanical stability of the equine carpus*. Vet Surg, **41**, 862–868.
23. **Stashak TS** (2002): Fractures of the small metacarpal and metatarsal (splint) bones. 821-826. In: Lippincott Williams & Wilkins (Eds) Adams' Lameness in Horses. 5<sup>th</sup> ed, Philadelphia.
24. **White C** (1999): Second and fourth metacarpal and metatarsal fractures.1594–1604. In: Colahan PT, Merritt AM, Moore JN et al, (Eds). Equine medicine and surgery. Mosby, Baltimore.