Double DCP Fixation for the Spiral Tibial Fracture of a Racehorse

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Plate fixation was conducted in a 3 year old male Thoroughbred racehorse (480 kg) for a spiral undisplaced fracture of the tibia. The fracture line spirally occupied approximately two-thirds of the bone. The horse was anesthetized with sevoflurane and oxygen and placed in dorsal recumbency. Two dynamic compression plates (DCP) were applied on the cranio-lateral and cranio-medial sides. Histopathological examination revealed active callus formation and remodeling on the fracture line 180 days after the surgery. Based on these findings, it was concluded that good synostosis was achieved. Therefore, it was suggested that DCP fixation based on the present technique can be applied to adult horses with undisplaced or minimally displaced fractured tibia to prevent their developing a completely displaced fracture.

Key words: adult horse, double DCP fixation, tibial fracture

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The efficacy of conservative therapies for horses with incomplete tibial fractures [8] has been poor. In the case of young horses, internal fixations are frequently performed [7, 10]. However, these techniques are less successful in adult horses [1, 2]. For obvious reasons, in clinical cases, histopathological examinations have not been reported after surgical treatment has been performed. We conducted internal fixation using double dynamic compression plates (DCP) on a racehorse with the spiral undisplaced tibial fracture, and observed the postoperative outcome to evaluate the healing of the fracture through histopathological examination.

The subject, a male, 3-year-old, 480-kg Thoroughbred racehorse developed a severe lameness on the left hind leg during training. Radiographic examination revealed an incomplete fracture of the tibia. The fracture line extended spirally from the proximal lateral tibial ridge, distally through the caudal side, then to the medial side, accounting for approximately two-thirds of the bone. The horse was kept in box rest under close observation. Radiographic examination performed 10 days later revealed minimally dehiscence of the fracture line at the

proximal site (Fig. 1). Internal fixation was then recommended.

Following sedation with 1.0 mg/kg of xylazine intravenously, induction of anesthesia was achieved by administration of 400 ml of 10% glyceryl guaiacolate solution mixed with 2 g of thiopental sodium. Anesthesia was maintained by the administration of sevoflurane-oxygen through endotracheal intubation, and the horse was positioned in dorsal recumbency. Twenty minutes after the anesthetic treatment, dobutamine was intermittently administered with lactated Ringer's solution at 10 ml/kg per hour to maintain the mean arterial pressure at or above 70 mmHg.

Based on Bramlage *et al*'s method [1], a 40 cm skin incision was made over the medial border of the cranial tibial muscle, extending from the lateral patellar ligament to the hock. The incision was extended through the inner crural fascia to identify the tibia. The periosteum was incised along the tibial fascia line (tibial crest). The dissection was extended on the medial and lateral aspect of the tibial crest to expose the proximal tibia and the fracture line. The length and shape of the medial plate (4.5 mm broad DCP, 12 holes) was determined through the use of a bending plate. The medial plate was fixed with 5.5 mm cortical screws and applied as a compression

Fig. 1. Lateral view of the left tibia at 10 days after fracture (arrows).

Fig. 3. Lateral view of the left tibial at 90 days after surgery. Complete healing without abnormal periosteophytes.

Fig. 2. The positions of the DCPs and Lag Screw are illustrated.

plate. The lateral plate was placed similarly after lateral retraction of the cranial tibial muscle and extensor digitorum longus muscle. Finally, the semitendinosus muscle tuberosity was fixed with a 4.5 mm cortical screw (Fig. 2). After the cranial tibial muscle was repositioned, the inner crural fascia and subcutaneous tissue were closed with absorbable sutures, while the skin was closed with a non absorbable suture. The surgical time was six hr and 20 min. The fractured limb was bandaged from the hoof to the patella. Post operatively, the horse was administered 4.5 mg/kg of phenylbutazone and 1.1 mg/kg of flunixin meglumine every 24 hr as anti-inflammatory and analgetic agents for five days, and 22 mg/kg of cephalothin and 1.3 mg/kg of gentamicin post operatively every 12 hr for five days.

Serosanguinous discharge was observed from the incision three days after surgery, and partial (10 cm) skin dehiscence followed. The incision healed by second intention with local treatment within 30 days of surgery. Pain gradually subsided so the horse could trot without lameness 60 days after the operation. Radiographic evaluation 90 days after surgery showed complete healing without abnormal periosteophytes (Fig. 3). No other anomalies were observed post operatively.

The horse was submitted to a necropsy 180 days after

Fig. 4. Macroscopical finding of the tibia deprived of osteophytes on the DCPs 180 days after the operation.

Fig. 5. Showing the soft X-ray finding of the cross section of tibia at diaphysis. Much linear or punctiform new bone formation was observed, suggesting active remodeling of the cortical bone at the fracture site.

the operation. Gross evaluation revealed that the callus and osteophyte at the caudal diaphysis of the proximal tibia and the fixed plates were covered by new periosteal bone (Fig. 4). Upon examination of the tibia at mid-diaphysis, periosteal reaction was found to be 0.5 to 1.5 cm in thickness, and the fracture line was difficult to identify macroscopically. In addition, radiographic evaluation of the tibia revealed mineralization, at the mid-diaphysis, of the lateral periosteum similar to that on the cortical bone. Much linear or punctiform new bone formation was observed, suggesting active remodeling of the cortical bone at the fracture site (Fig. 5). Histopathological examination confirmed that periosteal reaction formed on the surface of the tibia and around the plates. Periosteal reaction protruded irregularly into the connective tissue over the thickened lateral periosteum, and there were large and juvenile osteocytes in the bone collagen fiber extending radially in the direction of the lateral periosteum. How ship lacunae were found to be scattered, whereas very few osteons exhibited lamellar structures (Fig. 6). No clear dystrophic necrosis or inflammation was observed on the osteophytes adjacent to the plates. The normal area of the cortical bone was characterized by concentrically arranged osteons with uniform dimensions, while irregular osteons with different dimensions concentrated

around the area of the fracture. These findings indicate that callus remodeling was largely complete (Fig. 7).

Using conservative therapy, approximately 50% of incomplete tibial fractures in racehorses tend to progress to severe complete fractures [8]. Because internal fixation of tibial fractures is difficult in adult horses and operative failure occurs during recovery from anesthesia, the current recommendation for management of incomplete tibial fractures is stall rest with frequent radiographic examination. Surgery is performed only if displacement occurs. In the present case, internal fixation was selected because displacement of the proximal fracture line was confirmed 10 days after the injury. Dorsal recumbency was selected because it was believed that it is effective in preventing myopathy of the shoulder muscles.

There are three possible approaches for internal fixation repair of a tibial fracture: the medial side, lateral side, and cranio-medial approach [1, 6]. However, approaches from the medial and lateral sides are not recommended. The medial approach gives poor soft tissue coverage of the plates and soft tissue, and poor exposure of the lateral aspect of the tibia [11]. The lateral approach gives good soft tissue coverage of the plates, but gives limited exposure of the tibia and requires that

Fig. 6. H.E. stained thin ground section. X24, showing callus formed on the tibia surface. Periosteal reaction protruded irregularly into the connective tissue over the thickened lateral periosteum, and there were large and juvenile osteocytes in the bone collagen fiber extending radially in the direction of the lateral periosteum.

Fig. 7. H.E. stained thin ground section. X24, showing the tissue on the fractured site. Irregular osteons with different dimensions concentrated around the area of the fracture. These findings indicate that callus remodeling was largely complete.

the anterior tibial artery and peroneal nerve be identified and separately protected. Therefore, the cranio-medial approach is preferred [1]. Based on these facts, we decided to approach the fractured area through the cranial tibial fascia. This technique did not damage the muscular tissue surrounding the tibia, gave good exposure to the cranio-medial and cranio-lateral aspects of the tibia, and facilitated insertion of the plates. Furthermore, the fact that no plate was positioned just under neath the sutured skin effectively prevented the spread of bacterial infection from the skin dehiscence to the fracture site. We did not apply any external fixation, except for a support bandage during the anesthetic recovery period, in light of the high risk of secondary fracture due to changes in tension sites of the tibia associated with biomechanical changes from the placement of a cast on the tibia [4].

The histopathological findings of the present case suggest the following: no clear osteon structure was identified in the osteophytes formed around the plates or over the fracture site. How ship lacunae due to

osteoclast were found to be scattered, suggesting that remodeling had begun. Only bone resorption was observed on some external periosteal surfaces of these osteophytes. This observation indicates that bone formation had been induced by resorbing the emerged osteophytes. In many of the fracture lines on cortical bones, callus was replaced or supplemented by irregular osteons, suggesting that remodeling was largely complete. Based on these histopathological findings, it is suggested that the active remodeling of the fracture site promoted favorable fracture healing.

It is known that closed tibial fractures recover during a period of 90–150 days in young horses [11]. The present case showed histopathologically good remodeling 180 days after the fracture. In addition, it was possible to impose a mild exercise load in 60 days. These findings suggest that adult horse tibial fractures may also recover in 90–150 days. However, the continuous drainage from the postoperative wound suggested that the use of drains should be considered. Large torsional and axial compressive forces on the horse tibia are considered to cause tension on the cranio-lateral aspect of the proximal and mid diaphysis, and on the cranial aspect of the distal

diaphysis [1, 4, 8]. The present technique established the positions for the internal plates based on the internal fixation and the tension-band principle [2, 3, 5, 6, 10, 11]. We concluded that the technique used in this horse is applicable to adult horses with fractured tibia, and it should be considered in the management of horses with incomplete tibial fractures.

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References

1. Bramlage, L.R. and Hanes, G.E. 1982. Internal fixation of a tibial fracture in an adult horse. *J. Am. Vet. Med. Assoc.* 180: 1090–1094.
2. Denny, H.R. 1978. Papers and Articles. *Vet. Rec.* 102: 273–277.
3. Perren, S.W. 1973. Developments of compression plate techniques for internal fixation of fractures. *Prog Surg.* 12: 152–179.
4. Schneider, R.K. *et al.* 1982. Multidirectional *in vivo* stain analysis of the equine radius and tibia during dynamic loading with and without a cast. *Am. J. Vet. Res.* 43: 1541–1550.
5. Turner, A.S., Milnc, D.W., and Gabel, A.A. 1976. Use of the dynamic compression plate for treatment of equine long-bone fractures. *J. Am. Vet. Med. Assoc.* 168: 308–315.
6. Turner, A.S. 1984. Large animal orthopedics. pp. 768–949. *In: The Practice of Large Animal Surgery*, vol. II (Jennings, P.B. ed.), W.B. Saunders, Philadelphia.
7. Wagner, P.C., DeBowes, R.M., Grant, B.D., Kaneps, A.J., and Watrous, B.J. 1984. Cancellous bone screws for repair of proximal growth plate fractures of the tibia in foals. *J. Am. Vet. Med. Assoc.* 184: 688–692.
8. Watkins, J.P. 1996. Chapter 27. Fractures of the tibia. pp. 273–283. *In: Equine Fracture Repair* (Nixon, A.J. ed.), W.B. Saunders, Philadelphia.
9. Wright, I.M. 1995. Surgical treatment of the tibial tuberosity in 6 adult horses. *Equine Vet. J.* 27: 96–102.
10. White, N.A. 1982. Use of a bone plate for repair of proximal physeal fractures of the tibial in two foals. *J. Am. Vet. Assoc.* 181: 252–254.
11. Young, D.R., Richardson, D.W., Nunamaker, D.M., Ross, M.W., and Tulleners, E.P. 1989. Use of dynamic compression plates for treatment of tibial diaphyseal fractures in foals nine cases (1980–1987). *J. Am. Vet. Assoc.* 194: 1755–1763.