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Management of tibial diaphyseal fractures with linear external skeletal fixators using carbon connecting rods in dogs

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ABSTRACT

Dogs (12) with unstable tibial diaphyseal fractures, selected for this study, were stabilized with bilateral uniplanar Type II external skeletal fixators using stainless steel positive profile centrally threaded transfixation full pins, 2-way AO clamps and indigenously designed carbon fiber rods. Clinical lameness evaluation and radiographic evaluation for fixator stability, fragment alignment and callus formation were studied. Post-operatively, no breakage or bending of the carbon fiber rods was seen throughout the fixation period. Fixator staged disassembly and complete removal was done on an average 4–9 weeks in all cases which showed grade I lameness after removal. Complications like pin tract infection, wound at suture site due to wound dehiscence and wound at pin-skin interface were seen, which subsided later without any affect on bone healing. Lameness grading, pain score and radiographic evaluation of healing were estimated in all the cases throughout the fixation period. ESF using carbon fiber connecting rod appears as a practicable method for repair of tibial diaphyseal fractures with minimum risk of fixator destabilization. Fixator staged disassembly at 4 weeks accelerated bone healing and promoted earlier limb function.

Key words: Carbon connecting rod, Dog, External skeletal fixator, Tibial diaphyseal fractures

The aim of fracture treatment is to achieve the fastest possible healing, to restore anatomical shape of a fractured bone and enable the animal to function normally by allowing early walking. External fixators are used in many types of long bone fractures. Because limb fractures are often open fractures, it is recommended to use external fixator in place of invasive methods (Johnson 1999). Use of external fixators is suggested for multiple fractures, comminuted ones, fractures with bone loss, infected fractures, fractures caused by firearms, non-unions or hypertrophic and atrophic bone mal-unions, corrective osteotomies (Johnson *et al*. 1996). Tibial diaphyseal fractures, more frequent in juvenile animals compared to adult animals because of their aggressive nature (Boone *et al*. 1986), are effectively repaired using external skeletal fixators. Type II frames (bilateral with connecting rods) can be easily applied to the simple, comminuted, infected and nonunion tibial fractures and they provide rigid stabilization in most cases and are 100% stiffer and successful compared to Type I external fixators in comminuted tibial fractures. Not much clinical research was reported on the use of carbon fiber bars as connecting rods but only biomechanical study has been carried out to some extent up to date. The purpose of this study was to evaluate the outcome of these fixators using carbon fiber connecting rods for tibial diaphyseal fractures in dogs.

MATERIALS AND METHODS

Dogs (12) of unstable tibial diaphyseal fractures were selected to study the fracture stabilization technique and were fixed with bilateral uniplanar Type II external skeletal fixators using stainless steel positive profile centrally threaded transfixation full pins, 2-way AO clamps and indigenously designed carbon fiber rods as frame components (Fig. 1). Carbon fiber connecting bars corresponding to the body weight of the dogs were selected and used in the study. A rod size of 4 mm was used for dogs weighing less than 12 kg and a carbon fiber rod of 6.3 mm was used for dog weighing between 12 and 25 kg.

After premedication with atropine sulphate (0.02 mg/kg subcutaneously) and xylazine hydrochloride (1 mg/kg IM), anaesthesia was induced with diazepam (0.25 mg/kg IV) along with ketamine hydrochloride (5 mg/kg IV) and maintained with isoflurane. The animals were positioned in lateral recumbency after anaesthesia and the limb was suspended to ceiling vertically for muscle relaxation and overridden fracture fragments were reduced and kept in alignment with traction and counter traction. With the help of a low power driller (150 rpm), 4 pilot holes were placed from medial to lateral side by taking care of the regional

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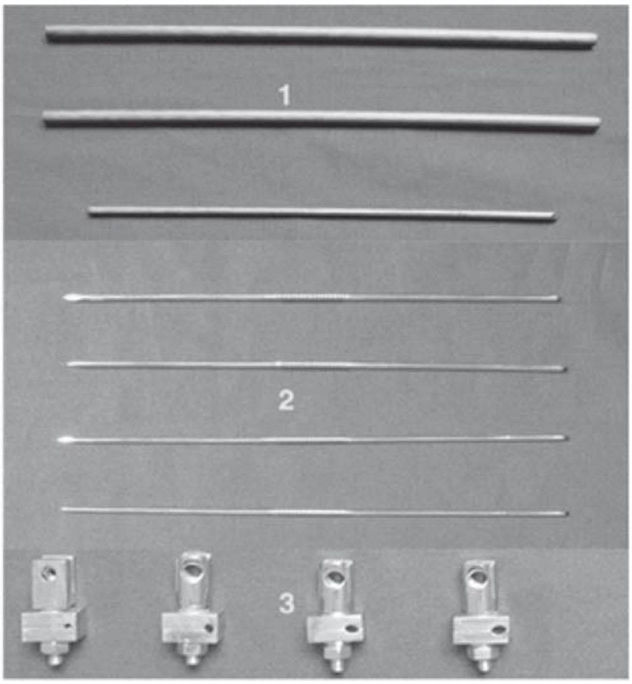

Fig. 1. External skeletal fixator components. 1, Carbon fiber connecting rods (6.3mm and 4mm); 2, centrally threaded trans fixation pins (3mm and 2.5mm); 3, connecting 2-way AO clamps.

anatomy so that vessels, nerves and large muscles were avoided. Then the pins were placed in those drilled slots and assembled with AO clamps and connecting rods. After application of the ESF, the entire limb was wrapped by padded bandage preferably using non-absorbent cotton to avoid

Fig. 2. Tibial diaphyseal fractured limb on day 1 after application of linear external skeletal fixator using 4 mm carbon connecting rod.

Table 1. Mean ±SE values of pain score evaluated in 12 dogs in post-operative days

Days	Pain score
1^{st} day	8.91± 0.43^{a}
7^{th} day	5.57±0.27^{b}
14^{th} day	6.61±0.51^{a}
28^{th} day	3.49 ± 0.49^{b}
45^{th} day	1.16 ± 0.35^{a}
60^{th} day	0.58 ± 0.41^{b}

contamination. The suture site was cleaned with 1% povidone-iodine and the pin insertion sites were irrigated with normal saline with an alternate day bandaging. Cefotaxime (25 mg/kg intravenously for 5 days) and meloxicam (0.2 mg/kg for 3 days) were administered. Restricted movement was advised to enhance early bone healing.

RESULTS AND DISCUSSION

Based on the body weight of the dogs, different sizes of carbon fiber connecting rods were used that did not showed any bending or breakage throughout study period. No technical difficulties were encountered while application of Type II maximal (positive profile centrally threaded full pins) constructions of fixators in all the dogs. Pre-drilling a pilot hole (less than the diameter of the shank of the pin) provided satisfactory application of transfixation pins.

Lameness grading: Pre- and post-operatively lameness grading were recorded based on weight bearing. All the animals pre-operation showed grade V lameness before surgical stabilization of the fracture. Use of centrally-threaded full pins and rigid light weight carbon fiber rods in all the dogs facilitated post-operation weight bearing with grade I lameness (Fig 2) except in 1 case, which showed

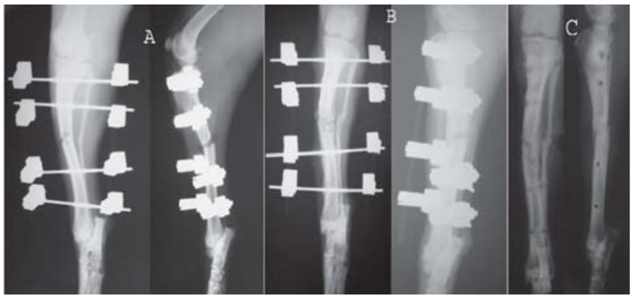

Fig. 3. Radiographic evaluation. (A) Immediate post-operative, (B) 5 weeks post-operation and (C) healed fracture 7 weeks post-operation.

Fig. 4. Grade 1 lameness 7 weeks post-operation after fixator removal.

Grade II lameness after 3 weeks with pin tract infection but it did not affect the healing.

Pain score: Higher mean values (P<0.01) of University of Melbourne pain score in all 12 animals between 0 day and 15th post operative day and lesser values on 60th day in all 12 cases were observed (Table 1). Significantly lesser values (P<0.01) on 60th post operative day indicated Type II external skeletal fixator with carbon connecting rods providing good stability on tibial diaphyseal fractures.

Radiographical evaluation: The radiographic evaluation of fracture site regarding implant position, fragment alignment and callus formation in immediate postoperative stage, after 3 weeks, 5 weeks, 7 weeks and 9 weeks in 12 dogs was studied. The overall healing time in all the dogs was noticed during 4–10 weeks except delayed healing and periosteal callus formation was seen in case with pin tract infection. Excellent healing was noticed radiographically with absence of fracture lines with endosteal callus or bridging callus (Fig. 3). Post-operation radiographical evaluation did not show any pin migration or frame destabilization.

Complications: Slight pin tract infection, wound at suture site and wound at pin-skin interface were observed in 3 cases respectively. As a result, case with pin tract infection showed delayed healing, whereas the other 2 cases were subsided without any affect on bone healing.

External skeletal fixator removal: Diassembling and complete removal of external skeletal fixators was done between 4–9 weeks post operatively after confirming radiographic appearance of cortical union (Fig. 4). All the cases and all the dogs showed grade I lameness after removal.

Limited information is available as published data in describing the use of carbon fiber rods for stabilization of tibial fractures in dogs. Pain was evaluated based on University of Melbourne pain score (UMPS) (Firth and Haldane 1999) and lameness grading was recorded according to Vasseur *et al. (*1995). Type II external skeletal fixators comprising maximal frames were applied in a closed manner in 5 tibial diaphyseal fracture cases to prevent intervention of the fracture site and in seven cases the fixators were applied with open reduction. Closed reduction helped in minimizing the disruption of the fracture site that supported biological osteosynthesis (Johnson *et al*. 1996). Pre-drilling a pilot hole (less than the diameter of the shank of the pin) facilitated easy and perfect placement of pins while assembling external skeletal fixators (Johnson and Simon 1988). Pin loosening was not noticed with centrally threaded pins which facilitated perfect stabilization of fractured bone fragments (Kraus *et al*. 1998, Aronsohn and Burk 2009). The comminuted fractures showed complete cortical union with periosteal and bridging callus within 5–9 weeks and in others 4–7 weeks.

Carbon fiber rods showed superior mechanical performance when compared to stainless-steel connecting rods (Kowalski *et al*. 1996, Migliaresi *et al*. 2003, Radke *et al*. 2006, Johnson and Schaeffer 2008). Carbon rods are light weight and rigid, which helped in early weight bearing and it was suitable for steam sterilization (Migliaresi *et al*. 2003). Radiolucent property of carbon fiber connecting rods enabled better visualization of the fractured site in assessing bone healing mainly when radiographed in medio-lateral view by preventing overlapping of the rods. Even though carbon fiber is an expensive orthopaedic material, the ability to reuse the rods further reduce their cost, making it amicable to use in Veterinary practice (Robbins *et al*. 2012).

REFERENCES

Aronsohn M G and Burk R L. 2009. Unilateral uniplanar external skeletal fixation for isolated diaphyseal tibial fractures in skeletally immature dogs. *Veterinary Surgery* **38**: 654–58.

Boone E G, Johnson A L, Montavon P and Hohn R B. 1986. Fractures of the tibial diaphysis in dogs and cats. *Journal of American Veterinary Medical Association* **188**: 41–45.

Firth A M and Haldene S L. 1999. Development of a scale to evaluate postoperative pain in dogs. *Journal of American Veterinary Medical Association* **214**: 651–59.

Johnson A L, Seitz S E, Smith C W, Johnson J M and Schaeffer D J. 1996. Closed reduction and Type II external fixation for comminute fractures of the radius and tibia in dogs: 23 cases (1990–1994). *Journal of the American Veterinary Medical Association* **209**: 1445–48.

Johnson A L and Schaeffer D J. 2008. Evolution of the treatment of canine radial and tibial fractures with external fixators. *Veterinary Comparative and Orthopaedic Traumotology* **21**: 256–61.

Johnson A L. 1999. Management of open fractures in dogs and cats. *Waltham Focus* **9** (4): 11–17.

Johnson K A and Simon C. 1988. Use of an aiming device for application of a type -II (bilateral) external fixator to a fractured tibia of a dog. *Journal of the American Veterinary Medical Association* **192**: 1573–76.

Kowalski M, Schemitsch E H, Harrington R M, Chapman J R and Swiontkowski M F. 1996. Comparative biomechanical evaluation of different external fixation sidebars: stainless-steel tubes versus carbon fiber rods. *Journal of Orthopaedic Trauma* **10** (7): 470–75.

Kraus K H, Wotton H M, Boudrieau R J, Schwarz L Diamond D and Minihan A. 1998. Type-II external fixation using new clamps and positive-profile threaded pins for treatment of fractures of the radius and tibia in dogs. *Journal of the American Veterinary Medical Association* **212**: 1267–70.

Migliaresi C, Nicoli F, Rossi S, and Pegoretti A. 2003. Novel uses of carbon composites for the fabrication of external fixators. *Composites Science and Technology* **64**: 873–83.

Radke H, Aron DN, Applewhite A, and Zhang G. 2006 . Biomechanical analysis of unilateral external skeletal fixators combined with IM-Pin and without IM-Pin using finite element method. *Veterinary Surgery* **35** (1): 15–23.

Robbins J, Gerlinger T L and Ward J A. 2012. Can the carbon fiber rods for the Hoffmann II external fixation system be reused? *The American Journal of Orthopedics* **41**(12): 551–53.

Vasseur P B Johnson A L Buder berg S C Linwln J B Toombs J P Whitebain J G and Lent E L. 1995. Randomized controlled trials of the efficiency of carprofin, a non steroidal anti – inflammatory drug in the treatment of osteoarthritis in dog . *Journal of American Veterinary Medical Association* **206**: 807–11.