

A new approach for tibiotarsal fractures in falcons with the FixEx tubulaire

Type F.E.S.S.A system

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Abstract: Tibiotarsal fractures are very common fractures in birds. In 5 falcons which were presented at the Abu Dhabi Falcon Hospital tibiotarsal fractures were diagnosed. A combined fixation, the so-called hybrid fixation or “tie-in” method with intramedullary pin and external skeletal fixators was used in all cases in the same way for the fracture repair. The FixEx tubulaire Type F.E.S.S.A. fixation bar system was tried to achieve an improved fracture healing and enable better weight bearing of the fractured legs. All falcons were able to stand on the operated leg within 30-60 minutes after surgery with full weight. The fractures showed callus formation within 7-14 days post operatively in the radiographic examination. The fractures healed uneventfully in 28 to 40 days. All falcons showed full function of the operated legs after surgery without any time delay. The advantage of the FixEx tubulaire Type F.E.S.S.A. system is the easy use, light weight, flexibility of the size and holes of the bars for the realignment of the bones, the possibility of partial pin removal or partial connection. The result of this study may suggest that this system is very well suitable for all different kinds of fracture repair in falcons and other birds as well as in other animals species like exotics or small animals.

Keywords: fracture, tibiotarsus, falcon, “tie-in” method, FixEx tubulaire Type F.E.S.S.A. system

Introduction

Tibiotarsal fractures in falcons are a common fracture type frequently experienced during the training and hunting period from September to April. Routine orthopaedic

approaches are intramedullary pin fixation, external fixations with Technovit® and/or cerclage wires. The main problems in fixing these fractures are the heavy weight of the fixation bars in external fixations and rotation of intramedullary pins. The other problem is that a partly removal of the pins is difficult as it affects in most cases the stability of the fractures. The purpose of this case report was to study and improve the orthopaedic method for tibiotarsal fractures in falcons. Therefore the FixEx tubulaire Type F.E.S.S.A. system (figure 1) from medical solution GmbH from Switzerland was used in 5 similar tibiotarsal fractures of falcons during the time period from October 16th to December 5th 2005. A combined IM pin and external skeletal fixation with the FixEx tubulaire Type F.E.S.S.A. system was performed in all cases (figure 2).

Material and Methods

Material

From October 16th to December 5th 2005, 5 first year female Gyr-Saker hybrid falcons (*Falco rusticolus* x *Falco cherrug*) were presented at the Abu Dhabi Falcon Hospital with the complaint of pain in one leg. The falcons were in good physical condition and their weight was above 1150g. X-Rays were performed on the legs of each falcon. The X-Rays revealed in each case a complete fracture of the tibiotarsus. 4 falcons had a fractured right leg and 1 falcon suffered from a fractured left leg. The fractures included a mid-shaft fracture, 2 oblique segmental fractures (figure 3) and 2 green stick fractures.

Methods

Anaesthesia and surgery preparation

All falcons were anaesthetized with Isoflurane (Aerrane™, Isoflurane USP, Baxter, USA). The initial flow rate for the anaesthesia induction through a gas mask was 5% Isoflurane which was reduced to the maintenance rate of 2.5-3% Isoflurane combined with Oxygen at 2-3 l/min. per min. The distal part of the limb was covered with sterile gauze and the exposed fracture area was cleaned with commercial prep solution containing 10% Povidone Iodine (Betadine® solution, Mundipharma AG, Basle, Switzerland) followed by Betadine® scrub (7.5% Povidone Iodine USP, Mundipharma AG, Basle, Switzerland) after complete plucking of the feathers.

Open fracture repair

In case of the 2 open fracture repairs, an incision of 4 cm was made using a medial approach and the muscle layers were carefully divided to reach the fractured bone ends. The intramedullary pin was inserted on the lateral condyles of the proximal tibiotarsus end and push down to the fracture site. Under sight, the intramedullary pin (3/16" (4.8mm), trocar point, Imex Veterinary Inc. Texas, USA) was put normograde into the distal medullary cavity of the fractured bone until the end of the bone marrow cavity of the distal tibiotarsus. Then the open wound was flushed with Piperacillin (Pipril® 1g, Hexal AG, Holzkirchen, Germany) and Aquopharm® Sodium chloride Ph Eur 0.9% (Animalcare limited, Dunnington, York, UK). The muscle layer was stitched with absorbable Vicryl 4/0® (Johnson&Johnson Intern., Brussels, Belgium) and the skin sutured with polyamide 6 monofilament non-absorbable suture Ethilon 3/0® (Johnson&Johnson Intern., Brussels, Belgium) in single mattress pattern.

Closed fracture repair

In case of the 3 closed fracture repairs, the intramedullary pin (3/16" (4.8mm), trocar point, Imex Veterinary Inc. Texas, USA) was inserted on the lateral condyles of the proximal tibiotarsus end and push down normograde to the fracture site. The fractured bone ends were held in correctly aligned position and the pin was carefully pushed through the fracture site until the end of the bone marrow cavity of the distal tibiotarsus.

External fixation

The lateral and medial area of the intended pin was disinfected again with 10% Povidone Iodine (Betadine® solution, Mundipharma AG, Basle, Switzerland). Then 1 external pin (1.8" (3.2mm), trocar point, Imex Veterinary Inc. Texas, USA) was carefully drilled proximal of the fracture site from lateral to medial through the bone while rotating the leg to the medial side like the non-fractured leg. Then a second external pin was placed distal of the fracture site in the same way. In the open fracture repair of case number 3, the external fixation was performed with 2 distal external pins. After insertion of the extramedullary pins, the IM pin was bent at a ninety degree angle to the long axis of the tibiotarsus. The external fixation of the pins followed by selecting the suitable fixation bars FixEx tubulaire M3 16 hole 6mmx46mm, FixEx tubulaire M3 24 hole 6mmx67mm and FixEx tubulaire 13 hole M4 8mmx97mm. The selected bars were fixed with hexagonal screws (figure 4).

Bandaging

The suture in the case of the open fracture repair and the pin entry area in all cases were disinfected with a sterile swab dipped in iodine solution (Betadine® solution,

10% Povidone Iodine, Mundipharma AG, Basle, Switzerland) and then Veterinary woundpowder® (Hayward and Bower Ltd., Crofton Drive, Lincoln, UK) was applied. The suture of the open fracture repair cases and pin areas in all cases were covered with low adherent absorbent non-adhesive dressing (Melolin, Smith&Nephew Medical Ltd, Hull, England) and bandaged with Sof-Kling conforming bandage™ (Johnson&Johnson, Arlington, Texas, USA) and adhesive bandaging tape 3M Vetrap™ (3M Health Care, Neuss, Germany).

The selection and use of the FixEx tubulaire fixation bar system in the single cases is described in table 1.

Results

Immediate post surgical result

All falcons received Marbofloxacin 10% injection im (Marbocyl®, Vétoquinol, Lure, Cedex, France) 0.1ml/kg BW BID as antibiotic coverage. An intravenous injection of 0.9% sodium chloride and glucose 5% (Vetivex® 3, Ivex Pharmaceuticals, Larne, UK) was administered with the amount of 10ml per falcons post surgical as well as a subcutaneous application of 40 ml compound sodium lactate (Hartmann's solution™, Baxter Healthcare Pvt Ltd, Toongabbie, Australia) was given. The non steroidal anti-inflammatory analgetique drug Tolfedine® 4% (Tolfenaminacid, Vétoquinol, Lure, Cedex, France) was applied in the dosage of 0.15ml/kg BW IM directly after surgery for the initial pain management. The falcons stood on both legs with equal pressure distribution approximately 24-48 hours after surgery. No lifting of the fractured leg was observed in any case.

Post-surgical management

In all cases, the antibiotic coverage with Marbofloxacin 10% injection (Marbocyl®, Vétoquinol) 0.1ml/kg BW BID was continued over a time period of seven days. For the enhancement of the wound healing, Traumeel® ad us. vet. and Zeel® ad us. vet. (Heel, Baden-Baden, Germany) were injected via subcutaneous route at a dose of 1.0ml per falcon daily for 2-3 days. The first radiographs (24x30 cm, Agfa™, Agfa-Gevaert, Belgium) were taken after 7 to 14 days postoperatively and then every 7-10 days later. Due to the fact that these falcons were not yet trained falcons and therefore very nervous and jumpy, they were kept on a sponge covered with artificial grass carpet on a square perch of 12.5 cm diameter and 25 cm height. Only the not fractured leg was tied with jesses. Moreover, the contralateral foot was protected from developing pressure sores with a soft shoe bandage. The food was fresh quail cut in small pieces to which 1.0ml calcium and vitamin D₃ supplement (Calcivet™, Vetafarm, Wagga Wagga, Australia) was added daily over a period of 3 weeks to support a faster callus formation. In case 1 and 2 a partial pin removal was performed on day 35 and 36 after surgery (figure 5). After the complete pin removal (figure 6), the falcons were kept another 7 days in the hospital without any medication to observe the healing process and proper motion. Before being discharged all falcons were radiographed again.

Immediately after their discharge from the falcon hospital, 4 falcons were sent back to intensive training and were used successfully for hunting within one to two months. The fifth falcon broke the leg again due to an accident.

Discussion

Tibiotarsal fractures in birds of prey are not a rare feature as the tibiotarsus is the most frequently fractured bone in raptors¹. Following the literature, the tibiotarsus is always fractured within 5mm of the distal end of the fibular crest due to a change in the cross-section of the bone from an almost triangular section formed by the reinforcement of the fibular crest to the round section of the tibiotarsus¹. This could not be observed in all 5 cases. The medial approach is preferred in tibiotarsal fractures¹ and was used in all open fracture repairs. Avian fractures usually heal rapidly within 3 weeks when the fracture site is correctly aligned and stabilised². The fact that the falcons in this study were young, untrained and very active birds contributed to a fracture healing within 28 to 40 days depending on the fracture type. Often radiographic visible callus can only be seen after 3 to 6 weeks although the callus is clinically palpable before³. This was not the case in all 5 falcons as their radiographs showed a clear callus formation within 7 to 14 days after surgery. In the case of the X-Rays taken after 14 days, the first callus formation most probably started already well before as the callus on the X-Ray was clearly visible. Due to the fact that the fractures were complicated in those 2 cases, the X-Rays were not taken earlier as a slower fracture healing was expected.

Nevertheless, the coincidence of receiving 5 falcons of the same species with very similar tibiotarsal fractures in a short time span was the prerequisite of the new orthopaedic approach. For birds below one kilo, a suitable fixation can be achieved with a type I fixator⁴. The combination of intramedullary pins with external skeletal fixators is well-known in mammals⁵ as well as in birds^{4,6,7}. Those combined fixations, also called hybrid fixation^{4,5,8} or “tie-in” method^{2,9} can be regarded as method of

choice for avian fracture repair⁸ and is recommended for birds above one kilo bodyweight. For them, tibiotarsal fractures are best to be fixed with a type II ESF with an intramedullary alignment⁴. Two fixation pins on each side of the fracture are ideal². Type IA hybrid external skeletal fixators have been successfully used in the tibiotarsal malunion correction¹⁰.

Other methods of fracture repair in avians have been described by use of thermoplastic casting material¹¹ or invasive methods like the use of plates¹². Complete rigidity as in plating methods have the disadvantage of primary bone healing and increased healing time^{5,6,7}. Other invasive methods like using bone cement involving polymethylmethacrylate^{13,14,15,16} to be filled in the bone marrow cavity might cause interference with callus formation. Moreover, methyl methacrylate and polypropylene rods have been used in all avian long bones except radius¹⁷. Normograde IM pinning and coaptation as well as polymethacrylate with either polypropylene or stainless steel shuttle pins have been used in the fracture repair of ulna and humerus¹⁸. The single use of external fixators (ESF) have often been used in avian fracture repair^{2,3,7,20,21} e.g. with the well-known Kirchner-Ehmer splints²². Intramedullary pins have been used without external fixation, but they can not withstand rotational or compressive forces^{3,23}. The external fixators have been fixed with acrylic materials as connecting bars²⁴ or acrylic material like Technovit®⁸. The problem of materials like Technovit® is not only the waiting time until it hardens, but also the development of a massive thermal increase during the hardening period thus leading to negative and possible damaging impact of tissues and bone of the fracture site. Moreover, the hardened Technovit® bar can not be partly removed or repositioned if required.

The FixEx tubulaire F.E.S.S.A. system has been used in wing fractures²⁵. Due to the very active nature of birds of prey, the system has been tested on the 5 tibiotarsal fractures to assess its use in birds of prey. For birds of prey, the perfect fracture healing with full function of leg and toes is very much required as otherwise they will not be able to catch prey. This applies not only for falcons used for hunting but also for wild falcons and birds of prey which will be rehabilitated and released. Therefore the requirements of a surgical fixation system of long bone fractures is light weight, easy application, early return to normal limb function, re-usability and cost-effectiveness.

One of the main advantages of the FixEx tubulaire F.E.S.S.A. system is its ability to be repositioned or partly removed without any disturbance of the pins or time delay. The order of the holes is arranged in horizontal and transversal direction which allows the placement of pins even in fracture parts in different angles. The diameter of the holes varies this allowing the use of different sized pins with proper fixation. Furthermore, this system helps in increasing the stability of the fracture as it can be placed very close to the skin due to its slim and elegant form. The tiny screws can be easily fixed with small screwdrivers and do not cause any obstacle for the bird from the medial or lateral side while perching or moving. This avoids even incorrect perching of the bird due to a massive bandage or screws or fixation bars touching the body.

Devices like Schanz screws²¹ have the disadvantage of the heavy weight. The fixation with Schanz screws and connecting bars of synthetics and aluminium joints used to reduce the weight of the fixation device still have a weight of 31.6g for a buzzard²¹ compared to 3.8g to maximum 11g of the FixEx tubulaire M3 24 hole and 11g of the

FixEx tubulaire M4 13 hole. The low weights of the fixation bars are even more important as the immediate postoperative weight bearing is desired to avoid problems of the contralateral foot⁴. Moreover, the fixation structure has to ensure the stability while weight bearing²¹. The direct weight bearing of the falcons postoperatively within 24-48 hours indicates also that the used FixEx tubulaire F.E.S.S.A. system helps to return to normal limb function extraordinarily fast due to its light weight and close proximity to the leg. Therefore no excessive bandaging is required thus preventing more inactivity of the bird and non acceptance of the bandage itself. The falcons stood with full pressure on the operated leg during the healing period and did not show any signs of reduced well being or picking of the bandage. Moreover, they even grabbed the chopped food with the operated leg in the same frequency like the healthy leg thus indicating a reduced pain postoperatively. This stands in positive contrast to other experiences where it took 4 months in a Cooper's hawk to regain full leg function after a proximal tibiotarsal fracture⁴.

The FixEx tubulaire F.E.S.S.A. system is very helpful in the repair of different avian fractures either for large or small birds due to different size of the bars. Moreover, it can be re-used and is therefore a cost-effective and long-lasting option which can even be used for other animal species like exotics or even small mammals. The light weight of the connector bars enables the birds to early weight bearing of the operated extremity. The flexibility of the FixEx tubulaire F.E.S.S.A. system allows part removal of pins depending of the healing process without disturbing the other remaining pins. Moreover, the different placement of the holes allows vertical and transversal placement of pins which might be useful in fractures with many comminuted bone pieces. It allows also the use of different sizes of pins due to the

varying diameters of the bar holes. The FixEx tubulaire F.E.S.S.A. system is a practical orthopaedic system which allows faster and more accurate fracture repairs.

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Product reference list

medical solution GmbH, Bannstrasse 16, 6312 Steinhausen, Zwitterland

Figures

Figure 1: Comparative view of the single fixation bars, screws and screw drivers of FixEx tubulaire F.E.S.S.A. system

Figure 2: Model of tibiotarsus with FixEx tubulaire F.E.S.S.A. system intramedullary pin 3/16" (4.8m) external pin 1/16" (1.6mm)

Figure 3: Case 1 before fracture repair

Figure 4: Case 1 after surgery with IM pin, 2 external pins and 2 external FixEx tubulaire fixation bars

Figure 5: Case 1 after partial pin removal on day 30 after surgery

Figure 6: Case 1 after pin removal on day 38 after surgery

Tables

Table 1: Orthopaedic fixation approach compared in the five cases

	Case 1	Case 2	Case 3	Case 4	Case 5
Type of fracture	Oblique segmental	Green stick	Oblique segmental	Mid-shaft	Green stick
Open/closed surgical approach	open	closed	open	closed	closed
No of days till start of callus formation	14*	8	7	13*	7
No of days till first pin removal	36	35	30	28	28
No of days till final pin removal	40	40	30**	28**	28**
Days in treatment incl. 7 days aftercare	45	48	36	34	34
Intramedullary pin	yes	yes	yes	yes	yes
Nos of external pins proximal of fracture	1	1	1	1	1
Nos of external pins distal of fracture	1	1	2	1	1
FixEx tubulaire M3 16 hole 6mmx46mm		1	2		
FixEx tubulaire M3 24 hole 6mmx67mm	2			1	1
FixEx tubulaire 13 hole M4 8mmx97mm	1	1	1	1	1

Please note: * Date of first X-Ray after surgery, possible callus formation earlier

**All pins were removed in the same time