Paper ISSN 0189-0514
Online ISSN 1427-4410

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J. Anim. Prod. Res. (2021) 33(2):101-108

EFFECTIVENESS OF MODIFIED PIN-IN-FIBERGLASS CAST IN THE MANAGEMENT OF TRANSVERSE MID-SHAFT TIBIA FRACTURE IN NIGERIAN INDIGENOUS BITCHES RADIOLOGICALLY

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ABSTRACT

This study investigated the effectiveness of pin-in fiberglass cast in the management of transverse mid-shaft tibia fractures in bitches using radiograph. Three (3), 7-month-old apparently healthy female indigenous bitches of varied weights (8-10 kg) were acquired from Samaru, Zaria for this study. They were housed in the dog kennels of the Veterinary Teaching Hospital, fed with homemade and restaurant meals (Rice, pap, fish and bones) twice daily and water was provided *ad libitum*. The bitches were acclimatized for 3 weeks prior to the commencement of the study. The bitches were sedated using atropine sulphate (0.02 mg/kg) and Xylazine (2 mg/kg) administered intravenously and intramuscularly respectively. Anesthesia was induced using 2% Lidocaine hydrochloride (7.5 mg/kg) into the epidural space. Transverse mid-shaft tibia fractures in the bitches were manually created and reduced using Pin-in-fibreglass casting and monitored radiographically for eight weeks post –operative. Early ambulation was achieved within a period of 24 hours post-surgery. Maximum callus formation was achieved in the 7^{th} week post-surgery and complete facture healing was attained at week 8 post-surgery. Modified Pin-In-fibreglass cast offered an excellent functional and cosmetic appearance. It was concluded that excellent reduction of transverse mid-shaft tibia fracture in bitches could be achieved using pin-in-fibreglass cast.

Keywords: Mid-shaft transverse tibia fracture, Pin-in-fibreglass cast, Bitches, Radiography.

INTRODUCTION

Fractures can be defined as disruptions or discontinuities of the surface of mesothelial organs generally or skeletal structures specifically, which occur when the stress level on the bone exceeds its loading capacity (Hassan and Hassan, 2003). Fracture can occur with or without displacement of the fragments (Denny, 1993).

Fracture could either arise from outside the bone (extrinsic causes) e.g. direct or indirect trauma; or those originating from the bone (intrinsic causes) e.g. fracture due to muscular action or pathologic fracture (Bada, 2016). The most common causes of fractures in small animals are automobile accidents, cruelty, gunshot, falling from a height and others (Greg, 2003; AbdulRahman *et al.*, 2006). According to Charles and David (1985) and Slatter (1985), most fractures resulting from violent direct trauma are either comminuted or multiple, while bending fractures are generally oblique or transverse which may have butterfly fragments. Torsional forces (Slatter, 1985). Compressive forces (Charles and David, 1985; Slatter, 1985).

In another study conducted by Eyarefe and Oyetayo (2016) on the prevalence and pattern of orthopaedic conditions presented to the Veterinary Teaching Hospital (VTH), University of Ibadan, Nigeria (1995-2015), a higher incidence of orthopaedic conditions was reported in younger dogs (< 1year) than in adult (> 1year) which were associated with automobile injuries and nutritional osteopathies than other causative factors (Streeter *et al.*, 2009). Naive young animals in an attempt to avoid on-coming vehicles wander around unfenced environment making them prone to orthopaedic injuries (Adeyanju *et al.*, 1988). Young dogs which have phobia for kennel confinement, often sleep under owners' vehicles making them prone to orthopaedic injuries (Eyarefe and Oyetayo, 2016). With the general security concern, dogs are increasingly used for security purposes in Nigeria, exposing them to trauma-related orthopaedic conditions inflicted by burglars and armed robbers (Ozanne-Smith *et al*., 2001). Bones are essential parts of the locomotor system; they act as lever arms during motion and resist the forces of gravity. Bones also protect and support adjacent tissues. In addition to these, bones serve an important chemical function, providing a reservoir for mineral homeostasis (Slatter, 1985). It is therefore necessary that fracture managements are aimed at achieving the fastest possible healing time and enabling the patient function normally by allowing early ambulation (Shahar, 2000). Fracture management and its prognosis depends greatly on the size of the dog involved (Greg 2003).

MATERIALS AND METHODS

Experimental study Location

The study was carried out in the Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Kaduna Sate. The site is located in the Guinea Savannah zone of Nigeria at Latitude 11^{o} 9' 46'' N, Longitude 7^{o}37'45''E and at an altitude of 610m above sea level. The temperature ranges between 26-40^{o}C depending on the season. The relative humidity during the dry and wet seasons are 21 and 72% respectively, with annual rainfall of about 1500mm (IAR, 2016).

Source of animals

Three (3) 7-month-old apparently healthy female Nigerian indigenous dogs of varied weights (8-10 kg) were acquired from Samaru, Zaria for this study. They were transported to the Faculty of Veterinary Medicine where they were housed in the dog kennels of the Veterinary Teaching Hospital, fed with homemade and restaurant meals (Rice, pap, fish and bones) twice daily and water was provided *ad libitum*.

Ethical approval

Ethical approval for the study was obtained from the Ethical Committee on Animal Use and Care of the Ahmadu Bello University, Zaria.

Experimental animal screening

The bitches were acclimatized for 3 weeks prior to the commencement of the study. During the conditioning period, the bitches were screened for ecto- and endo-parasites.

Creation of Transverse mid-shaft tibia fracture

Pre-operative preparation

The lumbosacral area and the left forelimbs from mid-thigh to mid-metatarsus of the dogs were liberally shaved, washed and scrubbed with soap and water

Induction of anesthesia

Atropine sulphate (0.02 mg/kg) (Amopin®, Yanzhou Xierkangtai Pharma Ltd, China) was administered intravenously and Xylazine (2 mg/kg) (XYL-M2®, VMD, Arendonk-Belgium) was administered intramuscularly. Anesthesia was induced using 2% Lidocaine hydrochloride (7.5 mg/kg) into the epidural space (Plate I).

Plate I: *Adminstration of anaesthetic agent into the epidural space*

Operative procedure for creation of transverse mid-shaft tibia fractures

Transverse mid-shaft tibia fractures in the bitches were manually created as described by Marturano *et al.* (2008) but modified. The area extending from the tarsal joint to the stifle joint of the left hind limb was well padded using a sterile surgical drape. An external blow was then applied to the tibia bone without violating the skin to create a closed, complete diaphyseal transverse fracture of the tibia which was verified radiographically. After which the bitches were properly restrained on lateral recumbency for surgical repair using Pin-in-fiberglass casting.

Fracture reduction

The fracture manipulation, reduction and percutaneous pins insertion were carried out as described by Bada *et al.* (2017). The bitches were restrained on lateral recumbency and the limb suspended from a drip stand with tension using a stirrup. (Plate II). The surgical site was fine-scrubbed with 0.05% Chlorhexidine gluconate (Purit® Saro Lifecare Ltd, Ibadan, Nigeria) and 10% povidone iodine solution (Povidone Iodine Topical Solution® Sirmaxo Chemical Ltd Maharashtra, India) before being draped. (Plate II).

Pin-in-fibreglass casting

Four stab incisions (2 over proximal and 2 over distal fracture segments) through the skin and underlying soft tissues for insertion of 3.5 mm threaded Steinman pins (Front threaded pin, Shanz Screw 3.5 x 200 mm, stainless steel, Asco, India) were made on the lateral aspect of the tibia. A power drill was used to drill the first Steinman pin at a low speed (less than150 revolutions/minute) into the most proximal stab incision on the distal fracture segment of the tibia in a medial direction until the pin passed through both cortices of the tibia taking into consideration the cranial tibial artery.

Plate II: *The fractured limb was draped appropriately. The foot and foot pad were covered with sterile gauze to reduce contamination of the surgical field*

A stab incision was then made over the tip of the pin to allow the pin to emerge few millimeters on the opposite side. After the first pin was placed, the second pin was then inserted into the proximal fracture segment distal to the first pin through the fourth skin stab incision. The third and fourth pins were inserted through the second and third skin stab incisions on the distal and proximal fracture segments close to the fracture line. Skin incisions were then sutured where necessary using size 2/0 Nylon suture with care not to create excess tension of the skin at pin entry sites. Cicatrin® powder was applied around each pin entry site and a compressive bandage, was applied over the operated limb extending from the foot to the mid-thigh without incorporating the transfixation pins to minimize postoperative swelling (Plate III).

Plate III: *The placement of all the four transfixation pins and Compressive bandage using sterile gauze*

Four rectangular shaped foams measuring (18x6x5 cm) were placed around the sheen and then wrapped with polythene bag to hold the foams in place. The fiberglass cast material (Perfect Cast® Hospital and Home Care UK) was wet by immersion in water at room temperature for 5 seconds and the water wrung off. The cast material was then rolled over the foam and polythene bag on the limb with the fiberglass cast fenestrating the protruding pins extending from proximal to distal tibia. This was continued until the whole length of the projecting transfixation pins were incorporated and covered by the cast. After the cast had set, the foams and polythene bag wrap were removed. Normal flexion and extension of the stifle and tarsus were verified. Two square shapes were marked out on the cranial and caudal surfaces of the cast and cut out using an oscillating cast cutter to create two windows. The proximal and distal cast edges were trimmed (Plate IV and V).

Plate IV: *Four rectangular shaped foams measuring 18x6x5 cm were placed around the sheen and then wrapped with polythene bag to hold the foams in place*

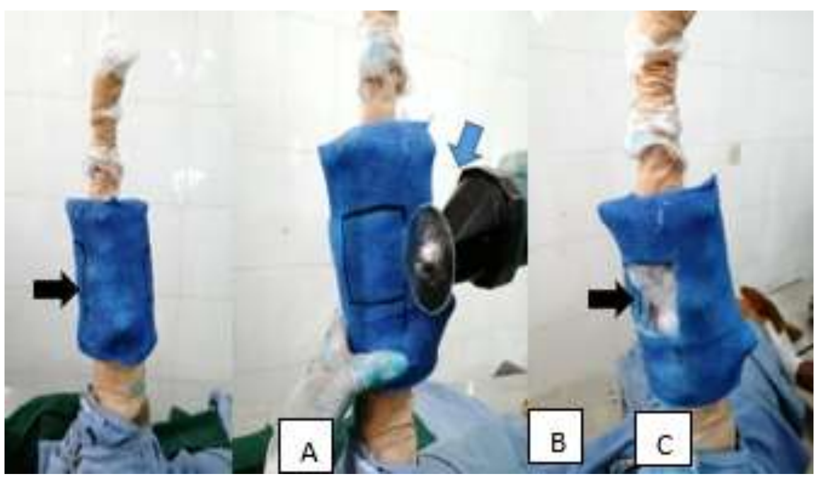

Plate V: *A; Two square shapes were marked out on the cranial and caudal surfaces of the cast, B and C; the shapes were cut out using an oscillating cast cutter to create two windows*

Post -operative care
Following recovery from anesthesia, improvised Elizabethan collars were applied on all the bitches. Analgesics (Diclofenac sodium injection) (4mg/kg, IM) (Diclowin®, Chupet Pharm. Ltd, China) was given for 3-5 days. Vitamin B complex injection (0.1ml/kg, IM) was given for 3 days. Antibiotics 5% Enrofloxacin injection (5 mg/kg, IM) was given for 5-7 days. Compressive bandage was removed at day 7 for both groups, and replaced with gauze bandage only for Group B enclosing the fixator up till when the fixative was removed. Exercise restriction was ensured for all groups

Post-operative clinical and radiographic examination
Physiological parameters (rectal temperature, pulse rate, and respiratory rate) were monitored daily throughout the duration of recovery. Clinical assessment was undertaken by subjecting the animals to ambulation test weekly, starting from the time of post anesthetic recovery. The time of first weight bearing on the affected limb was noted. Lameness was accessed weekly and was graded as present or absent.

Post-operative radiographs were taken a day after the surgery (day 1) using Medio-Lateral and Cranio-Caudal projections (Hassan and Hassan, 2003; Easton, 2006) which were repeated at 2 weeks interval until union (Hassan and Hassan, 2003; Easton, 2006). The radiographs were evaluated to estimate angulation, maintenance of fracture reduction and rate of bone healing. Bone healing was evaluated, and radiographic results graded as described by Gian *et al.* (2009),

- Excellent: fracture healed and angular deformity in any plane was < 5°
- Good: fracture healed and 5° to 10° angular deformity in any plane was present
- Fair: fracture healed and 10° to 30° angular deformity in any plane was present
- Poor: fracture not healed or healed with angular deformity in any plane was > 30°

Early complications were noted. Complications were considered minor if they were managed without additional procedures under epidural anesthesia, and complications were considered major if they required additional procedures or substantial modification under epidural anesthesia (Gian *et al.*, 2009).

The cast and pins were removed when the fractures were adjudged to have healed. The functional and cosmetic results were evaluated and clinically graded as described by Fox *et al.* (1995).

i. Excellent: functionally normal and similar in appearance to the contralateral normal limb.
ii. Good: slight lameness only after extensive exercise, or minor difference from the contra lateral normal limb.
iii. Fair: slight to moderate lameness but consistent weight bearing, or noticeable difference from the contra lateral normal limb.
iv. Poor: non-weight bearing lameness, or marked, disfigured alteration from the contralateral normal limb.

Data analysis
Radiographic interpretation was used to evaluate the healing profile.

DISCUSSION

This study evaluated the radiological monitoring of the effectiveness of pin-in fiberglass cast in the management of transverse mid tibia fracture in bitches. Radiography was used to ascertain that the fracture created was accurate, this agreed with the report of Kraus *et* *al.* (2003) who showed that radiography was used to accurately diagnose the fracture and detection of fissures that may propagate during reduction. Afterwards post-operative radiographs taken in this study at bi-weekly interval revealed the stages of the fracture healing, this agreed with the report of Gorse (1998) who demonstrated that post operative radiograph could be used to monitor the healing processes of fracture. Langley-Hobbs, (2003) stated that follow up radiographs are taken at intervals depending on the age of the patient, the severity of the fracture, the confidence of the clinician in the repair and the progress of the patient and are evaluated both in isolation and in comparison, with the previous radiograph.

The immediate post-operative radiographs in all the bitches in this present study revealed good fracture reduction and alignment. First post-operative radiograph of the fracture segment made greater than 50 percent contact and this agreed with the report of Shales (2008a) who stated that the ends of the fracture should make contact with each other by at least 50 per cent in both orthogonal radiographic views to achieve healing. The evidence of earlier periosteal tissue reaction at week 4 post-operative management observed in this current study indicated a lesser inter-fragmentary stability and this is in line with the report of Permattei *et al.* (2006) who reported that fractures heal through periosteal and endosteal callus formation.

The weight bearing observed in the pin-in-fiberglass at week 2 could be attributed to the optimum stabilization and better load sharing ability of the fixative devices (Nnaji *et al.*, 2015). According to Ozsov and Altunatimaz (2003) early weight bearing observed in this study could be important development with respect to avoiding possible complications such as joint stiffness, bone and muscle atrophy, by allowing early return to function of the extremity. The sores observed in the pin-in-fiberglass according to Permattei *et al.* (2006) is not an unusual finding as it constitutes about 55% of complications seen following the application of cast even by a very prudent surgeon.

CONCLUSIONS AND RECOMMENDATIONS

The study has established that maximum callus formation was achieved in the 7th week for the modified pin-in-fiberglass casting (M.P.I.C). M.P.I.C provided early ambulation within a period of 24 hours post-surgery. Complete facture healing was attained at week 8 post-surgery. M.P.I.C offered an excellent functional and cosmetic appearance.

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