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TIE in ESF for treatment of humerus fracture in rooster (*Gallus gallus domesticus*)

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Abstract

A 4-year-old rooster presented with history of trauma leading to fracture of the left wing. Radiography confirmed a simple complete transverse overriding proximal diaphyseal fracture of the left humerus. Due to the anatomical challenges and high muscular activity in avian humerus, a Tie-in External Skeletal Fixation (ESF) technique was adopted. The fixation incorporated a K-wire of size 2 mm tied in with a Type I-a external frame. The procedure resulted in satisfactory bone alignment and functional recovery. This report demonstrates the efficacy of the tie-in ESF technique for managing long bone fractures in birds, particularly in high-motion bones like the humerus.

Keywords: Tie-in ESF, humeral fracture, pneumatic bones, air sacs, rooster, fracture repair

Introduction

Fractures of the humerus in avian species are frequently encountered due to trauma and infighting especially in backyard poultry and gaming birds. Bones perform two critical functions: they support the muscular system structurally and they act as a storage for calcium and phosphate (Clarke, 2008., Doherty *et al.*, 2015) [2, 4]. Fragments can become dislodged from the soft tissues and blood supplies that surround them (Bennett and Kuzma, 1992) [1]. Bird's bones feature thin brittle cortices and broad medullas that may be pneumatic. This characteristic makes it difficult to employ implants that completely fill the extensive medullary canals without putting undue strain on the damaged bone (Harcourt Brown, 2002; Darrow and Bennett, 2021) [8, 3]. Due to the demand for a flight, birds have evolved bones that are lightweight but strong in aerodynamics (Dumont, 2010) [6]. The humerus is a pneumatic bone in most pet birds; the lateral diverticulum of the clavicular air sac enters through the pneumatic foramina on the medial side of greater tuberosity (Doneley, 2019) [5]. Stabilization of humeral fractures is particularly challenging due to restricted soft tissue coverage and significant muscular motion during wing use. It is particularly critical to preserving the length of the bones in birds due to the animal's balance and the unique mechanics of flying (Westfall *et al.*, 1979., Dumont, 2010) [11, 6]. The tie-in fixator (TIF), a combination of an intramedullary pin (IM) linked to external skeletal fixator pins (ESF), has been adapted and found extremely useful in managing avian fractures. Compared to standard methods used from the early 1970's through the mid-90's, a clear improvement in results was realized with overall success rate, as measured by full return to function, going from 40% to over 65% (Parikh, 2019) [10]. Traditional internal fixation methods often risk disrupting respiratory anatomy and soft tissue integrity. Hence, external skeletal fixation, particularly the tie-in method, has emerged as a superior option in such cases.

Case Description

A 4-year-old domestic rooster (*Gallus gallus domesticus*) weighing 2.8 kg was presented to Department of Surgery and Radiology, Hebbal Bengaluru with complaint of drooping of left wing following a traumatic injury. Showing signs of bluish green discoloration of skin which was due to accumulated biliverdin by breakdown of hemoglobin, birds lack the enzyme to convert biliverdin into bilirubin. Swelling and crepitus over the mid-humerus, inability to

extend its wing. Radiographic examination of medio-lateral and craniocaudal views revealed, a simple complete transverse proximal diaphyseal overriding fracture of the left humerus (Fig. 1). No comminution or involvement of the shoulder or elbow joints. Soft tissue swelling with no evidence of pneumocele rupture.



Fig 1: Simple complete transverse proximal diaphyseal overriding fracture of the left humerus

Fracture reduction was done by tie in ESF under general anesthesia. General anesthesia was induced with a xylazine-ketamine cocktail i.e. Xylazine @ 3 mg/kg B W I/M and Ketamine @ 30 mg/kg BW IM. Surgical site was prepared by plucking and trimming of feathers and aseptically prepared using povidone iodine 7.5% scrub solution. A 2.0 mm K-wire was inserted in a normograde fashion via the proximal humerus fragment and fracture site aligned manually by traction and counter traction. A unilateral external fixator frame using 1.2 mm Kirschner wires was applied transcortically. Transcortical k wires were stabilised using epoxy methyl acrylic which was filled into 4 mm endotracheal tube (Fig. 2). It acted as a connecting rod. The whole construct gave sufficient stability at the fracture site. Immediately after surgery radiographs were taken to assess the bone alignment (Fig. 3).



Fig 2: Fractured bone stabilised by ESF and acrylic splint



Fig 3: radiograph immediately after surgery

Postoperatively, Antibiotic Inj. Enrofloxacin 10 mg/kg PO once daily for 5 days, Antiinflammatory Inj. Meloxicam 0.2 mg/kg PO once daily for 4 days. Advised owner to restrict the movement in an isolated cage for 4 weeks, Wing support

using light bandaging for 10 days Daily monitoring for pin tract infection and wing use.

Results

Radiographs taken at 4th and 6th weeks post-op (Fig. 4 and Fig. 5). Progressive callus formation. Proper alignment maintained. No signs of implant failure or infection. The fixator was removed at 8th week. Proper alignment and repair of bone seen (Fig. 6). Bird regained normal wing posture and resumed limited flight within 2 weeks of implants removal. The bluish discoloration of skin subsided by 10th post-operative day.

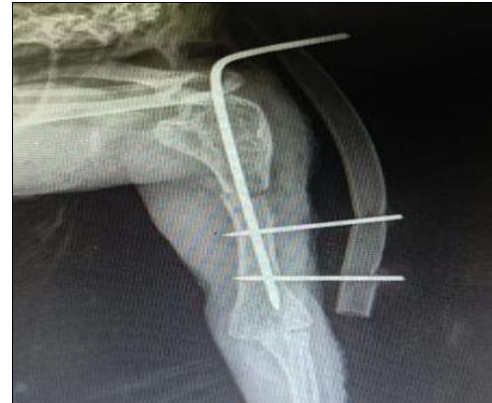


Fig 4: post op 4th week radiograph



Fig 5: post op 6th week radiograph



Fig 6: post op 8th week after removal of implants

Discussion

To provide the strength and stiffness desired with complicated humeral or femoral fractures, a combination of IM pin and type Ia or type Ib external fixator was often used (Fossum, T. W. 2019) [7]. Tie-in ESF reduced micromotion at the fracture site while minimizing soft tissue damage (Johnson *et al.*, 2020) [9]. Compared to internal fixation alone, this method avoided excessive surgical exposure and allowed for dynamic fracture healing under controlled motion. The IM pin resisted bending, while the external frame controlled rotational and axial forces. The Tie-in component ensured integration

between internal and external stabilization, creating a single biomechanical unit.

Conclusion

Tie-in external skeletal fixation was a highly effective and minimally invasive technique for managing humeral fractures in avian patients. In this 4-year-old rooster, it provided excellent stability, allowed early wing use, and resulted in full functional recovery. This method should be considered a preferred option for similar long bone fractures in birds.

Conflict of Interest

Not available

Financial Support

Not available

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