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Open reduction and internal fixation by intramedullary pinning of humerus fracture in a house sparrow (*Passer domesticus*) and subsequent release: A case report

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Abstract
Avian fracture surgery is quite distinct from mammalian fracture surgery. Avian bones are brittle and prone to fragmentation or shattering upon impact, and long bones lack sufficient soft tissue and muscle support. We present a successful case of an open reduction and internal fixation of a humerus fracture in a house sparrow using intramedullary pinning. The male house sparrow was found with a drooping wing, bleeding from a wound on the medial aspect of his right arm, and a complete compound fracture of his right humerus. It was decided to correct the fracture surgically via open reduction and internal fixation. Postoperative physiotherapy included PROM (passive range of motion) exercises with wing flexion and extension. Intramedullary pinning using a hypodermic needle resulted in excellent fracture immobilisation. The bird recovered completely and regained its normal flight ability.

Keywords: Sparrow, intramedullary pinning, passive range of motion, avian rehabilitation

Introduction
Veterinary surgeons frequently face substantial difficulties when it comes to fracture treatment in birds. Avian surgery is quite dissimilar to mammalian surgery (Bennett & Kuzma, 1992; Carrasco *et al*., 2017) [1, 4]. Without a fundamental understanding of anatomy and physiology, it becomes impossible to comprehend the pathophysiology of disease and the impact of treatment on the patient (Doneley, 2018) [8]. 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) [5, 7]. Due to the demand for a flight, birds have evolved bones that are lightweight but strong in aerodynamics (Dumont, 2010) [9]. They feature thin brittle cortices and broad medullas that may be pneumatic in some species and specific bones. This characteristic makes it difficult to employ implants that completely fill the extensive medullary canals without putting undue strain on the damaged bone (Darrow & Bennett, 2021; Harcourt-Brown, 2002) [6, 11]. Avian bones are prone to fragmentation or shattering upon impact, and long bones in birds' distal extremities lack soft tissue and adequate muscle support and are merely covered by tendons and skin. Fragments can become dislodged from the soft tissues and blood supplies that surround them (Bennett & Kuzma, 1992) [1]. These conditions all contribute to an increased prevalence of open, comminuted fractures. The majority of pioneering work in avian orthopaedics has been conducted on raptors utilizing small mammal methodologies (Redig, 1986) [20], hence in avian orthopaedics, the classical objectives of healing are the same to those in mammalian orthopaedics: 1) rigorous fixation, 2) proper opposition, 3) asepsis, and 4) prompt restoration of function (Bennett & Kuzma, 1992; Jalila, 2002; Westfall *et al*., 1979) [1, 12, 22]. 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 (Dumont, 2010; Westfall *et al*., 1979) [9, 22]. Other difficulties include small patient sizes, sparse soft tissue covering distal extremities, and fractures near joints, frequently resulting in decreased joint mobility (MacCoy, 1992) [15].

History and clinical signs
An injured adult male house sparrow (*Passer domesticus*) was presented at 11:15 AM on 03rd

April 2021 by an urban wildlife rescuer at Vet beyond Basics, a specialty veterinary clinic in Nagpur, Maharashtra. Right-wing was seen to be drooping on initial observation. On physical examination, blood was noted on the right arm's medial aspect. Further clinical examination indicated that the right humerus had a complete midshaft fracture which was confirmed radiographically. Based on the clinical look of the wound and the bird's condition, it was determined that the injury was recent, less than 24 hr old. Early clinical diagnosis and management can significantly improve the likelihood of recovery and further rehabilitation, albeit the severity of the injury at the time of admission also plays a role (Molony *et al*., 2007) [17].

Materials and Methods

The initial examination was kept to a minimum as the bird was in shock and pain. Oxygen supplementation, thermoregulation, and analgesia were provided immediately to stabilize the bird. A more thorough examination was conducted when the bird had been anaesthetized (Figure 1). Since the nature of the injury was precarious, it was decided to opt for surgical correction of the fracture by open reduction and internal fixation.

Fig 1: Pre-operative examination under anaesthesia

Meloxicam @ 0.1 mg/kg was injected intramuscularly as an analgesic and anti-inflammatory (Carpenter & Marion, 2017) [3]. Isoflurane was utilised at a flow rate of 2% for mask induction and 0.5 percent for maintenance in the anaesthetic procedure. The surgical site was prepared, meticulously cleaned and was aseptically produced by plucking feathers and cleaning in weak betadine solution. The skin and muscles were separated by undermining. Retrograde pinning was performed with a size 21 hypodermic needle (Figure 2A). 5-0 PGA sutures were placed in a basic interrupted pattern to appose the muscles, ligaments, subcutaneous tissues, and the skin separately. Dressing with betadine solution was performed, followed by insertion of a figure of eight body bandage to immobilise the wing.

Fig 2: Retrograde pinning was performed with a size 21 hypodermic needle

Antibiotic Inj. Enrofloxacin @ 15 mg/kg PO for 5 days, painkiller Inj. Meloxicam @ 0.1 mg/kg PO for 5 days, and multivitamin Inj. Vitamin B @ 0.1 ml/kg IM for 3 days were administered postoperatively (Carpenter & Marion, 2017) [3]. Oral calcium supplementation was done for 1 week post-op. Physiotherapy was performed by administering PROM (passive range of motion) exercises with wing flexion and extension (Kim *et al*., 2018) [14] while each dressing on alternate days. The bird was kept in a small, ventilated cage with a static perch at the height of 4 in. Prior to initiating physiotherapy for wild birds, it is vital to recognise uncomfortable behaviours in these patients (Goldberg, 2019) [10]. The enclosure was inside a thermoregulated room with minimal disturbances. A photoperiod of 12 h light and 12 h dark cycle was provided to maintain a healthy circadian rhythm. Circadian rhythms are more synchronised in birds than in mammals, and they function as a timing reference for many biological activities critical for survival (Rani & Kumar, 2013; Singh, 2022) [19, 21]. House sparrows are habitat generalists but favor agricultural grains, particularly millet *Panicum miliaceum* (Whelan *et al*., 2015) [23]. The bird was given a diet of seed mix comprising of Nyjer seed, oat, small sunflower seed, yellow millet, barnyard millet, and finger millet. On alternate days, calcium supplement (trade name: Cal-Care) and multivitamin supplement (trade name: Vita Boost) were administered mixed in water as indicated. Fresh water was always available in a clean bowl and was changed daily. The cage was spot cleaned daily and disinfected once a week. Spot cleaning was done when the bird was taken out for treatment.

Once the wound healed, the sparrow was shifted to a larger enclosure of dimensions 10 x 10 x 8 f. Perches were kept at different heights, and food was given on the floor to encourage flying practice inside the cage. Incidental disturbances, while passing by the enclosure and entering to clean and feed, acted as behavioral stressors that further encouraged the bird to fly. On the 18th post-operative day, complete healing of the bone was observed radiographically, and the pin was removed, and the bird recovered entirely. After a thorough assessment of its flight and wing use, the bird was released back to the location of its rescue.

Results and Discussion

The bird recovered completely and regained the ability to fly normally. The surgical outcome demonstrated that an appropriately sized hypodermic needle can be utilised efficiently to fixate a humerus fracture. Initial stress management was crucial, as was the focus on components of assessment and treatment that would improve its immediate welfare and survival chances. Because a seriously injured bird is likely in shock at this point, it is essential to minimise needless handling. Both stress and shock can impair the immune system, making the bird more prone to disease and delayed wound healing (Mander *et al*., 2003) [16]. The avian clinician must be willing to think laterally and evaluate each case individually, considering the fracture's specific characteristics, as well as the species' and individual's nature, behavior, and intended outcome. The goal should be to achieve an outcome that is as near to the original functioning anatomy as possible (Calvo Carrasco, 2019) [2]. Along with surgery and postoperative management, it is vital to incorporate physiotherapy and proper captive husbandry. Physiotherapy should begin soon following surgery and should be continued until the patient achieves maximum performance. Traditionally, patients were immobilised

postoperatively using restricted caging and cooptation, which frequently resulted in decreased limb extension, discomfort on movement, and contracture. Early intervention with physiotherapy can aid in the restoration, maintenance, and promotion of optimal function in certain conditions (Ponder, 2011) [18].

Conclusion

Urbanization subjects avian wildlife to a variety of environmental stressors, many of which end in clinical admission and hospitalization (Janssen *et al*., 2020) [13]. Orthopedic ailments, particularly fractures, are a frequent occurrence in avian practice. Recent advancements in orthopaedic treatments that have been thoroughly evaluated in mammals have been extrapolated to avian orthopaedic procedures with or without modification (Calvo Carrasco, 2019) [2]. Fractures treated with biomechanically sound fixation and adequate attention to soft tissue will have the best chance of healing functionally. Intramedullary pinning with a hypodermic needle resulted in excellent immobilization during fracture healing, and the sparrow was successfully rehabilitated back into nature after making a complete recovery.

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