STUDIES ON SURGICAL MANAGEMENT OF INJURED BIRDS DURING KITE FLYING FESTIVAL

BY

PATEL AMITKUMAR JITENDRABHAI

B. V. Sc. & A. H.

(Reg. No. 04-1712-2011)

DEPARTMENT OF VETERINARY SURGERY AND RADIOLOGY

COLLEGE OF VETERINARY SCIENCE & ANIMAL HUSBANDRY

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STUDIES ON SURGICAL MANAGEMENT OF INJURED BIRDS DURING KITE FLYING FESTIVAL

A THESIS SUBMITTED TO THE ANAND AGRICULTURAL UNIVERSITY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF Master of Veterinary Science IN VETERINARY SURGERY & RADIOLOGY

BY PATEL AMITKUMAR JITENDRABHAI B. V. Sc. & A. H. (Reg. No. 04-1712-2011)

DEPARTMENT OF VETERINARY SURGERY AND RADIOLOGY COLLEGE OF VETERINARY SCIENCE & ANIMAL HUSBANDRY ANAND AGRICULTURAL UNIVERSITY ANAND, GUJARAT, INDIA-388 001 2013
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<tr>
<td>DNS</td>
<td>Dextrose Normal Saline</td>
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<td>RL</td>
<td>Ringer’s Lactate</td>
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<td>IM</td>
<td>Intramuscular</td>
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<tr>
<td>IV</td>
<td>Intravenous</td>
</tr>
<tr>
<td>IO</td>
<td>Intraosseous</td>
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<tr>
<td>CRI</td>
<td>Continuous Rate Infusion</td>
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<td><em>et al</em></td>
<td>And associates</td>
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<td>IV</td>
<td>IntraVenous</td>
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<tr>
<td>hr</td>
<td>Hour</td>
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<tr>
<td>NSAID</td>
<td>Non Steroidal Anti-Inflammatory Drug</td>
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STUDIES ON SURGICAL MANAGEMENT OF INJURED BIRDS DURING KITE FLYING FESTIVAL

ABSTRACT
Gujarat enjoys ‘Uttarayan’ as kite-flying day every year on 14th January. The string/cord/line used to fly kites called ‘manja/manjha’ can unwittingly, severely wound birds that are flying in the air. Every year, thousands of birds like Pigeons, Kites and some wild species get injured by sharp, glass-coated ‘manja’. Clinical study on incidence and surgical management of these injuries was conducted on 168 injured birds of different species during November-2012 to February-2013. Based on species predisposition, the highest incidences of kite string injuries were observed in Blue-rock Pigeons (116, 69%) followed by Common Pariah Kites (21, 12.5%). The cases presented were more with left wing propatagium injury (55, 41.35%).

Preoperatively, after anamnesis pertaining to species and types of injury, the initial protocol for injured birds included control of haemorrhage, oxygenation, heat support, analgesics and parenteral antibiotics. Stabilization of the birds was done in all the cases by administration of the fluids and emergency medicines through intraosseous (IO) route. The goal of treatment was patient survival first and then assessing traumatized tissue. All the birds were treated for the respective injuries and kept indoor till the complete recovery.
After stabilizing the patient, in birds requiring surgical intervention, butorphanol was administered @ 0.1 mg/ kg IO/ IM to provide peri-operative analgesia. All the minor surgeries including suturing of the wound were done under the local anaesthesia using 2 % lignocaine @ < 4mg/ kg. All the major orthopaedic surgeries were done under the general anaesthesia using mixture of ketamine @ 5 mg/kg and diazepam @ 0.5 mg/kg IO.

To minimize the feather removal, micropore adhesive tape was used as an adhesive drape to decrease the microbial contamination of the surgical site. The wound involving propatagium was closed on both the sides (dorsal and ventral) by simple interrupted sutures using vicryl 3-0 absorbable suture material in 111 birds. In five birds with humerus fracture intramedullary pin tie in fixator was applied using small sized K-wires as per the size of the bird. The wires were connected using a plastic straw and dental acrylic. In three birds with radius-ulna fracture, under C-arm guidance, intra-medullary pinning was done. Wing amputation was performed at the level of humeral mid shaft in cases of the irreparable injury, severe infection, tissue loss, old fracture and necrosis in order to save the life of the birds in nine cases. External co-optation was provided using light weight cast bandage in one bird with stifle joint dislocation. In case of two birds with tibiotarsal fracture, retrograde intra-medullary pinning was done. The wound involving the foot was bandaged with an interdigitating bandage in three birds. In case of two birds with crop fistula, the crop was sutured with a double layer of inverting sutures.

Figure-of-eight wing bandage was applied using self-adherent wrap for ten days to protect the wound from self-mutilation in all the birds with
wing injuries. The wing was kept open in cases of the fractures involving humerus and radius-ulna. In injured birds, regular cleaning and anti-septic dressing of the wound was done on every third alternate day with warm normal saline, 5% povidone iodine solution, cetrimide spray and cephalexin powder. In birds with fractures, ceftriaxone sodium and tazobactam combination was administered @ 75 mg/kg IM/IO for seven days. All other injured birds were treated with enrofloxacin @ 15 mg/kg IM/IO for five days.

The birds were classified and provided with separate shelters according to their family and feeding habits till the complete recovery. Forceful hand feeding was done in > 20 birds which refused to take the food on their own. Birds were clinically examined for flying acuity once in a week up to one month and thereafter every 15 days for a variable time period.

On the whole, good surgical results were observed in 49% cases (83 out of 168) followed by fair in 17% (29 out of 168) and failure in 34% (58 out of 168) cases. 65% birds (110 out of 168) with complete recovery and good flying capacity were released in the environment at different places as per their natural habitat. In 12% birds (20 out 168) flying capacity could not be restored and became permanently disabled. During this study, the survival rate of the birds was 77% (130 out of 168) and the success rate was 65% (110 out of 168).
Dr. P. V. PARIKH  
Professor  
Department of Veterinary Surgery & Radiology  
College of Veterinary Science and Animal Husbandry  
Anand Agricultural University  
Anand- 388 001 (Gujarat).

CERTIFICATE

This is to certify that the thesis entitled “STUDIES ON SURGICAL MANAGEMENT OF INJURED BIRDS DURING KITE FLYING FESTIVAL” submitted by PATEL AMITKUMAR JITENDRABHAI (Reg. No. 04-1712-2011) in the partial fulfilment of the requirements for the award of the degree of MASTER OF VETERINARY SCIENCE in the subject of VETERINARY SURGERY AND RADIOLOGY of the Anand Agricultural University is a record of bonafied research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

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DATE: / / 2013  
(P. V. PARIKH) MAJOR ADVISOR
CERTIFICATE

This is to certify that I have no objection for supplying to any scientist one copy of any part of the thesis at a time through reprographic process, if necessary, for rendering reference services in a library or documentation center.

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Date:   /   / 2013

(P. V. PARIKH)
MAJOR ADVISOR
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I take this opportunity to extend my deep sense of gratitude and words of appreciation towards those who helped me during the pursuit of my present study. I remember the oceans of guidance, support and encouragement from innumerable sources.

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Place: Anand  
Date: / /2013  

(Amitkumar J. Patel)
“Uttarayan” is celebrated every year on 14th January in Gujarat. It is also known as ‘Makar Sankranti’ or ‘Pongal’ in other parts of India. Gujarat enjoys ‘Uttarayan’ as kite-flying day. On this day, the skies over most cities of the state are filled with kites from before dawn until well after dark, and almost all routine activities are shut and everyone takes to the rooftops and roadways to fly kites. All the family members come together and enjoy the zest of cutting each other’s kites.

The string/cord/line used to fly kites is called ‘manja/manjha’ which is usually made of cotton thread, but an abrasive coat of crushed glass is gummed on to it making it razor sharp – each person tries to make his line the sharpest. Using this manja, colourful paper-cum-bamboo kites are flown from rooftops with the aim of cutting other kite-strings, either by letting the line loose at high speed or by repeatedly yanking it.

The fact is that however carefully a kite is flown; the manja can unwittingly, severely wound birds that are flying in the air. Every year, thousands of birds like Pigeons, Kites and some wild species of birds get injured by sharp, glass-coated manja. They somehow get entangled with the manja, struggle in panic and then fall to the ground. The manja cuts their wings, bodies or feet so deep that it results in profuse bleeding and often gruesome death, if beheaded (Plate 1.1).
The worst hit in the kite war during Uttarayan are Vultures, Eagles, Owls and Hawks. Of these, the white rumped Vultures figure high on the conservation list as they are on the verge of extinction. Apart from vultures, migratory birds like Flamingos, Geese, Cranes, Storks and Pelicans also fall prey to sharp kite strings.

Studying birds has always been a popular pursuit, from prehistoric to modern times. Birds appeal to people for many reasons. Among these are their attractive, often breath-taking colors, their joyous spring songs, their spectacular migrations and fascinating habits, and perhaps most of all, the challenge that the identification of so many kinds affords the imaginative mind, the never ending quest of discovering something new. Now days, birds have become so popular, both for recreational enjoyment and for scientific studies.

Birds share with mammals the distinction of being the most recent vertebrates to inhabit the earth. The estimated 8700 living species are widely distributed over the world, ranging from the Arctic to the Antarctic and occurring as sea as well as on land. Even the most remote islands are visited by sea birds and many such small isolated land masses have their own endemic avifauna. As a class birds are strikingly uniform. The most obvious avian features are feathers and the possession of horny bill. However, there are many other structural characters that readily distinguish them from other forms of animal life. Offsetting these attractive advantages, however, is the fact that increasing demands for living space for an expanding human population, industrial spread, and continuing use of pesticides tend to restrict bird life more and more and to make good birding
areas less available. Even public lands ostensibly dedicated to the preservation of natural resources are under constant pressure for greater economic development. Our advanced and rapidly expanding technology now threatens the survival of many animal species, perhaps including man (Wallace and Mahan, 1975).

Birds comprise one of the seven classes of vertebrates. Each class is distinguished, in part, by its integumentary covering: dermal scales in bony fishes, a scaleless glandular skin in amphibians, scales of a new type (epidermal) in reptiles, hair in mammals, and feathers in birds. Feathers are unique to birds, thus making them among the most easily defined and readily recognized categories of animals. No other animal has feathers, and no bird is without feathers, except temporarily in the few that are hatched with no natal down. Birds vary in size, form and wingspread. They range in size from the diminutive Hummingbirds to the massive Ostrich. A Cuban bee Hummingbird (*Mellisuga helenae*) is about 2.5 inches in length, including bill and tail, and weighs less than 2 grams, while a male Ostrich may exceed 300 pounds (Wallace and Mahan, 1975).

As per the Zoological classification, the birds come under the class “Aves”. The distinct characteristics of this class are warm-blooded vertebrates with skull possessing only one condyle; a single bone in the middle ear; front limbs basically modified for flight; body covered with feathers; scales present on feet, which usually retain the reptilian formula of 2-3-4-5 phalanges; Jurassic to Recent; 2 subclasses (*Archaeornithes* and *Neornithes*) and 5 extinct and 27 living orders (Orr, 1976).
The avian skeleton is much lighter than that of mammals, in fact, a large part of their bones contain air (pneumatization) instead of bone marrow. These cavities are communicated with the respiratory system and act to decrease weight, so flying is easier. Bones which are not pneumatised include most vertebrae, and those distal to the humerus and pelvis. Avian bones are richer in inorganic substances (calcium phosphate). Long bones have a very thin cortex and the medullary cavity contains a network of trabeculae, which increases the strength of the bone. These factors mean that avian bones are harder, but at the same time more fragile and less elastic than those of mammals. This means that when fractured they splinter easily, but it is impossible to use plates or intramedullary screws to aid healing as they destroy the internal structure. Making external fixators is the most appropriate treatment for fractures (Cano and Zarzosa, 2012).

Different types of the injuries are found in birds due to the kite flying. The most common injuries include wing injuries. Wing laceration and abrasions, broken feathers, Injury to the propatagium, fracture of the humerus, radius, ulna, carpo-metacarpals and phalanges are very common. The injuries involving legs are fractures of the tibiotarsus, tarsometatarsus and phalanges. The less common injuries include crop fistula, injuries to the neck, eyes and beak.

The objectives of the present study were as follows:

There is an urgent need to record the incidence of injuries in birds and characterize it along with treatment protocols. There is a need of dedicated efforts to organize treatment camps for management of injured birds in the most scientific manner, involving government bodies, non-government organizations
and veterinarians especially trained for treatment of injured birds. Further, a tertiary center for critical care of birds is also necessary.

**Objectives:**

1. To study incidence of different bird injuries during kite flying festival.
2. Surgical management of different bird injuries during kite flying festival.
Avian surgery is still evolving, unlike the fields of large and small animal practices. Very limited research work on the management of bird injuries during kite flying festival has been reported and hence, there is paucity of relevant literature regarding baseline data. The comprehensive review pertinent to this subject is presented under the following headings and subheadings.

2.1 Anatomy
2.2 Physiology
2.3 Emergency and critical care
2.4 Wound management
2.5 Fracture management
2.6 Anaesthesia

2.1 Anatomy

The avian skeleton is specialized for both strength and lightness. Strength and rigidity are attained by the architecture of the bones themselves, by the fusion of bones of the skull and synsacrum, and in some birds by the fusion of several of the dorsal vertebrae. Resorption of bone marrow and its replacement by extensions of air sacs decrease the weight of many of the bones in most bird families (Tyne and Berger, 1975).

The axial skeleton is composed of the skull, vertebral column, hyoid elements, ribs and sternum. The appendicular skeleton is composed of the upper and lower limbs and their supporting bony arches, the pectoral and pelvic girdles. Each pectoral girdle is formed by three bones: clavicle, coracoid and scapula. The coracoid and scapula form the glenoid fossa, in which the head of the humerus articulates. In most birds (exceptions: some parrots, barbets, toucans), the clavicles fuse inferiorly to form the furcula (also
furculum; wishbone); the area of fusion may be expanded into a hypocleidium.

The clavicles are absent or rudimentary in the ratites and mesites, in some parrots, pigeons and barbets, and in *Atrichornis*. In *Fregata* and *Opisthocomus*, the furcula is ankylosed with the coracoids and the sternum. The coracoids and scapula are fused in ratites (Tyne and Berger, 1975).

The bones of a bird’s wing are the humerus, radius, ulna, two carpal bones, the carpometacarpus and usually three digits. Anatomically, the arm is the most proximal segment of the forelimb, the part that extends from the shoulder to the elbow. The avian humerus is similar to mammals, but pneumatized. The pneumatic opening is situated on the proximal end, where two tubercles are seen (dorsal and ventral) for muscular insertion. While the wing is folded, the humerus lies against the thorax and parallel to the scapula. The ulna is more developed than the radius and both are bowed along their length, so they are protected against bending forces. The distal epiphysis of the ulna can be used for intramedullary administration of substances. There is a great reduction in the number of carpal bones, compared to mammals. The proximal row consists of a radial carpal bone and an ulnar carpal bone, while the distal row fuses with the metacarpus forming the carpometacarpus. The three digits are the major digit, with two phalanges, the minor digit, with one phalanx and the alula digit, with two phalanges (Cano and Zarzosa, 2012).

The pelvic limbs are involved in locomotion, both on land and in the water. The proximal skeleton consists of three bones, as in mammals: ilium, ischium and pubis, which form the girdle. The two girdles do not fuse ventrally (and therefore the pelvic symphysis is not present), except in a very few species but ilium fuses with the synsacrum. The ischium is proportionally
larger than in mammals, forming a large part of the lateral wall of the pelvis. The pubis is long and thin, palpable through the skin and its flexibility indicates the age of the bird (Wallace and Mahan, 1975).

The distal end of the femur slopes craniolaterally bringing a large part of the hind limb close to the centre of gravity of the body. A patella is present and fibula is reduced to a thin bone. The tibia is fused with the proximal row of the tarsal bones to form the tibiotarsus. The femur and tibiotarsus are very rich in bone marrow, unlike other long bones. The foot skeleton is formed from metatarsals II, III and IV, which fuse with the distal tarsal bones forming the tarsometatarsus. There is a small metatarsal remnant which is attached to the tarsometatarsus by ligaments. Thus in the bird there are four digits in the foot (I to IV), formed by two, three, four or five phalanges. The most distal phalanx forms the bony core of the claw (Cano and Zarzosa, 2012).

In flying birds the pectoral musculature is reddish in colour, indicating a large number of muscle fibres rich in myoglobin (oxidative aerobic metabolism), whereas in birds which do not have the ability to fly, this musculature is pale due to the predominance of white glycolytic muscle fibres (anaerobic metabolism). The main muscles involved in flight are the pectoral muscles (breast). There is a superficial pectoral muscle and a deep pectoral or supracoracoid muscle. The deep pectoral muscle lifts the wing from the keel of the sternum. It develops a tendon that passes through the triosseal canal to the dorsal surface of the humerus. This tendon can be ruptured if a traumatic event occurs (flying into a window, for example) and the classic presentation is seen as the bird being unable to lift its wing. In this case repair of the tendon is required. However, by bandaging the affected wing the usual formation of a
callus in the trioseum canal results in the same outcome (Cano and Zarzosa, 2012).

The birds’ diaphragm is different to that of mammals as it does not form a complete wall between the thoracic and abdominal cavities. Thus, all the main organs are located within a unique peritoneal cavity which can be divided into several celomic compartments; the peritoneal sacs (Cano and Zarzosa, 2012).

In birds, feathers are specialised epidermal structures, without no living cells and very little keratinisation or mineralisation. Feathers have a diverse range of functions: helping to control body temperature; acting as an aerodynamic force during flight; colouring allows camouflage or communication between different individuals etc. In the adult bird there are three main types of feathers:

a) Contour feathers: remiges, rectrices, coverts and tectrices.

b) Down feathers: Small feathers overlaid by the contour feathers.

Psittacines have a special kind of down feather; dusty down feathers.

c) Filoplume: related to proprioception (Cano and Zarzosa, 2012).

Feathers are distributed over the body and are arranged into specific areas called pterylae, in between which there are bare areas or apteria. Recognising the pterylae and apteria is important in the case of any surgical intervention in order to avoid damage to the feather follicles. A typical feather is composed of the calamus (proximal part implanted in the follicle) and rachis (distal part). On either side of the rachis is a row of parallel barbes, which form the vane. A distal umbilicus is found on the proximal end of the calamus,
the area where the papilla of the feather is enclosed by blood vessels and nerves. Feathers which are accidently pulled out, with the exception if primary and secondary remiges, usually re-grow in two-four weeks if the follicle isn’t damaged. However, cut feathers do not regrow until the next shedding (Cano and Zarzosa, 2012).

2.2 Physiology

Birds are such delicate entities, in such intimate association with their environment, that they need special means, physical and physiological, for precise heat or temperature regulation (thermoregulation). They meet the problems of adjustment to environmental conditions in many different ways. Feathers are the chief means of regulating body temperature-fluffing the feathers to conserve heat and depressing them to lose heat. In warm weather the air sacs are the principal means of dissipating heat. Birds have no sweat glands but birds can reduce body heat by expelling moist warm air during expiration. They also have unique ways of dissipating heat through the unfeathered parts of the body-the feet, tarsi and perhaps even the ceres in raptors (Wallace and Mahan, 1975).

Body temperature of birds is normally high and variable. It ranges from about 102° F to 112° F. There is a considerable fluctuation in the temperature rhythm of most birds. In diurnal birds, body temperature is highest during the day, rising until about the midday and then gradually dropping to a minimum during the night. In nocturnal birds (Kiwis, Owls and Goatsuckers), the daily cycle is reversed, with the highest readings obtained at night. Body temperature also varies with other conditions, rising with muscular activity and dropping during rest periods, rising with active digestion
of food (full stomach) and dropping with hunger (empty stomach), rising to adjust to high environmental temperatures and dropping when air temperatures are lower (Tyne and Berger, 1975).

Normal respiratory effort in the bird should not be noticeable, and the mouth should remain closed. Open-mouthed breathing is an indication of severe dyspnea. Resting respiratory rates vary from 6 to over 30 cycles per minute, depending on the size of the bird. Small birds have higher respiratory rates; large birds have lower respiratory rates. Some avian species (notably Amazon parrots and *Pionus* spp.) may pant when stressed. This normal physiologic response should not be misinterpreted as disease-induced dyspnea (Harrison and Ritchie, 1997).

Air sacs are extra pulmonary membranous expansion, which lies between the viscera and walls of the body cavity. The main function of the air sacs is to reduce the body weight in order to allow flight and swimming, but they also help to stop the body from heating up during these two activities. Normally 9 air sacs are present: 2 cervical, 1 interclavicular, 2 cranial thoracic, 2 caudal thoracic and 2 abdominal (the left can be catheterized in the case of upper airway obstructions). The air sacs don’t take part in oxygen exchange, as they facilitate a continuous air flow over the lungs. Thus, both inhaled and exhaled air passes through the respiratory system (with an absence of dead spaces) which makes the system very efficient (Cano and Zarzosa, 2012).

Heart rate tends to increase with decreasing body size. The resting heart rate of the Ostrich and of Cassowaries is about 70 beats per minute, approximating the rate in man. The heart beat is considerably faster in most other birds, reaching its highest rate in the smallest and most active birds, such
as hummingbirds. Heart rate is dependent not only on the age and size of the
bird but also on its activity, its body temperature, and the air temperature. The
3-day-old nestling House Wren has a heart rate of 121 beats per minute at an
air temperature of 21° C, but this increases to 320 beats per minute at 32° C
and to 411 beats per minute at 38°C (Tyne and Berger, 1975).

Blood volume in birds depends on the species and varies from 5
ml/100g in the Ring-necked Pheasant to 16.3 to 20.3 ml/100g in the racing
pigeon. In general, birds are better able to tolerate severe blood loss than
mammals, which is due to their greater capacity for extravascular fluid
mobilization. However, there is a marked variation among avian species in
response to blood loss, which may be a reflection of differences in blood
volume or extravascular fluid depots (Campbell, 1997).

Due to their high rate of metabolism, birds ingest food equivalent of up
to approximately 25-30% of their body weight per day. Their high energy
requirements mean that small and young birds cannot survive for a long time
if they are left for more than a few hours without food (Cano and Zarzosa,
2012).

2.3 Emergency and critical care

Quesenberry and Hillyer (1997) described the use of an intraosseous
(IO) cannula for administration of fluids, blood, antimicrobials, parenteral
nutritional supplements, colloids, glucose and drugs used for cardiovascular
resuscitation in birds. The advantages of IO cannulas include the ease of
placement and maintenance, cannula stability, tolerance by most birds and
reduced patient restraint once the cannula is placed. Continuous fluid
administration by IO cannula is less stressful than repeated venipuncture. IO
cannulas can be placed in any bone with a rich marrow cavity. A cannula may be placed in the distal ulna in medium-sized to large birds that will require several days of therapy. The proximal tibia is ideal in birds that will require shorter terms of therapy. Pneumatic bones such as the humerus and femur cannot be used. In medium-sized or larger birds, 18 to 22 gauze, 1.5 to 2.5 inch spinal needle can be used as the cannula. In smaller birds, a 25 to 30 gauze hypodermic needle is used.

Most birds presented as emergencies have a history of inadequate water intake and can be assumed to be at least five percent dehydrated. An estimation of the fluid deficit can be calculated based on body weight:

Estimated dehydration (%) x body weight (grams) = fluid deficit (ml) Half of the total fluid deficit is given over the first 12 to 24 hours along with the daily maintenance fluid requirement. The remaining 50% is divided over the following 48 hours with the daily maintenance fluids. Lactated Ringer’s solution (LRS) or a similar balanced isotonic solution warmed to 100.4° to 102.2°F (38° to 39°C) is recommended for fluid replacement and shock therapy. Using warm fluids is particularly important with neonates and with intravenous or intraosseous administration of fluids for hypothermia or shock (Quesenberry and Hillyer, 1997).

In birds fluids are administered through the cannula using an infusion pump, buretrolc or Control-a-Flow regulator. Unlike a vein, the marrow cavity cannot expand to accommodate rapid infusions of large fluid volumes. Consequently the rate of infusion into the marrow cavity is limited. The ideal infusion rate to avoid fluid extravasation in birds is unknown. A flow rate of 10 ml/kg/hr is suggested for maintenance. Excessively rapid infusion of the
fluids may cause signs of discomfort or edema of the soft tissue in the area of the cannula (Quesenberry and Hillyer, 1997).

A warm ambient environment is necessary for birds that are debilitated or in shock. Many commercial enclosures and incubators are available with floor or ceiling heating elements, side heating consoles or radiant heat systems. Floor heating elements may occasionally cause hyperthermia when debilitated birds are forced to stand or lie on the enclosure floor or in direct contact with the heating surface. Alternatively, heat can be provided by a hot water bottle or well insulated heating pad (preferably water). Birds receiving supplemental heat from any source other than a commercial incubator should be carefully monitored to prevent burns (Quesenberry and Hillyer, 1997).

Septicemia and bacteremia should be considered in any bird that is severely depressed. Prophylactic antibiotics are frequently used in birds that are immunocompromised from a noninfectious disease. However, in many emergency patients the history and clinical signs are vague and inconclusive and antibiotics may be indicated on a precautionary basis. Parenteral antibiotics are recommended for the initial treatment of birds that are weak, sick, debilitated or in shock (Quesenberry and Hillyer, 1997).

The state of shock is difficult to determine in the avian patient. Clinical signs include weakness, pallor and poor perfusion of peripheral vessels. Therapy for shock includes administration of fluids to expand the circulating blood volume and rapidly acting corticosteroids. If possible, corticosteroids and fluids should be administered IV or IO. IM corticosteroids and SC fluids are beneficial but take more time to enter the circulation. In cases of shock, a state of metabolic acidosis may be present, and bicarbonate replacement
therapy should be considered. Parenteral bactericidal antibiotics are given if bacterial infections are suspected (Quesenberry and Hillyer, 1997).

Dorrestein (2000) stated that fluid therapy is extremely important in the critical avian patient. Parenteral fluids will restore effective blood volume, normalize cardiac output and optimize tissue oxygenation. Most metabolic imbalances can be corrected with proper fluid therapy. An additional benefit is enhanced diuresis, which facilitates the elimination of toxic by-products and metabolites (e.g. urates). Deciding the route of administration depends on patient status and co-operation, fluid type and cost. Oral and subcutaneous routes are inappropriate when dealing with critically ill patients. The routes of choice for a patient in shock are IV and IO. IO catheters are less stressful than repeated venipuncture, and are the favoured route in cases of shock.

The same basic rules of resuscitation apply to birds as in mammals. Most birds can be easily intubated. An open anaesthesia circuit should be used to deliver 100 per cent oxygen, and the anaesthesia system designed to allow the operator good control in delivery of positive pressure ventilation (a rate of once every 4–5 s). If there is no heart beat or peripheral pulse, firm and rapid compressions of the sternum should be started, ventilation continued and epinephrine (0.5–1.0 mg/kg IM, IV or IO.) and atropine (0.5 mg/kg IM, IV, IO or SC) administered. Epinephrine and atropine can be given intravenously, followed by a bolus of saline or sterile water to encourage transport of the drugs to the heart. Doxapram (20 mg/kg IM, IV, IO or dropped on the tongue) and sodium bicarbonate (5 mmol/kg IV, IO once) are also used in birds in situations of cardiopulmonary resuscitation (Dorrestein, 2000).
Single doses of corticosteroids have been reported to improve the prognoses in cases of shock, trauma and toxicity without the occurrence of clinically observable adverse side effects. Dexamethasone sodium phosphate (2 mg/kg IM or IV once) is the preferred steroidal anti-inflammatory for birds. Prednisolone sodium succinate (0.5-1.0 mg/kg IM or IV once) has been reported to be most effective in cases of neurologic emergencies (Harrison and Lightfoot, 2006).

Hand-feeding a sick bird using a warmed hand feeding product may be attempted prior to tube-feeding. Hand feeding will be more time-consuming but less stressful for the patient if accepted. Hand-feeding can be an ideal way to supplement birds that revert to baby begging and feeding behavior when ill. However, the administration of an adequate quantity of supplement at each feeding requires that the patient be strong enough to demonstrate an adequate feeding response, and that the person feeding be experienced enough to avoid causing aspiration of the material. Gavage-feeding (stomach tube) also requires experience. When gavage feeding is performed, the experienced person will be capable of avoiding the following inherent dangers: a) Mechanical damage to the oropharynx with the metal crop feeder b) Damage to the beak with inappropriate use of oral speculums c) Accidental tracheal gavage d) Reflux of the formula from the crop into the oral cavity (Harrison and Lightfoot, 2006).

2.4 Anesthesia

Machin and Caulkett (2000) evaluated isoflurane and propofol anaesthesia for intra-abdominal transmitter placement in 118 nesting female Canvasback Ducks. Propofol was delivered through an intravenous catheter,
while isoflurane was delivered in oxygen. Propofol provided smooth, rapid induction and recovery, whereas Ducks recovering from isoflurane tended to struggle. Propofol offers several advantages over isoflurane for field use; equipment is easily portable, lower anaesthetic cost, and ambient temperature does not alter physical characteristics of the drug. Advantages over isoflurane, including lower nest abandonment following intra-abdominal radio transmitter placement, make propofol a good anesthetic choice for field studies.

Murphy and Fialkowski (2001) explained that ketamine should not be used alone because it is associated with poor muscle relaxation, muscle tremors, myotonic contractions, opisthotonus and rough recoveries. Additionally, there is inter-species variability in the response to ketamine. Recovery from ketamine, until the bird can perch or stand, can take 40 - 100 min, depending on dose, body temperature, metabolic health, and size of the bird. It is recommended that ketamine not to be used alone and be combined with benzodiazepines or alpha2-adrenergic agonists to improve relaxation and depth of anesthesia.

Maiti et al. (2006) studied three different combinations of ketamine to induce general anaesthesia for typhlectomy in 30 adult, single-comb White Leghorn cockerels. Birds in group I received xylazine-ketamine combinations at the dose rate of xylazine @ 2 mg/kg and ketamine @ 10 mg/kg IV, whereas birds of group II received diazepam @ 2.5 mg/kg IV followed by ketamine @ 75 mg/kg IM after 5 min. In the group III, midazolam @ 2 mg/kg IM followed by ketamine @ 50 mg/kg IV after 5 min were administered. Sedation, muscle relaxation and surgical anaesthesia were optimal and excellent in group I compared with the other two groups.
Derniges (2008) concluded that preanesthetic sedatives and other drugs should not be used in birds, with the exception of analgesics (e.g., butorphanol). Anticholinergic drugs such as atropine are not routinely administered to birds because thickened respiratory tract secretions increase the risk of airway or endotracheal tube occlusion. Isoflurane is currently the anesthetic agent of choice, although sevoflurane is also an excellent, albeit more expensive, option. Injectable anesthetics, such as propofol or medetomidine–ketamine (followed by reversal with atipamezole) may be useful for remote field locations where commercial shipment of hazardous gases and anesthetic agents is logistically complicated or prohibited.

Durrani et al. (2008) compared the synergistic efficacy of detomidine, ketamine and their cocktail in 15 Pigeons. All the Pigeons were divided into three equal groups A, B and C. Birds of groups A and B were intramuscularly administered detomidine and ketamine @ 1.4 and 60 mg/kg b. wt., respectively. Pigeons of group C received detomidine + ketamine cocktail @ 0.7 and 30 mg/kg b. wt. It was concluded that in Pigeons, detomidine (alone) is safe for handling and for least painful procedures, while detomidine ketamine cocktail is safe as intramuscular anaesthetic for major surgical procedures. However, ketamine is not a good anaesthetic to be used alone in pigeons.

Hoybergs et al., (2008) used isoflurane in oxygen for the general anesthesia after premedication with buprenorphine intramuscularly for the surgical repair of a tarsometatarsal fracture in a Harris’s Hawk. Closed reduction and stabilization using a Type IIa external skeletal fixation device
was performed during anesthesia lasting 70 minutes. Recovery was fast, uneventful and complete 15 minutes after isoflurane was stopped.

Kamiloglu et al., (2008) compared intraosseous (IO) and intramuscular (IM) anaesthesia in 16 Domestic Pigeons. Pigeons in group I received ketamine @ 50 mg/kg IO and birds in group II received ketamine @ 50 mg/kg IM. Clinical and anaesthetic effects of the ketamine used in different route were assessed. They found that IO drug administration provides a more rapid and effective anaesthesia and might be useful for the birds requiring urgent anaesthesia.

Durrani et al. (2009) studied a comparison of the clinical effects associated with xylazine, ketamine, and a xylazine-ketamine cocktail in 15 Pigeons. All the birds were divided into 3 equal groups: A - xylazine (16 mg/kg), B - ketamine (60 mg/kg) and C - xylazine-ketamine cocktail (8 mg/kg + 30 mg/kg, respectively). All treatments were administered intramuscularly. Results of the study suggested that in Pigeons the use of xylazine (alone) is safe for handling and less painful procedures while a xylazine-ketamine cocktail is a suitable anaesthesia for painful procedures at the dosages used in the study. Ketamine alone is not recommended for anaesthesia in Pigeons.

Azizpour and Hassani (2012) studied clinical evaluation of general anaesthesia using a combination of ketamine and diazepam in 32 Pigeons. Group D received a 0.5 ml mixture of diazepam (0.2 mg/kg) and normal saline, group K received 0.5 ml mixture of ketamine 5% (30 mg/kg) and normal saline, and group KD received 0.5 ml mixture of ketamine 5% (10 mg/kg), diazepam (0.2 mg/kg) and normal saline, while group C (control) received 0.5 ml of normal saline only. Each mixture was administered
intramuscularly. It was found that the combination of low dose ketamine and diazepam overcame the adverse effects of ketamine alone. This combination produced a more rapid induction of anaesthesia, as well as an increase in anaesthesia duration, with good muscle relaxation and a smooth and slow recovery.

Desai et al., (2012) compared ketamine-diazepam combination and isoflurane anaesthesia in 20 injured birds during kite flying festival. Recovery after use of the Isoflurane was smooth and easy in comparison to the use of ketamine-diazepam anaesthesia.

Uzun et al., (2013) studied effects of medetomidine-ketamine (M+K) combination anaesthesia on electrocardiographic findings, body temperature, and heart and respiratory rates in seven Domestic Pigeons. The application of this combination was investigated in Pigeons in terms of the degree of anaesthesia (DA) and alterations in physiological parameters. An intramuscular (IM) injection of M (200 µg/kg) was followed by administration of K (120 mg/kg, IM) after 10 minutes. It was found that M + K combination anaesthesia caused alterations in the physiological parameters in Pigeons, but they did not possess a life threatening effect. The application of M + K at these dose levels might produce a reliable and deep anaesthesia lasting 15 to 60 min.

2.5 Wound management

Degerns (1997) described the initial goal in treating contaminated or infected wound is the removal of devitalized tissue, foreign material and bacteria. The feathers surrounding the wound should be gently plucked or trimmed to allow more thorough cleansing and to prevent feather matting during the healing phases. Wound lavage will remove foreign material,
reduce bacterial numbers and rehydrate soft tissues. Sterile isotonic saline with or without 0.05% chlorhexidine or 0.5-1.0% povidone iodine solution is recommended for wound lavage. Wound debridement following lavage involves removal of as much of the devitalized and necrotic tissue as possible until viable, vascularized tissue is recognized. After lavage and debridement, the wound should be sutured, managed by second intention healing or managed as an open wound with delayed closure. Wounds less than eight hours old and not heavily contaminated or wounds that were surgically created under sterile conditions should be sutured. Older, infected or more complicated wounds should be managed as open wounds and allowed to heal by second intention.

Ferrell et al. (2004) studied assessment of a caudal external thoracic artery axial pattern flap for treatment of sternal cutaneous wound in 16 adult Japanese Quail. In six Quail (group I), an axial pattern flap was created from the skin of the lateral aspect of the thorax and advanced over the sternal defect. In eight Quail (group II), a flap was similarly created and advanced but the flap vasculature was ligated. Results indicated that the caudal external thoracic artery axial pattern flap could be used successfully in the treatment of surgically created sternal cutaneous defects in Quail with no signs of tissue necrosis or adverse effects overall.

Coles (2007) described the surgery of the skin and associated structures in birds. Overall the skin of birds is much thinner than that of mammals of comparable size. In the feathered area the thickness and strength varies between the feather tracts (pterylae) and the featherless areas between these tracts (apteria). In the apteria the dermis has a stronger mesh of collagen
fibers. Surgical incisions are best made in the apteria, parallel and midway between the adjacent feather tracts and the subsequent sutures placed in the apteria, where it is attached to the bone. The skin is best sutured using suture material swaged on to atraumatic, taper-pointed needles. There are numerous blood vessels, both capillary and larger vessels, within the skin and hemorrhage can be a problem. When possible, incisions should be made with a radio or laser surgical instrument.

Coles (2007) explained management of the lacerated wound caused by the telephone or barbed wire. If these wounds involve the anterior sternum, as they often do, there may be damage to the clavicular air sac, with resulting subcutaneous emphysema. This usually resolves spontaneously, but, if necessary, can be deflated with a hypodermic needle and syringe. Providing the wound is fresh and hemorrhage has been controlled it can be treated on a routine basis and usually heals by first intention without secondary infection. If skin has been lost and the wound has started to granulate, debride the wound and then cover with a hydrocolloid dressing.

Chaudhary et al. (2010) operated crop fistula under ketamine and diazepam anaesthesia in 16 baby Pigeons. The crop was sutured with (5-0) polyglycolic acid suture in single row continuous pattern and skin was sutured separately with nylon (4-0). Fourteen baby Pigeons recovered successfully however, two birds died post operatively.

Birds may often present with older, contaminated wound and wet to dry bandaging and delayed primary closure may be used to good effect. When preparing the wound for the surgery, the feather removal should be minimized as it is painful and highly stressful to the birds. Adhesive drapes reduce the
need for extensive feather removal and increase the ease and speed of surgery. Use of adhesive drapes would also decrease microbial contamination of the surgical site. Adhesive drapes impregnated with an anti-septic compound, like povidone-iodine reduces the wound contamination by 15 to 16%. Analgesia is an important part of wound management and butorphanol, tramadol and NSAIDs, such as meloxicam or carprofen, have been used to good effect (Barron and Powers, 2012).

2.6 Fracture management

Degernes (1997) explained use of the figure-of-eight wing bandage and wing-body wrap as external cooptation methods. The indications for figure-of-eight wing bandages include wing fractures distal to the elbow, most closed fractures of the radius and ulna, when the fragments are relatively well aligned; most fractures of the major and minor metacarpals; fractures that are too close to a joint or too comminuted to surgically repair; fractures in birds that may not require full return to flight capability; fractures in small or very young birds and following most orthopedic surgeries of the wing. Fracture or luxation involving the humerus, coracoid, furcula or scapula should be immobilized with a wing-body wrap.

Martin and Ritchie (1997) described use of numerous types of external fixation devices in birds. A variety of Kirschner wires and Steinman pins may be passed into the bones, and a variety of connecting bars and acrylic cements can be used for stabilizing the pins. These devices are inexpensive, lightweight, easy to remove and are well tolerated by many avian. When properly used, external fixators provide rigid stabilization and preserve joint and periarticular structure, while neutralizing rotational, bending and shear forces.
In many cases, external fixators allow a bird to use repaired limb within several days of surgery. External fixators can be applied in conjunction with intra medullary pins to further neutralize rotation and increase stability.

Wander et al. (2000) compared fracture healing after stabilization with intramedullary xenograft cortical bone pins in 30 mature Pigeons. Fractures were stabilized with intramedullary ostrich or canine xenograft cortical bone pins or Krischner wire. Xenograft cortical bone pins induced a mononuclear inflammatory reaction that did not impair bone healing. Bones stabilized with intramedullary cortical bone pins had more periosteal callus and inflammation at the fracture site than bones stabilized with stainless steel Krischner wires. The results indicated that intramedullary xenograft cortical bone pins, derived from mammalian or avian sources, appear to represent an alternative for the repair of avian humeral fractures.

Davidson et al. (2005) used plate fixation for the coracoid fracture repair in a Bald Eagle. Physical examination of the bird revealed crepitus in the left shoulder, and radiographs revealed a middiaphyseal coracoid fracture with overriding fragments. The fracture was surgically stabilized with 2 bone plates under isoflurane general anaesthesia. The figure-of-eight bandage and body wrap were used for 4 weeks after surgery to immobilize the left pectoral girdle and minimize the likelihood of injury. The eagle was released near the site it was originally located 121 days after presentation.

Coles (2007) stated that avian fractures heal in the same manner as those in mammals. This has been demonstrated by Bush et al. (1976), who showed that fibrous followed by cartilaginous callus develops from both the periosteal and endosteal membranes. The rate at which the bone heals is
probably a little faster than in mammals. It is most rapid in the smaller birds and one can detect signs of healing on X-ray plates within eight days. As in mammals, excessive displacement of the fractured ends, movement and infection all retard healing. The very rapid healing of the avian bones may be due to the swift mobilization of fibroblasts and the formation of collagen fibers binding the bones together, rather than to complete resolution of the fracture with newly formed bone. Under optimum conditions the gap between the fractured ends is filled with fibrous tissue within five days and cancellous bone within nine days. True bony union takes 22 days and complete remodeling takes six weeks.

Coles (2007) explained use of Redig’s ‘tie in’ technique for the humerus fracture repair in birds. The intramedullary pin can be smaller in diameter and lighter in weight since it only needs to fill 50% of the medullary cavity. At the pin’s exit it is bent at 180°. One or two further pins are inserted transversely through the two ‘solid ends’ of the bone. These should be threaded to provide a firm anchorage in the bone. The intramedullary pin which has been bent through 180° and the one or two transverse pins are rigidly connected using any suitable epoxy resin fixative such as Aradite, car body repair material or Technovit (horse hoof repair material) etc. After mixing the powder and liquid components of the epoxy to form putty like mixture this is then squeezed around the pins to form a rigid external bar after the plastic mixture has set rigidly in a few minutes. Alternatively, he used thermoplastic casting tape squeezed around the connections but the ends of the transverse pins are first bent at 90° with bent ends lying parallel to the
diaphysis of the bone. The tie in method achieves both longitudinal and rotational stability and is relatively light in weight.

Coles (2007) described use of External fixation for the long bone fractures of in birds. The pins pass perpendicularly at an angle of 30–45° through the skin and then through the cortex of the bone from one side to the other. Four pins are used, two in the proximal half of the bone and two in the distal half. The four pins traversing the bone are then clamped to a rod running parallel to the longitudinal axis of the bone. This is half-pin method. If the external clamping rod can be placed on the dorsal surface of the wing this causes less discomfort to the bird. If the pins are pushed further through the bone they can be clamped to another pin or bar on the other side of the bone, the full-pin technique. In this case the pins must be inserted perpendicularly to the longitudinal axis of the bone. The disadvantages of this method are increased weight, the need to insert four transverse pins, so increasing the likelihood of splitting the bone and also the more cumbersome nature of the device when compared with the tie-in method.

Gull (2011) compared three different miniplate systems in experimentally induced ulnar and radial fractures in 18 Pigeons. All the birds were divided into three equal groups. Three plate systems were used: in group A, a 1.3 adaption plate; in group B the same plate with washers to achieve a limited contact system; in group C a maxillofacial miniplate. Healing was evaluated with radiographs after two and four weeks, a flight test was performed after 4 weeks. Group A achieved the best flight results (100% good) and only the adaption plate 1.3 met the requirements for avian osteosynthesis.
Kubiak and Forbes (2011) described the use of tie in hybrid fixator for the repair of typical simple transverse tibiotarsal fractures. This technique provides rotational and longitudinal stability, and improved reduction and alignment, without the restriction of a splint. Tie-in fixators meet the requirements for avian fracture repair, with no need for cooptation, relatively low cost, avoidance of joint impairment and complete removal following healing. The use of tie-in fixators for closed tibiotarsal fractures has a good success rate with a complete return to function in the overwhelming majority of cases. ESF and intramedullary pins should be joined with a straight bar, restrained with circlage wires and overlaid with methyl methacrylate to secure the fixator. In the case of uneventful healing, the intramedullary pin should be removed 10 days following initial surgery and the ESF pins two weeks later.
CHAPTER – III

MATERIALS AND METHODS

The present clinical study entitled ‘STUDIES ON SURGICAL MANAGEMENT OF INJURED BIRDS DURING KITE FLYING FESTIVAL’ was carried out on clinical cases of injured birds during kite flying festival which were presented at the Department of Veterinary Surgery and Radiology, College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand and Veterinary Polyclinic, Vadodara, Department of Animal Husbandry, Gujarat, during November-2012 to February-2013.

Part A

3.1 Birds

The present clinical study was conducted on injured birds presented to the Department of Veterinary Surgery and Radiology, Anand and Veterinary Polyclinic, Vadodara with history of kite string injury.

3.2 Clinical Examination

3.2.1 General Information

Name of rescue team ________________________________________________

Village ____________ Taluka ____________ District______________

Date ___________ Mob no ________________
3.2.2 Detail Examination

<table>
<thead>
<tr>
<th>Species</th>
<th>Type of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wing injuries</td>
</tr>
<tr>
<td></td>
<td>Left wing</td>
</tr>
<tr>
<td>Pigeon</td>
<td></td>
</tr>
<tr>
<td>Kite</td>
<td></td>
</tr>
<tr>
<td>Owl</td>
<td></td>
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<tr>
<td>Goose</td>
<td></td>
</tr>
<tr>
<td>Stork</td>
<td></td>
</tr>
</tbody>
</table>

Part B

3.3 Instrumentation (Plate 3.1)

For the soft tissue surgery, instrument set consisted of three curved mosquito artery forceps, three straight mosquito artery forceps, three atraumatic tissue forceps, small rat tooth forceps, straight and curved small scissors, Bard Parker handle No. 3, Bard Parker blade No. 14, 1 ml tuberculin syringe with 26G needle, vicryl 3-0. For orthopedic surgery, instrument set consisted of the double ended threaded K-wires of different size (0.6-2.5 mm), K-wire introducer, pin cutter, micro hand drill, plier, bone cutting forcep,

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1 *Tuberculin syringe 1 ml with 26G needle*: BD 1ml Syringe, BD, Singapore.
2 *Vicryl 3-0*: Ethicon, Johnson & Johnson LTD, Aurangabad.
plastic straws/tubing of variable size and dental acrylic\(^3\). IITV (C-Arm)\(^4\) was used during the surgery for the image guidance.

### 3.4 Preoperative Stabilization (Plate 3.2a, 3.2b)

#### 3.4.1 Intra-osseous (IO) Catheter Placement

The anatomic site used for the IO catheter placement was distal ulna. The feathers were plucked from the site and the site was painted with alcohol to make it sterile. 20-24 gauze (depending upon the size of bird), 3.50 inch styletted spinal needle\(^5\) was used to minimize the potential problem with bone particles obstructing the catheter. After the aseptic site preparation, 2\% lignocaine\(^6\) was injected using tuberculin syringe at the entry point of the needle. The landmark for placement of the catheter is the dorsal condyle of the distal ulna, which is about 1 cm proximal to the tip of the carpus. The wing was supported with one hand while positioning the needle parallel to the ulna at flexor tendon groove just distal to the dorsal condyle. Using \(\frac{1}{4}\) turns back and forth, the needle was drilled into the cortex using firm pressure and minimal wobble. Once the needle was within the cortex, there was minimum resistance in advancing it to the hub. After that the stylet was removed and the needle was flushed with saline. This IO catheter was used just as an IV catheter and all the emergency medicines and fluids were administered through this route (Redig and Ponder, 2012).

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\(^3\) **Dental acrylic:** Rapid Repair, powder (110 g) and liquid (110 ml), Pyrax Polymars, 114/2, Krishan kunj, 7 civil lines, Roorkee-247667 (UK), India.

\(^4\) **C-arm:** Surgico 60D, Medico Imaging Company, Silvassa.

\(^5\) **Spinal needle:** BD Spinal Needle, Becton Dickinson India Pvt. Ltd., New Delhi.

\(^6\) **Lignocaine HCl:** Inj. Xylocaine (20mg/ml), Astra Zeneca Pharma, Bangalore.
3.4.2 Fluid therapy

All the birds were stabilized by giving warmed Ringers Lactate (RL) solution\(^7\) and Dextrose normal saline (DNS) solution\(^8\) @ 10-30 ml/kg/hour CRI using syringe pump\(^9\) through Intra-osseous (IO) route as per the blood loss and dehydration status, wherever feasible, otherwise routine infusion set was used. In case of the severe blood loss, administration of the synthetic colloid (Haemaccel)\(^10\) was done @ 10 ml/kg/hour.

3.4.3 Body temperature regulation

All the birds were kept on the orthopaedic clinical heating mats\(^11\) continuously to maintain the body temperature and to prevent the hypothermia during the pre-operative stabilization and surgery. After surgery, the birds were shifted to the pre-heated room using room heaters till the complete recovery of the birds.

3.4.4 Emergency drugs administration

In cases of the shock and severe trauma, dexamethasone\(^12\) was administered @ 2 mg/kg IO along with long acting enrofloxacin\(^13\) @ 15 mg/kg IO. The birds with severe blood loss were given vitamin B complex\(^14\) @ 10

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\(^7\) Ringers Lactate (RL) solution: inj. RL, Nirlife Healthcare, Gujarat.
\(^8\) Dextrose normal saline (DNS) solution: inj. DNS, Nirlife Healthcare, Gujarat.
\(^9\) Infusion pump: Infutek 400, Simtek Medico Systems Pvt. Ltd. India.
\(^11\) Orthopaedic Clinical Heating Mat: Activeheat, Home Care Remedies, Mumbai.
\(^12\) Dexamethasone: Inj. Dexona (4mg/ml), Zydus LTD, Ahmedabad.
\(^14\) Vitamin B complex: Inj. Tribivet, INTAS, A’bad, Gujarat, India.
In all the birds, meloxicam\textsuperscript{15} was administered as a NSAID @ 0.1 mg/kg. The birds with a severe respiratory distress and dyspnea were administered with doxapram\textsuperscript{16} @ 10 mg/kg IO.

3.4.5 Passive oxygenation

The injured birds with severe respiratory distress and showing the signs of gasping were subjected to passive oxygenation. An appropriate sized non-cuffed endotracheal tube\textsuperscript{17} was used for the administration of the passive oxygen.

3.5 Anaesthesia

After stabilizing the patient, in case of all the birds for any surgical intervention butorphanol\textsuperscript{18} was administered @ 0.1 mg/kg IO, IM to provide peri-operative analgesia. All the minor surgeries including suturing of the wound were done under the local anaesthesia using 2% lignocaine @ < 4mg/kg. In case of simple lacerations and minor wounds, lignocaine gel\textsuperscript{19} was applied. All the major orthopaedic surgeries were done under the general anaesthesia using mixture of ketamine\textsuperscript{20} @ 5 mg/kg and diazepam\textsuperscript{21} @ 0.5 mg/kg IO.

\textsuperscript{15} Meloxicam: Melonex, Neovet, INTAS,A’bad, Gujarat, India.
\textsuperscript{16} Doxapram: Inj. Caropram (20mg/ml), Khandelval Lab. Pvt. Ltd. Mumbai.
\textsuperscript{17} Non-Cuffed Endotracheal tube: Jorvet, Jorgensen Laboratories, 1450 Van Buren Ave, Loveland Co 80538 USA.
\textsuperscript{18} Butorphanol: Inj. Butodol-1 (1mg/ml), Neon Laboratories Ltd., Mumbai.
\textsuperscript{19} Lignocaine gel: Xylocaine Jelly (2%), Astra Zeneca Pharma, Bangalore.
\textsuperscript{20} Ketamine: Inj. Ketmin 50 (50mg/ml), Themis Medicare Ltd., Haridwar.
\textsuperscript{21} Diazepam: Inj. Anxol (5mg/ml), Maneesh Pharmaceuticals Ltd., Mumbai.
3.6 Operative Procedure

3.6.1 Preparation of the surgical site (Plate 3.3)

3.6.1.1 Feather plucking

In case of all the wounds involving the skin, minimum plucking of the feathers was done. The feathers present on the edges of the wound were only removed by gentle plucking to allow more thorough cleansing and to prevent feather matting during the healing phases.

3.6.1.2 Wound lavage

The wound lavage was done using warm sterile normal saline with 0.5% povidone-iodine solution\textsuperscript{22} to remove foreign material, reduce bacterial numbers and rehydrate soft tissues.

3.6.1.3 Adhesive drape

To minimize the feather removal, adhesive drape was applied before performing any surgery as feather removal is highly stressful and painful to the birds. Micropore adhesive tape\textsuperscript{23} was used as an adhesive drape to decrease the microbial contamination of the surgical site.

3.6.1.4 Wound debridement

After covering the wound with adhesive drape, wound debridement was done using Bard Parker blade No. 14 to remove as much of the devitalized and necrotic tissue as possible until viable, vascularized tissue was recognized.

\textsuperscript{22} 5 \% povidone-iodine solution: Betadine, Win Medicare Pvt. Ltd., New Delhi.
\textsuperscript{23} Micropore adhesive tape: Micropore Surgical Tape, 3M India Ltd., Pune.
3.6.2 Propatagium injury (Plate 3.4a, 3.4b)

3.6.2.1 Wound suturing

The wound involving propatagium was closed from both the sides (dorsal and ventral) by simple interrupted sutures using vicryl 3-0 absorbable suture material. In case of small birds (Pigeons, Egrets) the wound was closed in a single layer including both muscle and skin together, while in case of large birds (Goose, Stork, and Duck), the wound was closed in a double layered pattern including muscle and skin separately.

3.6.2.2 Anti septic dressing

In case of the minor bruises and abrasions, anti-septic dressing was done using 5% povidone-iodine solution and cetrimide spray\textsuperscript{24}.

3.6.2.3 Infected wound

The older, infected and more complicated wounds were managed as open wounds and allowed to heal by second intention.

3.6.2.4 Application of prolene mesh

A goose was presented with old contaminated propatagial wound and previously the wound was applied with lindane (benzene hexachloride) powder. After proper cleaning and debridement, the wound was sutured routinely. But, there was a necrosis, loss of the tissue and a gap was developed in the propatagium. Hence a polypropylene surgical mesh\textsuperscript{25} was inserted between the two edges of the wound by suturing the mesh between the two layers of the propatagium.

\textsuperscript{24} Cetrimide spray: Healex Plus Spray, Shreya Life Sciences Pvt. Ltd., Andheri (E), Mumbai, India.
\textsuperscript{25} Polypropylene surgical mesh: Prolene Mesh, Ethicon, Johnson & Johnson LTD, Aurangabad.
3.6.3 Humerus fracture (Plate 3.5a, 3.5b)

Application of an Intra-medullary pin tie-in fixator to a humeral fracture

A small sized intramedullary pin (K-wire) with threading at two ends was used to repair the humerus fracture. Under the C-arm guidance, pin was inserted retrograde initially into the proximal fragment of the bone and then inserted normograde into the distal fragment. At the pin’s exit at proximal side, it was bent at 90°. One threaded K-wire of very small size (1.2-1.5 mm) was transversely inserted into the proximal fragment through the two ‘solid ends’ of the bone and the other K-wire of same size was inserted into the distal fragment in the same manner. A plastic straw was placed over the interface pin and the two K-wires. The intramedullary pin which had been bent through 90° and the two transverse pins were rigidly connected using liquid dental acrylic. After mixing the powder and liquid components of the dental acrylic to form putty like mixture this was then squeezed around the pins to form a rigid external bar. To assure proper rotational alignment, the wing was then fold against the body in a normal resting position and hold until the acrylic cured. The wound was then closed by simple interrupted sutures using vicryl 3-0 absorbable suture material.

3.6.4 Radius-ulna fracture (Plate 3.6)

In case of the simple fractures involving radius-ulna, C-arm guided normograde intra-medullary pinning was done in ulna using small sized pin or K-wire as per the size of the bone. While, in case of the compound fractures the pin was inserted retrograde initially into the proximal fragment of the bone and then it was inserted normograde into the distal fragment of the ulna. The radius was left untouched as it was comparatively thinner to ulna. The wound
was then closed by simple interrupted sutures using vicryl 3-0 absorbable suture material.

3.6.5 Wing amputation (Plate 3.7)

In case of the irreparable injuries, necrosis, severe infection, tissue loss and old fracture, amputation of the wing was done as a last resort to save the life of the bird. The amputation was performed at the level of the mid shaft of the humerus. The incision was made near the elbow joint, and all the bleeding vessels were ligated. The humerus was cut from the midshaft using bone cutter and the wound was closed by simple interrupted sutures using vicryl 3-0 absorbable suture material.

3.6.6 Limb injury (Plate 3.8)

3.6.6.1 Limb laceration

The simple wound involving the leg of the bird was closed by simple interrupted sutures using vicryl 3-0 absorbable suture material.

3.6.6.2 Limb fracture

In case of the dislocations involving the tibiotarsus bone, major metatarsal bone external cooptation was provided using thermoplastic light weight cast bandage\(^\text{26}\). In case of the tibiotarsal fracture, retrograde intramedullary pinning was done.

3.6.6.3 Foot injury

The wound involving the foot was bandaged with an interdigitating bandage that leaves the toes exposed for perching. While in case of the fractures and dislocations of the toes (phalanges) ball bandage was applied.

\(^{26}\) Light weight cast bandage: Cobra Cast, Korea.
Materials and Methods

3.6.6.4 Limb amputation

In case of the old fractures and irreparable injuries involving the limb of the bird, amputation of the limb was done as a salvage surgery to save the life of the bird.

3.6.7 Crop fistula (Plate 3.9).

The crop was sutured with a double layer of inverting sutures using vicryl 3-0 and the skin was closed with simple interrupted sutures using nylon 3-0.

3.6.8 Head Injury (Plate 3.9).

In case of the head injury due to the skin and tissue loss, the wound was managed as open wound and allowed to heal by second intention.

3.6.9 Body injury (Plate 3.9).

The wound involving body of the bird was closed by simple interrupted sutures using vicryl 3-0 absorbable suture material.

3.7 Post-operative care (Plate 3.10a, 3.10b, 3.10c)

3.7.1 Wing Injury

Figure-of-eight wing bandage was applied using self-adherent wrap\textsuperscript{27} for ten days to protect the wound from self-mutilation. The wing was kept open in cases of the fractures involving humerus and radius-ulna.

3.7.2 Limb injury

The wounds involving the tibiotarsus and tarsometatarsus were protected by applying a simple bandage using self-adherent wrap, while the wounds of the foot region were secured by applying interdigitating bandage or ball bandage using the same as per the clinical condition. In case of the simple fractures and

\textsuperscript{27} Self-adherent Wrap: Coban, 3M Health Care, St. Paul, MN, U.S.A.
dislocations of the limb, external cooptation was provided using light weight cast bandage for 21 days.

3.7.3 Crop fistula

The wound was kept open and the bird was given semi-solid/liquid diet for 3 days after surgery.

3.7.4 Head and body injury

In cases of the injury involving head or body of the bird, the wound was kept open.

3.7.5 Anti Septic Dressing

In case of all the birds, regular cleaning and anti-septic dressing of the wound was done at every third alternate day with warm normal saline, 5% povidone iodine solution, cetrimide spray and cephalexin powder.²⁸

3.7.6 Post-operative Medication

In case of the birds with fractures, a broad spectrum systemic antibiotic like ceftriaxone sodium and tazobactam combination²⁹ was administered @ 75 mg/kg IM/IO for seven days. While rest of all the birds were treated with enrofloxacin @ 15 mg/kg IM/IO for five days.

Meloxicam was used as a NSAID in case of all the birds and administered @ 0.1 mg/kg IM/IO for three days, while vitamin B-complex injection was administered @ 10 mg/kg IM for once in a week. To reduce the stress, multivitamin drops were given orally.

²⁸ **Cephalexin powder**: Lixen Powder (20 g), Virbac Animal Health Pvt. Ltd., Mumbai.
²⁹ **Ceftriaxone sodium and tazobactam**: Inj. Intacef tazo pet (562.50 mg), INTAS,A’bad, Gujarat, India.
In case of the birds with dehydration and weakness, dextrose normal saline (DNS) was administered @ 10 ml/kg/hr IO. The birds which were unable to take the feed by their own, forceful hand feeding was given.

3.7.7 **Provision of the food and shelter (Plate 3.10c, 3.11a, 3.11b, 3.11c)**

The birds were classified and provided with separate shelters according to their family and feeding habits till the complete recovery. According to the habitat of the bird, shelter was provided with facilities like Water pool for the duck, grassland for goose, tree trunk for the prey birds (Kite, Buzzard, Owl) etc. In the same manner, as per the natural feeding habit of the bird, food was offered to them like fish to the Storks, meat to the prey birds, grass and paddy for the Ducks and Goose, cereals to the Pigeons etc. Forceful hand feeding was done in case of birds which refused to take the food by their own.

3.8 **Evaluation of Surgical Outcome**

Birds were clinically examined for flying acuity once in a week up to one month and thereafter 15 days for a variable time period. Outcome of the surgery as well as the complications, if any, were recorded.

The surgical result was categorized as good, fair and failure. The good surgical result was assigned to the bird which had completely healed wound with full restoration of the normal flight one month after the surgery.

The fair surgical result was assigned to the bird in which good surgical result was hampered by some postoperative complications, sufficient to prevent restoration of good flight, but not as great as to result in total disability to fly.

The failure of the surgery was nominated to the bird which died during post-operative period or became totally disabled to fly due to the infection,
necrosis, tissue loss, amputation of the wing and limb and non-union of the fracture.

3.9 Rehabilitation

Fully recovered birds with restoration of good flying acuity were released at different places in the environment as per their natural habitat.
CHAPTER – IV

RESULTS

Avian surgery has gained a wide acclaim all over the world in recent years. This is primarily because of increased awareness among the people regarding wild life health care coupled with availability and success of modern techniques of avian medicine and surgery.

A detailed study was undertaken in 168 injured birds due to the kite string or other injuries presented to the Department of Veterinary Surgery and Radiology, Veterinary College, Anand and Veterinary Polyclinic, Vadodara during November 2012 to February 2013. The history of the birds regarding species, type of injury, weight, and probable etiology were recorded. All 168 clinical cases of kite string injuries were treated for the respective injuries. The results on incidence of the bird injury and its surgical management during kite flying festival are documented in this chapter.

PART A

Incidence of bird injury during kite flying festival

Anamnesis regarding species, no. of the birds received and different types of injury is presented in Table 4.1 and Charts 4.1 to 4.7.

Based on species predisposition, the highest incidences of kite string injuries were observed in Blue-rock Pigeons (116, 69%) followed by Common Pariah Kites (21, 12.5%), Barn Owls (4, 2.38%), Indian Peahen (3, 1.78%) and Cattle Egrets (3, 1.78%). There were two cases each (1.19%) of Black-eared Kite, Indian Peafowl, Comb Duck, Greylag Goose and Black Ibis followed by one case each (0.59%) of Woolly-necked Stork, Honey Buzzard,
Results

Painted Stork, Khakhi campbell Duck, Domestic Duck, Changeable Hawk-Eagle, Peregrine Falcon, Montagu’s Harrier, Demoiselle Crane, Indian Fowl and Domestic Turkey (Chart 4.1).

Out of 168 clinical cases, 55 birds (32.73%) had left wing injuries, 44 (26.19%) right wing injuries, 12 (7.14%) bilateral wing injuries, 22 (13.10%) wing fractures, five (2.98%) left limb injuries, four (2.38%) right limb injuries, two (1.19%) bilateral limb injuries, seven (4.16%) limb fractures, 12 (7.14%) body injuries, three (1.78%) head injuries and two (1.19) crop injuries (Chart 4.2).

Out of 168 clinical cases, 133 (79%) birds with different wing injuries were categorized as- left wing propatagium injury - 55 (41.35%), right wing propatagium injury - 44 (33.08%), bilateral wing propatagium injury - 12 (9%) and wing fractures - 22 (16.54%). The cases presented were more with left wing propatagium injury (55) and least with bilateral wing propatagium injury (12) (Chart 4.3).

On the basis of the type of injury, 18 (10.71%) birds with different limb injuries were categorized as - left limb injuries - 05 (27.77%), right limb injuries - 04 (22.22%), bilateral limb injuries – 02 (11.11%) and limb fractures - 07 (38.88%) (Chart 4.4).

Out of 168 clinical cases, 139 (82.74%) birds had different soft tissue injuries, while 29 (17.26%) had fractures involving different bones (Chart 4.5).

Out of 22 (13.10%) clinical cases of wing fractures, 13 (59%) birds had humerus fracture, 08 (36.40%) fracture of the radius-ulna and 01(4.60%) major metacarpal fracture (Chart 4.6).
Results

Out of 7 (4.16%) clinical cases of limb fractures, 03 (42.85%) birds each had tibiotalar and phalangeal fractures, and 01 (14.28%) tarsometatarsus fracture (Chart 4.7).

PART B

4.1 Preoperative stabilization

Administration of fluids and emergency drugs through intra osseous (IO) route was done for stabilization of the birds. IO route in the distal ulna was easy and safe to administer the medications. Orthopaedic clinical heating mats helped to prevent the hypothermia and ultimate development of shock in critical patients. Recovery time of the birds from anaesthesia was reduced with the use of the heating mats.

In cases of the birds with severe trauma and shock, administration of dexamethasone @ 2 mg/kg IO aided in recovery. The birds with significant blood loss and signs of respiratory distress improved after the passive oxygenation.

4.2 Anaesthesia

Administration of butorphanol @ 0.1 mg/kg IO resulted in desired analgesia during surgery. Use of 2% lignocaine @ < 4 mg/kg as a local anaesthetic was satisfactory for desired surgical intervention without any complication post-operatively. General anaesthesia administered in 31 birds using mixture of ketamine @ 5 mg/kg and diazepam @ 0.5 mg/kg IO showed slight respiratory depression and somewhat delayed recovery. Three injured birds failed to recover after general anaesthesia and treatment.
4.3 Preparation of the surgical site

Wound lavage using normal saline with 0.5% povidone-iodine solution effectively removed the debris, clots and crushed glass from the kite string. Use of micropore surgical tape as an adhesive drape minimized the feather plucking and reduced the contamination of the wound during surgery.

4.3 Propatagium injury (Plate 4.1 - 4.4)

Closure of the propatagium wound on both the sides (dorsal and ventral) with simple interrupted sutures using vicryl 3-0 showed uneventful healing in majority of the cases after ten days of surgery (78 out of 111). However, breakdown of the sutures occurred in 13 cases. In two cases the sutures were broken by the bird itself.

In case of the Greylag Goose, polypropylene surgical mesh was anchored using vicryl 3-0 sutures between the two edges of the gap that developed in the propatagium. After ten days, the mesh got anchored in the tissue at one edge of the gap, but the opposite edge gave way due to absence of any tissue for the attachment, as ulna was stripped of tissue due to injury. The gap developed due to the tissue loss could not be filled up, hence the mesh was removed.

4.4 Humerus fracture (Plate 4.5a - 4.5c)

Application of an intra-medullary pin tie-in fixator to a humeral fracture gave good results. The use of the dental acrylic to secure the intra-medullary pin with external transverse pins yielded satisfactory results. Use of dental acrylic in tie-in external fixator gave rigid stability to the assembly and was simple to use, cheap and readily available. The tie in fixator was applied in five birds with
humerus fracture, out of which, in two birds clinical union of the fractured fragment occurred 21 days after surgery. However, in one case mal-union of the fractured fragment occurred and two birds died on second and fifth post-operative days. In two birds with humerus fracture, intra-medullary pinning was done, out of which, in one case clinical union occurred, while other bird died during surgery.

4.5 Radius-ulna fracture (Plate 4.6)

In three birds with radius-ulna fracture, under C-arm guidance, intra-medullary pinning was done. Out of that, one survived and developed clinical union 35 days after surgery and the other died on third post-operative day.

4.6 Wing amputation

Wing amputation was performed in nine birds at the level of humeral mid shaft in cases of the irreparable injury, severe infection, tissue loss, old fracture and necrosis in order to save the life of the bird. In all these cases surgical wound healed without any complication within ten days.

4.7 Limb injury

External co-optation was provided using light weight cast bandage in one bird with stifle joint dislocation. The bird died after 15 days, probably due to sepsis following extensive bed sores caused by sternal recumbency.

In case of two birds with tibiotarsal fracture, retrograde intra-medullary pinning was done. One bird died post-operatively, while in other clinical union of the fractured fragment occurred 21 days after surgery (Plate 4.7).

The wound involving the foot was bandaged with an interdigitating bandage in three birds. The bird could perch without any discomfort after
application of the interdigitating bandage, and in all cases wound healed without any complications within ten days (Plate 4.8).

Limb amputation was done in one case with old metatarsal fracture. The wound healed without any complication.

### 4.8 Other injuries

In case of two birds with crop fistula, the crop was sutured with a double layer of inverting sutures. Both the birds started taking food normally after two days and the wound healed without any complication (Plate 4.8).

Two birds had the head injury, which was managed as an open wound with regular anti septic dressing. In both the birds, the wound healed without any complications.

In case of two birds with body injuries, the wound was closed by simple interrupted sutures using vicryl 3-0 absorbable suture material. In both the birds, the wound healed without any complication.

### 4.9 Post-operative care

The use of self-adherent wrap for the application of the figure-of-eight wing bandage gave excellent result. In majority of the cases, the wound was well protected from the self-mutilation by the self-adherent wrap and it healed without any complication.

Immobilization with light weight cast bandage as an external co-optation was satisfactory and there was no complication associated with it.

Use of the warm normal saline, 5% povidone iodine solution and cephalexin powder for the anti-septic dressing gave satisfactory results. In majority of the cases the wound was dry with less discharge.
Enrofloxacin @ 15 mg/kg IM/IO proved to be satisfactory for any soft tissue surgical intervention. In majority of the cases there was no infection. However, seven Common Pariah Kites developed severe wing infection even after the administration of the enrofloxacin (Plate 4.4). These seven birds were again administered a course of ceftriaxone and tazobactam combination @ 75 mg/kg IM which gave satisfactory result. However, flight could not be restored in all these birds.

Use of ceftriaxone and tazobactam combination @ 75 mg/kg IM/IO for seven days gave good results in all the orthopedic cases. The wound was completely dry two days after surgery in majority of the cases. The use of the meloxicam @ 0.1 mg/kg IM/IO was found satisfactory for the pain management during post-operative period.

Forceful hand feeding in >20 case of the weak birds during post-operative period yielded desired results. It helped in rapid recovery of the birds. In majority of the cases, birds started taking food within three days of surgery.

Provision of the individual shelter as per the family, feeding habits and habitat of the birds helped in reducing the stress of the birds and the birds started recovering early. In majority of the birds, based on the demeanor, it was observed that the level of the fear reduced to a great extent within few days and started taking food and water normally.

4.10 Evaluation of the surgical outcome

Flying acuity was assessed by allowing the bird to fly in a large closed area. Complete return of flight was observed in majority of the birds within 20 days. In 27 cases partial flight could be restored. 38 birds died during the
Results

post-operative period. In 20 birds flight could not be restored. It was observed that all the birds with fresh wound/fracture showed excellent results.

On the whole, good surgical results were observed in 49% cases (83 out of 168) followed by fair in 17% (29 out of 168) and failure in 34% (58 out of 168) cases (Chart 4.8)

4.10 Rehabilitation (Chart 4.9, Table 4.2)

65% birds (110 out of 168) with complete recovery and good flying acuity were released in the environment at different places as per their natural habitat (Plate 4.9a – 4.9c).

In 12% birds (20 out 168) flying acuity could not be restored and became permanently disabled. Such birds were sent to different permanent shelters according to their species run by forest department and different N.G.Os.

During this study, the survival rate of the birds was 77% (130 out of 168) and the success rate was 65% (110 out of 168).
DISCUSSION

The present study was undertaken to study the incidence of different injuries to the birds during kite flying festival and to standardize the surgical management of these injuries.

In total 168 clinical cases of the injured birds during kite flying festival were studied in detail. History related to species of the bird and type of injury was recorded. All the birds were treated for the respective injury and kept indoor till the complete recovery. The results of the studies on incidence of bird injuries during kite flying festival, its surgical management and standardization of emergency and critical care in birds are discussed in this chapter.

5.1 Incidence of bird injuries during kite flying festival

In the present study, the incidence of bird injuries was more in the Blue-rock Pigeons (116, 69%) followed by Common Pariah Kites (21, 12.5%). Similarly, in a study, among 3826 injured birds during kite flying festival, the incidence was more in Blue-rock Pigeons (2618, 68%) followed by Common Pariah Kites (749, 19%) (Tiwari et al., 2011).

Out of 168 clinical cases, left wing injuries were 55 (32.73%), right wing 44 (26.19%) and bilateral 12 (7.14%). In 49 White rumped Vultures with kite string injuries, 24 (49%) left wing, 15 (31%) right wing and 7 (14%) bilateral injuries were recorded (Kavechiya et al., 2012). The involvement of left wing is more, probably due to reflex deviation to the
right in the event of threat, hence predisposing left wing to thread injury (Anonymous).

5.2 Surgical management of injured birds during kite flying festival

Traumatic injuries are common in birds. The initial protocol for injured birds includes control of haemorrhage, oxygenation, heat support, analgesics and parenteral antibiotics. External haemorrhage should be stopped immediately (Bowles et al., 2007). The goal of treatment is patient survival first and then assessing traumatized tissue. A bird that has been struggling for hours with a trapped wing may have a fractured bone, but is in more danger of dying from stress related to prolong struggling than complications from the fracture itself. Temporary stabilization of the traumatized tissue is enough until the bird is stable (Lightfoot, 2008).

In the present study, stabilization of the birds was done by administration of the fluids and emergency drugs through intraosseous (IO) route. IO route in the distal ulna was easy and safe to administer the medications. Once the spinal needle was fixed in the distal ulna, then even the conscious bird could not disturb it. IO cannulation provides access for critical fluid and medical therapy in the event that intravenous access is not possible (Morgan, 2008). IO catheterization may be preferable to IV catheterization, as the latter is often more technically difficult in terms of placement/maintenance and has a higher risk of significant blood loss if removed by the bird. IO catheters can be placed in the distal ulna, proximal tibiotarsus and lateral femur. Short spinal needles, 20-22G, were used for larger birds and 22-25G for smaller birds as suggested (Silva, 2012).
Use of orthopaedic clinical heating mats helped to prevent the hypothermia and ultimate development of shock in critical patients. Birds are generally efficient homeotherms. Normal core body temperatures are around 105 F (40.5 C). In an emergency situation, however, heat loss is often exacerbated in birds, particularly those that are in shock, very ill, or undergoing treatment for trauma with administration of fluids, oxygen, or general anesthesia (Jenkins, 2005). Hot water bottles and heating pads are readily accessible and cheap and are ideal for taking into the field. However, care must be taken and it is recommended that heated objects such as hot water bottles be wrapped in a towel before use (Morgan, 2008).

The aids of supportive care are heat, fluid administration, oxygen supplementation and gavage feeding. The optimum temperature for the ill bird is 29-30°C. Heat sources should include a heating pad, clamp lamp, ceramic heat emitter or light bulb on one side of the cage avoiding direct contact of the heat source with the patient or putting the cage in a room with a space heater combined with thermometers to monitor cage temperature. Birds should be transported to the hospital in a warm enclosure (Harrison & Lightfoot, 2006).

Administration of the dexamethasone in cases of the severe trauma and shock helped in recovery. Beneficial effects of corticosteroid administration are improved capillary membrane integrity, stabilization of lysosomal membranes, improved tissue perfusion and microcirculation, and gluconeogenesis. For optimum effect, water soluble drugs, such as dexamethasone (2 mg/kg) and prednisolone sodium succinate (2–4 mg/kg) should be given for the first 24–48 hours (Ford et al., 2008).
The birds with severe blood loss and signs of respiratory distress improved after the passive oxygenation. Dyspnoic patients will benefit from the provision of supplemental oxygen; either via a mask or in an oxygen tent, prior to further handling. Stress resulting from handling and other procedures can be fatal in a severely debilitated bird. Clinical signs suggestive that handling for examination is contraindicated until the bird is stabilized include prolonged dyspnoea, and prolonged panting and gasping for air. These patients benefit significantly from oxygen therapy prior to handling. Prior to examination, oxygen may be administered in a chamber where the air comprises 40–50% oxygen (Morgan, 2008).

Indications for O\textsubscript{2} therapy include respiratory/cardiac disease, shock, post-surgical recovery and stress. Critical patients may have a diminished CO and O\textsubscript{2} maximizes cardio-respiratory efficiency. For any dyspnoic bird, O\textsubscript{2} is recommended and hyper-oxygenating the patient prior to handling may also decrease its risk. Some patient’s don’t tolerate masks and if an oxygen cage is not available, most incubators, cages and aquariums can be modified so that supplemental O\textsubscript{2} can be provided into them. For most critical patients kept in a closed clear chamber, a 40-50% O\textsubscript{2} saturation level is recommended (Echols, 2007).

Administration of butorphanol @ 0.1 mg/kg IO resulted in desired analgesia during surgery. Butorphanol is the most effective and safe analgesic for Psittacines available thus far. Butorphanol can be administered as a part of pre-anesthesia, delivered @ 1 mg/kg/hour IV or IO continuous rate infusion (CRI) with fluids throughout surgery and/or post surgically at recovery. Butorphanol (0.5-1 mg/kg) intramuscularly has been shown as a
useful analgesic in birds (Lennox and Nemetz, 2011). Regardless of the severity of disease, analgesia should always be considered in any critically ill patient; especially if the illness is trauma related. Opioids such as butorphanol (0.4–2.0 mg/kg IM) are commonly used; especially to provide perioperative analgesia (Ford et al., 2008). Most seriously ill birds experience pain and anxiety during hospitalization and administration of analgesics is strongly recommended in these birds (Lichtenberger 2005).

Pharmacodynamic studies have demonstrated that Pigeons have more kappa opioid receptors than mu opioid receptors. This one piece of information in Pigeons is used to explain why birds do not respond as do mammals to mu agonists like morphine, buprenorphine and fentanyl, and why kappa opioids, such as butorphanol, may be more efficacious analgesic in birds (Murphy and Fialkowski, 2001)

Use of 2% lignocaine @ < 4 mg/kg as a local anaesthetic along with butorphanol sedation @ 0.1 mg/kg IO was satisfactory for desired surgical intervention and did not show any complications post-operatively. Local anesthetics block ion channels to prevent pain impulse generation and conduction, and they should be combined with general anesthesia when used in birds to reduce handling stress. Lidocaine (maximum recommended dose: ≤4 mg/kg to prevent toxicosis) can be used preoperatively (Degernes, 2008). Lidocaine and bupivacaine are local analgesic agents that can be used in conjunction with sedation for procedures that may produce mild to moderate discomfort, such as intraosseous catheterization wound cleansing and debridement, lancing of abscesses and amputation of digits. Sedation, with the addition of local analgesia when indicated, is a viable alternative to general
Discussion

anesthesia for those procedures where stress of handling and/or general anesthesia carries excessive risk. While more data is required to directly compare relative safety, it is clear that sedation is not associated with increased risk when compared to general anesthesia (Lennox, 2011).

General anaesthesia administered in 31 birds using mixture of ketamine @ 5 mg/kg and diazepam @ 0.5 mg/kg IO showed slight respiratory depression and somewhat delayed recovery. The combination of ketamine and diazepam provides more ideal conditions for the veterinary surgeon. It produces rapid induction of anaesthesia and increases the duration of anaesthesia. The recovery is smooth but slow in the Pigeons anaesthetised with the ketamine and diazepam combination. There is a good muscle relaxation without any adverse effects. It can therefore be considered an important tool for the light anaesthesia of Pigeons (Azizpour and Hassani, 2012).

Wound lavage using normal saline with 0.5% povidone-iodine solution effectively removed the debris, clots and crushed glass from the kite string. Copious warm lavage of the wound to remove surface contaminants is recommended at a pressure of 7–8 psi, which can be achieved with a 20–30-ml syringe and an 18-gauge needle. Commonly used lavage solutions include sterile isotonic saline, dilute chlorhexidine, hydrogen peroxide, and dilute povidone iodine (Grunkemeyer, 2011).

Use of micropore surgical tape as an adhesive drape minimized the feather plucking and reduced the contamination of the wound during surgery. Feather removal is painful and highly stressful hence, its removal during preparing the wound for surgery is minimized. Adhesive drapes
reduce the need for extensive feather removal and increase the ease and speed of surgery (Barron and Powers, 2012).

It is important to understand the anatomy and function of a normal wing before assessing injuries or recovery. The radius and the ulna work together when the elbow and carpus are extended or flexed. It is the radius’ ability to rotate around the ulna that allows the bird to have lift or descent. The extension of the proximal wing moves the ulna distally, which pushes the carpometacarpus into extension (Beaufrere, 2009). Flight feathers should be examined for correct spacing during flexion and extension of the wing. The propatagium of the wing should also be routinely palpated and examined. This important web of skin contains the propatagial tendons and ligaments that are necessary for flight. These structures provide elasticity and connectivity that reduce turbulence when a bird is in flight. Contraction of the propatagium will occur when the wing is immobilized for fractures or wound management (Hildreth, 2011).

An intact and flexible propatagium is necessary for the airfoil function of the wing. Traumatic damage to the propatagium often results in the development of fibrous, inelastic scar tissue that limits wing extension and impedes flight, while excessive or prolonged cooptation will often result in contracture and loss of flexibility. The tensor propatagialis muscle is a complex muscle with 2 major tendons of insertion. The pars longus tendon connects to the extensor process of the carpometacarpus and runs along the cranial margin of the wing forming the leading edge of the airfoil. The pars brevis tendon inserts on the fascia overlying the forearm musculature, and becomes the interremigial ligament. Trauma to any of these structures is
difficult to repair and has a high risk of decreasing flight capacity (Ponder, 2011)

Flight styles vary among birds, but the principles of flight are consistent. The wing functions as an airfoil to produce lift; the air passing over the top of the wing moves more quickly than the air passing under the wing. This creates a pressure differential, with the lower pressure being on the top side of the wing, causing lift. The airfoil is created by the musculoskeletal system, skin, propatagium, and feathers. The propatagium is composed of skin and elastic connective tissue fibers. Damage to this structure is of concern as it is difficult to repair, with injuries often resulting in contracture and rendering the bird flightless. Normal anatomy in the wing is needed to create an ideal airfoil for the bird. Lacks of extension, loss of joint range of motion, loss of flight feathers, or reduction in the flexibility of the propatagium will all impact flight capacity (Orosz, 2002).

Closure of the propatagial wound on both the sides (dorsal and ventral) with simple interrupted sutures using vicryl 3-0 showed uneventful healing in majority of the cases within ten days of surgery. Delay in return of flight was attributed to compromised post-operative management like irregular anti-septic dressing and post-operative medication. In a bird rescue camp, in case of six white backed vultures and two peacocks injured during kite flying festival, the muscle layer was opposed with vicryl 2-0 in interrupted pattern and dorsal and ventral layers of propatagium were sutured with vicryl 3-0 in continuous pattern (Sutaria and Sutaria, 2012; Sutaria et al., 2012).

The use of physical therapy, specifically passive range of motion (PROM) techniques, is critical to successful rehabilitation of raptors with wing
injuries (Scott, 2010). Goals using PROM therapy are to achieve full wing extension and improve propatagial elasticity without causing further injury and minimal pain. PROM on raptors should be done under general anesthesia to reduce stress and pain responses. The amount and frequency of PROM therapy can vary based on the bird’s initial injury, complications during the healing process, and differences in individual species behavior. In most cases PROM therapy will begin on day 3 or 4 post surgery or potentially sooner for birds without fractures with constricting bandages. PROM therapy continues 3 times a week for about one to two weeks. Then based on progress it can be tapered or adjusted as needed (Cooper, 2002). In this study, delay in the flight return was probably due to lack of physiotherapy during post-operative period. Application of figure-of-eight wing bandage for more than a week without any physiotherapy causes development of the propatagium stiffness and reduced flying acuity.

Application of an intra-medullary pin external skeletal fixator tie-in to a humeral fracture gave good results in four birds. It prevented axial as well rotational movement of the fractured fragments. Intramedullary pin-external skeletal fixator tie-in is the most effective form of fixation for avian fractures that largely meets all of the objectives. This device utilizes an intramedullary pin placed in such a manner as to avoid damage to joints and tendons at the point of exit and an external skeletal fixator which is ‘tied’ to the IM pin by means of a mechanical link. The ESF pins themselves are positioned at relatively precise locations at the distal ends of the long bones to maximize strength of the construct and reduce morbidity. The resultant structure has the qualities of an I-
beam that effectively opposes shear, bending, compression and rotation of bone fragments around a fractured site (Redig and Ponder, 2012).

The tie-in external skeletal fixator is the treatment of choice, for the tibiotalarsus fracture repair as this provides rotational and longitudinal stability, improved reduction and alignment, without the restriction of a splint. A tie-in fixator meets the requirements for avian fracture repair, with no requirement for cooption, relatively low cost, avoidance of joint impairment and complete removal following healing. In birds, two pins in each fragment are sufficient for stability, and three may predispose to re-fracture. Use of a tie-in fixator for closed tibiotalarsal fractures has a good success rate with complete return to function in the overwhelming majority (Kubiak and Forbes, 2011). In this study, two tibiotalarsal fractures were repaired using retrograde intramedullary pinning.

In this study, use of dental acrylic in tie-in external fixator gave rigid stability to the assembly and was simple to use, cheap and readily available. The external fixators have been fixed with acrylic materials as connecting bars or acrylic material like Technovit (Tomlinson and Constantinescue, 1991).

In this study, the fractures of radius-ulna and tarsometatarsus were repaired by intradmedullary pinning. 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 humerus (Howard and Redig, 1994). In all such cases the clinical union developed 35 - 40 days after surgery. The delayed union occurs due to the rotational movement of the fractured fragments with simple intramedually pinning. Intramedullary pins have been used without external fixation, but they cannot withstand rotational
Discussion

or compressive forces (Meij and Westerhof, 2006). In case of the birds under optimum conditions the fractured defect is filled with fibrous tissue within five days and cancellous bone within nine days, while true bony union takes 22 days and complete remodeling takes six weeks (Coles, 2007). The avian fractures usually heal rapidly within three weeks when the fracture site is correctly aligned and stabilized (Bush, 1981).

External co-optation was provided using light weight cast bandage in one bird with stifle joint dislocation. Dependent on the location; fractures may be supported with external cooptation (Zeeland, 2012). Fractures distal to the knee are stabilized with a lateral splint (similar to dogs), or, in smaller species, with a tape splint. A spica splint or off weight-bearing sling may be used in case of femoral fractures. Tarsometatarsal and tibiotarsal fractures are easily diagnosed by palpation and can be supported with the use of a tape splint or overlapping lightly adhesive bandage in birds (Echolas, 2008).

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 to all the 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 (Grimm, 1993).

The prognosis for return to function after repair of avian fractures is often poor. In one study, surgical repair of 51 avian humeral fractures resulted in 18 (35%) healed fractures, and only 12 (24%) birds achieved full flight capability. The avian humerus is a large pneumatic bone with a large medullary cavity and sparse trabeculae, making fracture fixation challenging.
Discussion

The humeral cortex of mature Pigeons contains few haversian systems, and the bone is arranged in a circumferential lamellar pattern. The large pectoral flight muscles tend to distract the bone ends of the humerus after fracture, leading to poor alignment and loss of wing function. Avian wing fractures are often comminuted and open because of the thin, brittle cortices and the absence of soft tissue support (Wander et al., 2000).

In cases of the irreparable injury, wing amputation was performed in nine birds at the level of humeral mid shaft as a salvage surgery to save the life of the birds. In all these cases surgical wound healed without any complication within ten days. Amputation of the humerus at the junction of the middle and proximal thirds of the bone provides adequate soft tissue coverage and creates a stump short enough to prevent self-trauma (Bennett and Harrison, 1997). Amputation of the wing is the treatment of choice for the surgical management of contaminated and infected fractures in grey parrot (Hatt et al., 2007).

In this study, the crop was sutured with a double layer of inverting sutures. Both the birds started taking food normally after two days and the wound healed without any complication. In a case report, the crop was sutured in two layers with first layer of simple continuous appositional sutures followed by interrupted pattern in two Pigeons (Basha et al., 2010).

The use of self-adherent wrap for the application of the figure-of-eight wing bandage gave excellent result. Application of the figure-of-eight wing bandage using self-adherent wrap are useful in stabilizing fractures, traumatic injuries and intravenous and intraosseous catheters (Degernes, 1997). Bandaging material should be soft and pliable for initial layer followed by a
Discussion

Self-adherent bandage for the outer layer (Echolas, 2008). Self-adherent bandages can tighten when wet, so the access of bandaged birds to open containers of water should be limited or monitored (Bowles et al., 2007).

In this study, use of the warm normal saline, 5% povidone iodine solution and cephalaxin powder for the anti-septic dressing gave satisfactory results. In case of birds, the lesions should be flushed with chlorhexidine or povidone-iodine solution. Large recent wounds should be flushed with sterile saline solution and sutured partially closed and older lacerations should be flushed, debrided and bandaged with wet to dry bandages. These wounds may be closed later when infection is minimized (Hess, 2002).

Enrofloxacin @ 15 mg/kg IM, IO proved to be satisfactory for any soft tissue surgical intervention. Enrofloxacin is currently the only veterinary-labeled fluoroquinolone. It has an excellent activity against mycoplasma, some gram-positive bacteria and most gram-negative bacteria. Enrofloxacin and ciprofloxacin have been widely used in psittacine nurseries without reports of side effects (Flammer, 1997).

Use of ceftriaxone and tazobactam combination @ 75 mg/kg IM, IO for seven days gave good results in all the orthopedic cases. The use of intraoperative, broad-spectrum antibiotics with good tissue penetration such as cephalosporin, chloramphenicol, and tetracycline is satisfactory in orthopaedic surgery (Martin and Ritchie, 1997). The use of meloxicam @ 0.1 mg/kg IM, IO was satisfactory for the pain management during post-operative period. Regardless of the severely of disease, analgesia should always be considered in any critically ill patient; especially if the illness is related trauma. In clinical
Discussion

Avian practice, meloxicam (0.1–0.2 mg/kg PO or IM q24 hours) is commonly used for its analgesic anti-inflammatory effects (Ford et al., 2008).

In this study, forceful hand feeding in case of the weak birds during post-operative period yielded desired results. It helped in rapid recovery of the birds. If the bird is not eating at all, forced feeding is necessary (Wilson, 2005). Birds can be nutritionally supplemented in many ways: by hand, syringe/tube feeding, IV parenteral nutrition or surgically placed feeding tubes (Graham & Heatley, 2007). Critical patients suffering from anorexia, maldigestion and weight loss are in need of nutritional support. If possible, enteral feeding is preferred to parenteral feeding since the former decreases intestinal cellular death and subsequent bacterial translocation leading to sepsis (Lichtenberger, 2005).

Maintaining wild birds in captivity is expensive, time-consuming, and requires expertise. The captive living conditions should be appropriate for each species of bird and should contribute to both health and comfort. In this study, provision of the individual shelter as per the family, feeding habits and habitat of the birds helped in reducing the stress of the birds and the birds started recovering early. Several species may be routinely held in a single area or facility, provided the requirements or habits of the species are not in conflict and social factors such as interspecific dominance over food or nervous responses of one species to another’s calls does not result in additional stress (Hahn and Silverman, 2007). Aquatic species have special needs mainly to do with the anatomy of their feet and the importance of waterproofing in their plumage. Maintenance of waterproof plumage is fundamental to the comfort and health of all aquatic birds and requires access
Discussion

to absolutely clean water. Aquatic birds must be allowed to bathe at least once a day (Bocetti and Swayne, 1995). In this study, total four aquatic birds (two Greylag Geese, two Comb Ducks) were kept indoor during post-operative period till complete recovery. They were provided with the facilities of water pool and artificial grass land in their shelter.

In this study, flying acuity was assessed by allowing the bird to fly in a large closed area. Birds with complete recovery and good flying capacity (n=110) were released in the environment at different places as per their natural habitat. For a bird to survive in the wild post-release, adequate conditioning, strong flight skills, and general good health are mandatory. Final evaluation requires knowledge of the bird’s natural history, flight, and hunting style in order to understand its needs. Release time and location should be appropriate to the species (consider habitat and migration). Ideally, raptors should be released at their recovery location; however, sometimes this is not possible due to migratory status, length of time in captivity, or incomplete information presented at the time of admission. In our study, three birds were leg banded before release. It is recommended that birds be leg-banded with plastic or metal bands to facilitate identification of individuals (Ponder, 2011).

Wildlife rehabilitation is a unique form of wildlife management that targets individuals instead of populations (Williams, 1990). Rehabilitated animals are individuals that would have died without intervention (Ress and Guyer, 2004) and, thus, each potentially represents the addition of one individual to a species’ population. The rehabilitation of birds is gaining acceptance as a conservation management tool, particularly for endangered species (Dubois and Frazer, 2003). The ultimate aim of wildlife rehabilitation
is to treat and rehabilitate sick or injured individuals so that they can be released and live on as healthy members of wild populations. The successful treatment and release of individuals of a rare or locally rare species can benefit the population and we may contribute to the conservation of the species as a whole (Mander et al., 2003).
SUMMARY AND CONCLUSIONS

A clinical study on incidence and surgical management of injured birds during kite flying festival was undertaken in 168 birds irrespective of species. The birds presented with a history of kite string injury during November-2012 to February-2013 were eligible for surgical maneuver irrespective of type of injury.

The history of the birds regarding species, type of injury, weight, and probable etiology were recorded. Based on species predisposition, the highest incidences of kite string injuries were observed in Blue-rock Pigeons (116, 69%) followed by Common Pariah Kites (21, 12.5%), Barn Owls (4, 2.38%), Indian Peahen (3, 1.78%) and Cattle Egrets (3, 1.78%). There were two cases each (1.19%) of Black-eared Kite, Indian Peafowl, Comb Duck, Greylag Goose and Black Ibis followed by one case each (0.59%) of Woolly necked Stork, Honey Buzzard, Painted Stork, Khakhi campbell Duck, Domestic Duck, Changeable Hawk-Eagle, Peregrine Falcon, Montagu’s Harrier, Demoiselle Crane, Indian Fowl and Domestic Turkey.

Out of 168 clinical cases, 55 birds (32.73%) had left wing injuries, 44 (26.19%) right wing injuries, 12 (7.14%) bilateral wing injuries, 22 (13.10%) wing fractures, five (2.98%) left limb injuries, four (2.38%) right limb injuries, two (1.19%) bilateral limb injuries, seven (4.16%) limb fractures, 12 (7.14%) body injuries, three (1.78%) head injuries and two (1.19%) crop injuries.

All the birds were stabilized first by administration of the intraosseous (IO) fluids and emergency drugs. Styletted spinal needles (18-25 G) were used
as an IO catheter as per the size of the bird. All the birds were kept on the orthopaedic clinical heating mats continuously to maintain the body temperature and to prevent the hypothermia during the pre-operative stabilization and surgery. The injured birds with severe respiratory distress and showing the signs of gasping were subjected to passive oxygenation using appropriate sized non cuffed endotracheal tube.

In case of all the birds, butorphanol was administered @ 0.1 mg/ kg IO. All the minor surgeries including suturing of the wound were done under the local anaesthesia using 2 % lignocaine @ < 4mg/ kg. In case of simple lacerations and minor wounds, lignocaine gel was applied. All the major orthopaedic surgeries were done under the general anaesthesia using mixture of ketamine @ 5 mg/kg and diazepam @ 0.5 mg/kg IO.

In case of wounds involving the skin, minimum plucking of the feathers was done. The wound lavage was done using warm sterile normal saline with 0.5% povidone-iodine solution to remove foreign material, reduce bacterial load and rehydrate soft tissues. Micropore adhesive tape was used as an adhesive drape to decrease the microbial contamination of the surgical site. Wound debridement was done using Bard Parker blade No. 14 to remove as much of the devitalized and necrotic tissue.

The wound involving propatagium was closed on both the sides (dorsal and ventral) by simple interrupted sutures using Vicryl 3-0 absorbable suture material. In case of small birds (Pigeons, Egrets) the wound was closed in a single layer including both muscle and skin together, while in case of large birds (Goose, Stork, and Duck), the wound was closed in a double layered pattern including muscle and skin separately.
In case of five birds with humerus fracture, intra-medullary pin tie-in fixator was applied. A plastic straw was placed over the interface pin and the two K-wires. The intramedullary pin which had been bent through 90° and the two transverse pins were rigidly connected using liquid dental acrylic. Out of which, in two birds clinical union of the fractured fragment occurred 21 days after surgery. However, in one case mal-union of the fractured fragment occurred and two birds died on second and fifth post-operative days. In two birds with humerus fracture, intra-medullary pinning was done, out of which, in one case clinical union occurred, while other bird died during surgery.

In case of two birds with radius-ulna fracture, C-arm guided intra-medullary pinning was done in ulna using small sized pin or K-wire as per the size of the bone. Out of that, one survived and clinical union occurred 35 days after surgery and the other died on third post-operative day. In case of two birds with tibiotarsal fracture, retrograde intra-medullary pinning was done. One bird died post-operatively on the same day of surgery, while in other clinical union occurred 21 days after surgery.

The wound involving the foot was bandaged with an interdigitating bandage in three birds. The bird could perch without any discomfort after application of the interdigitating bandage, and in all cases, wound healed without any complications within ten days. The crop was sutured with a double layer of inverting sutures using vicryl 3-0 and the skin was closed with simple interrupted sutures using nylon 3-0. In nine birds with irreparable injuries, necrosis, severe infection, tissue loss and old fractures involving wings, amputation of the wing at the level of the mid shaft of the humerus was done as a last resort to save the life of the bird. Figure-of-eight wing bandage was applied
using self-adherent wrap for ten days to protect the wound from self-mutilation. The wing was kept open in cases of the fractures involving humerus and radius-ulna. In all the birds, regular cleaning and anti-septic dressing of the wound was done on every third alternate day with warm normal saline, 5% povidone iodine solution and cephalexin powder. In case of the birds with fractures, ceftriaxone sodium and tazobactam combination was administered @ 75 mg/kg IM/IO for seven days. While other injured birds were treated with enrofloxacin @ 15 mg/kg IM/IO for five days. Meloxicam was used in all the birds @ 0.1 mg/kg IM/IO for three days.

The birds were classified and provided with separate shelters according to their family and feeding habits till the complete recovery. Forceful hand feeding was done in 23 birds which refused to take the food on their own. It helped in rapid recovery of the birds. In majority of the cases, birds started taking food within three days of surgery.

Flying acuity was assessed by allowing the bird to fly in a large closed area. Complete return of flight was observed in majority of the birds within 20 days. In 27 cases partial flight could be restored. 38 birds died during the post-operative period. In 20 birds flight could not be restored. It was observed that all the birds with fresh wound/fracture showed excellent results. On the whole, good surgical results were observed in 49% cases (83 out of 168), followed by fair in 17% (29 out of 168) and failure in 34% (58 out of 168) cases.

65% birds (110 out of 168) with complete recovery and good flying acuity were released in the environment at different places as per their natural habitat. In 12% birds (20 out 168) flying capacity could not be restored and
became permanently disabled. Such birds were sent to the different permanent shelters according to their species run by forest department and different N.G.Os. During this study, the survival rate of the birds was 77% (130 out of 168) and the success rate was 65% (110 out of 168).

In view of the results obtained in the present study, following conclusions were drawn.

1. The highest incidence of the kite string injury was seen in Blue-rock Pigeons followed by Common Pariah Kites.
2. The most common injury in birds during kite flying festival was the propatagium wing injury.
3. Intraosseous route was preferred for the administration of the fluids and emergency medicines.
4. Hypothermia was managed using heating pads in case of the critically ill patients.
5. Butorphanol was safe and provided potent analgesia during surgery.
6. Use of micropore adhesive tape reduced the contamination and minimized feather plucking and pain.
7. Repair of the propatagial lacerations using 3-0 absorbable suture material (Vicryl) on dorsal and ventral sides by simple interrupted sutures yielded positive results.
8. Use of self-adherent wrap yielded desired immobilization and prevented the birds from self-mutilation.
10. Use of dental acrylic in tie-in external fixator gave rigid stability to the assembly and was simple to use, cheap and readily available.

11. Forceful hand feeding was important for rapid recovery during post-operative period.

12. Provision of the individual shelter as per the family, feeding habits and habitat reduced the stress and facilitated early recovery.

13. The birds presented with fresh wound/injury healed well and regained flying acuity.

14. Birds after complete recovery and with good flying acuity were rehabilitated at places where it could find other birds of the same species.
REFERENCES


References


Annual Congress of Indian Society for Veterinary Surgery. Anand, Gujarat, India.


<table>
<thead>
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<th>Species</th>
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<td>Limb injury</td>
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<td>Right wing</td>
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<td>Barn Owl (Tyto alba)</td>
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</tr>
<tr>
<td>Comb Duck</td>
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</tr>
<tr>
<td>(<em>Sarkidiornis melanotos</em>)</td>
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<tr>
<td>(<em>Pseudibis papillosa</em>)</td>
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<td>(<em>Ciconia episcopus</em>)</td>
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<tr>
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<tr>
<td>(<em>Pernis ptilorhynchus</em>)</td>
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<tr>
<td>(<em>Anas platyrhynchos domesticus</em>)</td>
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<td>Khakhi campbell Duck</td>
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<tr>
<td>(<em>Anas platyrhynchos domesticus</em>)</td>
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<td>Painted Stork</td>
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<tr>
<td>(<em>Mycteria leucocephala</em>)</td>
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<td>(<em>Spizaetus cirrhatus</em>)</td>
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<td>Peregrine Falcon</td>
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<tr>
<td>(<em>Falco Peregrinus</em>)</td>
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<td>(<em>Circus Pygargus</em>)</td>
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<td>Demoiselle Crane</td>
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<tr>
<td>(<em>Grus virgo</em>)</td>
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</tr>
<tr>
<td>Indian Fowl</td>
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</tr>
<tr>
<td>(<em>Gallus gallus</em>)</td>
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<td>Domestic Turkey</td>
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<td></td>
</tr>
<tr>
<td>(<em>Meleagris gallopavo</em>)</td>
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<td>Total</td>
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### Table 4.2 Survival and success rates of injured birds during kite flying festival

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<tr>
<th>Sr. No.</th>
<th>Species of bird</th>
<th>No. of birds received</th>
<th>No. of birds died during treatment</th>
<th>No. of birds disabled</th>
<th>No. of birds released</th>
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<tr>
<td>1</td>
<td>Blue-rock Pigeon (<em>Columba livia</em>)</td>
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<td>5</td>
<td>Indian Peahen (<em>Pavo cristatus</em>)</td>
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<td>Indian Peafowl (<em>Pavo cristatus</em>)</td>
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<td>Cattle Egret (<em>Bubulcus ibis</em>)</td>
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<td>8</td>
<td>Comb Duck (<em>Sarkidiornis melanotos</em>)</td>
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<td>Honey Buzzard (<em>Pernis ptilorhynchus</em>)</td>
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<td>19</td>
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<td>20</td>
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<tr>
<td>21</td>
<td>Domestic Turkey (<em>Meleagris gallopavo</em>)</td>
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</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>168</strong></td>
<td><strong>38</strong></td>
<td><strong>20</strong></td>
<td><strong>110</strong></td>
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</tbody>
</table>
Chart 4.1 Incidence of kite string injuries based on species predisposition (n=168)

- Blue-rock Pigeon
- Common Pariah Kite
- Barn Owl
- Indian Peahen
- Cattle Egret
- Black-eared kite
- Indian Peafowl
- Comb Duck
- Greylag Goose
- Black Ibis
- Woolly-necked Stork
- Honey Buzzard
- Domestic Duck
- Painted Stork
- Khakhi campbell Duck
- Montagu’s Harrier
- Peregrine Falcon
- Changeable Hawk-Eagle
- Demoiselle Crane
- Indian Fowl
- Domestic Turkey

69%
Chart 4.2 Types of injuries during kite flying festival (n=168)

- Left wing injuries: 33%
- Right wing injuries: 26%
- Bilateral wing injuries: 7%
- Wing fractures: 7%
- Left limb injuries: 3%
- Right limb injuries: 3%
- Bilateral limb injuries: 4%
- Limb fractures: 3%
- Body injuries: 3%
- Head injuries: 2%
- Crop injuries: 1%
Chart 4.3 Types of wing injuries (n=133)

- Right wing propatagium injury: 41%
- Left wing propatagium injury: 33%
- Bilateral wing propatagium injury: 17%
- Wing fractures: 9%
Chart 4.4 Types of limb injuries (n=18)

- Limb fractures: 39%
- Right limb injuries: 22%
- Left limb injuries: 28%
- Bilateral limb injuries: 11%
Chart 4.5 Types of injuries (n=168)

- Soft tissue injuries: 83%
- Fractures: 17%
Chart 4.6 Types of wing fractures (n=22)

- Humerus fracture: 36%
- Radius-ulna fracture: 5%
- Major metacarpal fracture: 59%
Chart 4.7 Types of limb fractures (n=7)

- Tibiotarsal fracture
- Phalangeal fracture
- Major metatarsal fracture
Chart 4.8 Surgical result (n=168)

- Good: 49%
- Fair: 17%
- Failure: 34%
Plate 1.1 Bird injuries during kite flying festival

Barn Owl entangled in the kite flying strings and hanging from a tree

Blue-rock Pigeon entangled in kite strings

Wing injury in a Black-eared Kite

Bilateral limb injuries in a Barn Owl

Wing injury in a Blue-rock Pigeon

Wing injury in a Painted Stork
Plate 3.1 Instrumentation

Instruments for soft tissue surgery

C-arm unit

Instruments for orthopaedic surgery

A. K-wire introducer (T)  E. Plier  I. Double ended threaded K-wire (different sizes)
B. K-wire introducer  F. Micro hand drill  J. Styelleted spinal needle
C. Pin cutter  G. Dental acrylic (liquid)  K. Plastic straw/tubing
D. Bone cutting forcep  H. Dental acrylic (powder)
Plate 3.2a Pre-operative stabilization of birds

Entry point (distal condyle of ulna) for the intraosseous catheter placement

Intraosseous catheter in an Indian Peafowl

Intraosseous catheter in a Cattle Egret

Confirmation of the intraosseous route using C-arm

Intraosseous fluid administration in a Common Pariah Kite using routine infusion set

Intraosseous fluid administration in a Black-eared Kite using infusion pump
Plate 3.2b  Pre-operative stabilization of birds

Use of orthopaedic heating mat to prevent hypothermia in a Blue-rock Pigeon and Black Ibis

Stabilization of an Indian Peahen using heating mat, passive oxygenation and intraosseous fluid administration

Emergency drug administration using intraosseous route in a Blue-rock Pigeon

Passive oxygenation in an Indian Peafowl using non-cuffed endotracheal tube
Plate 3.3 Preparation of surgical site

Feather plucking

Wound lavage

Adhesive drape

Wound debridement
Plate 3.4a Propatagium injury

Suturing of propatagium wound in a Woolly-necked Stork

Suturing of propatagium wound in a Honey Buzzard
Plate 3.4b Propatagium injury

Suturing of propatagium wound in a Common Pariah Kite

Application of prolene mesh in a Greylag Goose
Plate 3.5a Application of an intra-medullary pin tie-in fixator to a humeral fracture

C-arm guided retrograde intra-medullary pinning

90° bending of intramedullary pin at its exit

Insertion of threaded K-wire transversely into proximal and distal fragments

Post-operative radiograph

Closure of the wound with simple interrupted sutures

Intra-medullary and two transverse pins connected using plastic straw and dental acrylic
Plate 3.5b  Application of an intra-medullary pin tie-in fixator to humeral fracture in different birds

Indian Peahen

Barn Owl

Domestic Turkey

Blue-rock Pigeon
Plate 3.6 Fracture repair in radius-ulna

C-arm guided normograde intra-medullary pinning

Pre- & post-operative radiographs
Plate 3.7 Wing amputation

Irreparable wing injury in a Painted Stork

Skin incision

Cutting of the humeral bone

Closure of the wound with simple interrupted sutures

Immediate post-operative photographs of the wound and the bird
Plate 3.8 Limb injury

Suturing of the wound involving leg

Wound involving foot

Interdigitating foot bandage in an Indian Peafowl

External cooptation using thermoplastic lightweight cast bandage in a Black-eared Kite with stifle joint dislocation

Intramedullary pinning in a Domestic Duck with tibiotarsal fracture
Plate 3.9 Crop fistula, head and body injury

Double layer inverted suturing of the crop fistula in a Khaki Campbell Duck

Large abdominal wound in an Indian Peafowl

Pre- & post-operative photographs of wound
3.10a Post-operative care

Figure-of-eight wing bandage in a Greylag Goose and Honey Buzzard using self adherent wrap

Figure-of-eight wing bandage in a Woolly-necked Stork

Figure-of-eight wing bandage in a Comb Duck  Leg bandage in a Barn Owl
3.10b Post-operative care

Wound lavage

Anti septic dressing with 5% povidone-iodine

Application of cephalexin powder

Application of cetrimide spray

Figure-of-eight wing bandage
3.10c Post-operative care

Intramuscular injection in a breast muscle using tuberculin syringe

Administration of oral multivitamin drops in a Common Pariah Kite

Forceful hand feeding in a Barn Owl

Forceful hand feeding in a Honey Buzzard
Plate 3.11a  Provision of food and shelter

Shelter for Geese and Ducks

Shelter for Storks and Egrets
Plate 3.11b Provision of food and shelter

Shelter for Blue-rock Pigeons

Individual shelter for Honey Buzzard
Plate 3.11c Provision of food and shelter

Shelter for Kites

Shelter for Barn Owl
Plate 4.1 Propatagium injury

Healed propatagial wounds in Blue-rock Pigeons
Plate 4.2 Healed propatagial wounds in different birds

Honey Buzzard

Comb Duck

Greylag Goose

Black-eared Kite

Common Pariah Kite
Plate 4.3 Disruption of propatageal wound sutures in different birds

Blue-rock Pigeon

Common Pariah Kite

Cattle Egret

Woolly-necked Stork

Greylag Goose
Plate 4.4 Post-operative complications

Wing infection in Common Pariah Kites

Detachment of prolene mesh from the propatigum wound in a Greylag goose
Plate 4.5a  Repair of humeral fracture in an Indian Peahen

Pre-operative

Immediate post-operative

Clinical union on 21st Post-operative day

30th Post-operative day after removal of implants
Plate 4.5b Repair of humeral fracture in a Domestic Turkey

Pre-operative

Immediate post-operative

Clinical union on 21st post-operative day before and after implant removal
Plate 4.5c  Repair of humeral fracture in a Barn owl

Pre-operative

Immediate post-operative

Delayed healing - 30th post-operative day

Malunion - 42nd post-operative day
Plate 4.6 Repair of radius-ulna fracture in an Indian Fowl

Pre-operative

Immediate post-operative

Clinical union on 35th and 48th post-operative days
Plate 4.7 Repair of tibiotarsal fracture in a Domestic Duck

Pre-operative

Immediate post-operative

11th Post-operative day

Clinical union on 21st post-operative day
Plate 4.8 Healing of crop and foot injuries

Healing of crop fistula in a Khakhi campbell Duck

Healing of foot injury after application of interdigitating foot bandage in an Indian Peafowl
Plate 4.9a Rehabilitation

Release of Blue-rock Pigeons at Anand

Release of Common Pariah Kites at Anand

Release of Black-eared Kite at Parlej bird sanctuary
Plate 4.9b Rehabilitation

Release of Greylag Goose at Pariej bird sanctuary

Release of Comb Duck at Pariej bird sanctuary

Release of Cattle Egret at Pariej bird sanctuary

Release of Barn Owl at Vadodara
Plate 4.9c  Rehabilitation

Release of Woolly-necked Stork at Bhandaraj Lake

Release of Greylag Goose at Thol lake bird sanctuary

Release of Honey Buzzard in Dharaj forest