CHAPTER

16

TRAUMA MEDICINE

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Proper management of traumatic injuries in birds significantly decreases complications and wound-healing time. Many of the principles and techniques for wound management and bandaging in mammals apply to birds; however, anatomic differences require modifications and adaptations. Treatments and bandaging techniques for soft tissue wounds and nonsurgical fractures in birds will be discussed.

An understanding of wound healing is important in order to devise a treatment plan for optimal results. Wound healing is a complex interaction of host responses to an injury leading to regeneration of connective tissue, vascular supply and epithelium.[1] The three basic phases of wound healing are inflammatory (exudative), collagen and maturation.

Inflammatory Phase: The hemodynamic and cellular responses of the acute inflammatory response in birds have been studied in chickens and pigeons[2,6,10,19,22] (see Chapter 40). The response is similar in both mammalian and chicken skin in the first 12 hours. Immediate vasoconstriction to control hemorrhage is followed by vasodilation within 30 minutes.[22] Polymorphonuclear leukocytes and monocytes infiltrate the margins of the injured and necrotic tissue within the first 2 to 6 hours, causing active phagocytosis of necrotic cellular debris and bacteria.[10,22]

By 12 hours post-injury, the ratio of polymorphonuclear to mononuclear cells shifts toward a predominance of mononuclear cells.[22] During the next 36 hours, necrotic leukocytes that were active in phagocytosis accumulate at the periphery of the necrotic tissue and are phagocytized by macrophages and multinucleated giant cells. Fibroblasts appear in the wound during this period and continue to proliferate during the next few days, signaling the end of the first phase of the healing process.

Collagen Phase: Beginning the third or fourth day following injury in chickens, fibroblasts synthesize collagen in the form of microfibrils, which aggregate into larger fibers over time.[10] During this phase, which lasts approximately two weeks, capillaries develop from bud-like structures from nearby vessels and penetrate the wound. Wound contraction occurs, and epithelial cells proliferate and migrate across the wound surface.[20,21]

Maturation Phase: The final phase of wound healing may take weeks to months, and is marked by remodeling of the collagen bed and a decrease in the number of fibroblasts.[21] The weak, poorly developed collagen is replaced by thicker, stronger collagen fibers, which become oriented relative to the normal tension on the wound margins (see Chapter 40).

Principles of Wound Management

Impediments to Wound Healing

There are many factors that can impair or prevent normal wound healing.[8] Dehydration, starvation, severe protein deficiency and chronic anemia may have adverse effects on wound healing (Figure 16.1). Necrotic tissue or blood clots may harbor bacteria and physically impede epithelial cell migration. Infection by pathogenic bacteria may significantly delay wound healing. Dirt, debris, dead bone and even suture material[6] may cause host reaction leading to the development of fistulous tracts.

Tissue destruction resulting from desiccation, severe trauma (eg, crushing or projectile injuries) or poor surgical technique will delay healing. Wounds of the distal extremities (reduced vascular supply) and non-immobilized injuries over joints, the axilla and the patagia tend to heal more slowly.

Initial Assessment

Preliminary assessment of the injured avian patient will determine if immediate life-saving treatments are necessary.[11] A complete history is taken to determine the cause of injury, followed by a thorough physical exam. It is important to avoid overlooking less obvious injuries and unrelated problems. Traumatized birds often have multiple injuries and may be further compromised by dehydration, malnutrition and other problems, especially if there has been a delay (hours to days) between injury and presentation. Shock, fluid and nutritional therapy are critical in the early management of traumatized birds. Overzealous wound and fracture treatment before stabilization of the patient may result in the patient's death. Anesthesia may be necessary with fractious birds or in birds with extensive soft tissue or orthopedic injuries. However, if the bird is not stable, partial wound management and bandaging may have to suffice until more thorough treatment can be safely completed.

FIG 16.1 A mature female Sulphur-crested Cockatoo was presented for a unilateral non-weight-bearing lameness noted the day before presentation. The bird was reluctantly willing to use the affected limb but when she did, she ambulated on the distal tibiotarsal area with the foot closed and held in extension. A large blue-black wound was located on the caudal tarsometatarsus. Radiographic findings were limited to soft tissue swelling. The wound was thoroughly cleaned with chlorhexidine scrub and flushed with copious quantities of warm lactated Ringer's solution. A Gram's stain of the wound after cleansing revealed a few gram-positive cocci. The wound was placed in a sterile bandage that incorporated a ball bandage to keep the foot open. The bandage was changed every two to three days. By the fourth bandage change, a healthy granulation bed had formed, and a primary skin closure was performed. The bird was returned to the aviary with no further complications.

When assessing a wound, one should note the location, extent and age of the injury. Associated orthopedic injuries and the vascular and nerve supply to the area should also be evaluated (Figure 16.2). It is common to have underlying fractures or luxations associated with soft tissue wounds of the limbs. Wounds can be located by parting or wetting the feathers and viewing the normal translucent avian skin. Greenish discoloration of the skin is normal in bruised birds due to accumulation of biliverdin pigment following breakdown of hemoglobin. This discoloration develops two to three days post-injury and may persist for a week or more.

The vascular integrity may be evaluated by palpating the warmth of the limb, checking the capillary refill time of the skin, clipping a toe nail or pricking the skin. Other diagnostic tests used to assess an injured bird include microbiological cultures, hematology, radiology and ophthalmologic examination. Biopsies may be indicated in chronic, non-healing or self-inflicted wounds.

Surface Preparation and Wound Treatment

The initial goal in treating contaminants or infected wounds 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. Plucking feathers will allow for earlier regrowth of feathers, but caution should be used to prevent additional trauma to friable skin while plucking.

Wound lavage using a curved tip irrigating syringe will remove foreign material, reduce bacterial numbers and rehydrate soft tissues. Sterile isotonic saline with or without 0.05% chlorhexidine[a] or 0.5-1.0% povidone iodine[b] solution is recommended for wound lavage.[33] Cultures should be obtained after surface contaminants have been removed and before any antiseptics have been applied. Hydrogen peroxide has been shown to be ineffective for bacterial infections, but may be effective as a sporicide in cases of suspected clostridial infections, or for initial cleansing of dirty wounds.[3] The volume of solution required will depend upon the severity and location of the wound and the degree of contamination.

FIG16.2 An immature Red-tailed Hawk was found beside a highway, unable to fly. A severe wing droop was noted on physical examination. Radiographs indicated a fractured coracoid. The bird was placed in a figure-of-eight bandage. Fracture repair was uneventful, but when the bandage was removed, a severe wing droop was still evident and muscle atrophy had occurred to the wing musculature. EMG findings indicated denervation of all of the muscles in the wing. Necropsy indicated a brachial plexus avulsion.

Wound debridement following lavage involves removal of as much of the devitalized and necrotic tissue as possible until viable, vascularized tissue is recognized. In complicated or older wounds, the debridement process may have to be repeated over a period of a few days.

Topical medications in certain wounds may be beneficial; however, use of non-water-soluble medications should be avoided due to loss of insulation with soiled feathers. Bacitracin, neomycin and polymyxin are effective against a wide spectrum of bacteria.[33] One percent silver sulfadiazine[c] is effective for thermal burns and other wounds.[27] Topical use of hemorrhoid creams containing live yeast cell derivatives[d] (LYCD) has been shown to stimulate epithelialization and collagen synthesis in human[23] and canine[33] wounds. LYCD has been successfully used in raptors with granulating wounds and pododermatitis (bumblefoot) lesions.[12] A topical medication commonly used for pododermatitis in raptors and other birds is dimethyl sulfoxide (DMSO), used either alone or with a combination of dexamethasone and an antibiotic, such as carbenicillin or piperacillin.[30]

Products that have been shown to retard wound healing in mammals include nitrofurazone, which slows epithelialization,[13] and gentamicin sulfate, which impairs wound contraction.[24] Although similar studies have not been conducted in birds, it is advisable to avoid these products in avian wounds.

After lavage and debridement, the wound should either be sutured, managed by second intention healing or managed as an open wound with delayed closure.[8] 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.

Bandaging Principles

Properly applied dressings and bandages will provide an optimal environment for epithelialization and wound contraction with the fewest complications.

The functions of bandages[32] are to:

- Apply pressure to reduce dead space, swelling, edema and hemorrhage
- Protect the wound from pathologic microorganisms
- Immobilize the wound and underlying fractures, if present
- Protect the wound from desiccation and additional trauma from abrasions or self-mutilation
- Absorb exudate and help debride the wound surface
- Provide comfort for the patient.

The three layers of a bandage are the primary layer (or dressing that is in contact with the wound), the secondary layer for absorption and the tertiary layer, which serves to hold the other layers in place.

Primary Layer

The primary layer is the most critical layer for optimal wound healing. This layer should be sterile, remain in place even with patient movement, provide a moist wound environment and assist with the debridement process.[32]

The two basic groups of dressings include adherent and non-adherent dressings. Adherent dressings such as fine mesh or open weave gauze pads are indicated during the initial phase of wound treatment when there is a large amount of necrotic debris that cannot be surgically debrided, or with excessive exudate production. Wet-to-dry bandage techniques involve the application of sterile saline-soaked, warm gauze pads over the wound surface.[8,9] The exudate and necrotic debris will be mechanically removed with daily dressing changes during the first few days of treatment, at which time the type of dressing used can be changed to a non-adherent one. Disadvantages of wet-to-dry bandages may include tissue maceration and bacterial colonization with the moist environment, and disruption of the wound healing surface with each dressing change.[8]

Non-adherent dressings, by definition, do not adhere to the healing wound surface,[25] and include a variety of products. Traditional non-adherent products commonly used in veterinary wound management include cotton film dressings[e] and petrolatum-impregnated fine mesh gauze pads[f]. Advantages of these products for use in avian medicine include availability and low cost. However, disadvantages include disruption of the healing surface when the dressing is removed after being in place for more than two to three days, soiling of feathers (petrolatum-impregnated products), slippage of dressings under the bandage and difficulty in bandaging certain anatomic locations.[11]

Increased understanding of wound healing processes has resulted in the development of many new synthetic adhesive, non-adherent dressings for use in humans.[4,5,14,15] These new dressings keep the wound surface moist and prevent scab formation, which significantly increases the rate of re-epithelialization, compared to air-exposed and wet-to-dry gauze dressings.[1] Adaptation of these products to avian wound management has resulted in elimination of many of the problems outlined earlier, and significant improvements in the rate and quality of wound healing.[11] The two product groups discussed include hydrocolloid dressings and moisture vapor permeable (MVP) dressings.

Hydrocolloid dressings or hydroactive dressings (HAD)[g,h] are semi-flexible, opaque membranes that are impermeable to moisture vapor and oxygen, and absorb fluid and exudate to develop a moist, gelatinous cover over the wound. These dressings adhere to normal skin and not wounds, but generally require additional bandaging material to be held in place. Hydrocolloid dressings have been used successfully in a variety of avian species,[9,11,12,17] and are most useful for extensive wounds with greater than normal exudate production, wounds that require debridement or for slow healing wounds (Figure 16.3).

Moisture vapor permeable (MVP) dressings[i,j,k] are thin, flexible, transparent polyurethane membranes that are oxygen permeable, impermeable to water and bacteria, allow accumulation of fluid and exudate under the dressing and are adhesive to normal skin but not wounds.[26] The maintenance of a moist, aerobic environment under the dressing promotes leukocyte debridement of the wound surface, prevents desiccation and scab formation and reduces pain associated with desiccation of raw nerve endings.[4] Epithelialization is more rapid when scabs are not present to impede cell migration from the wound margins.[1,4,5]

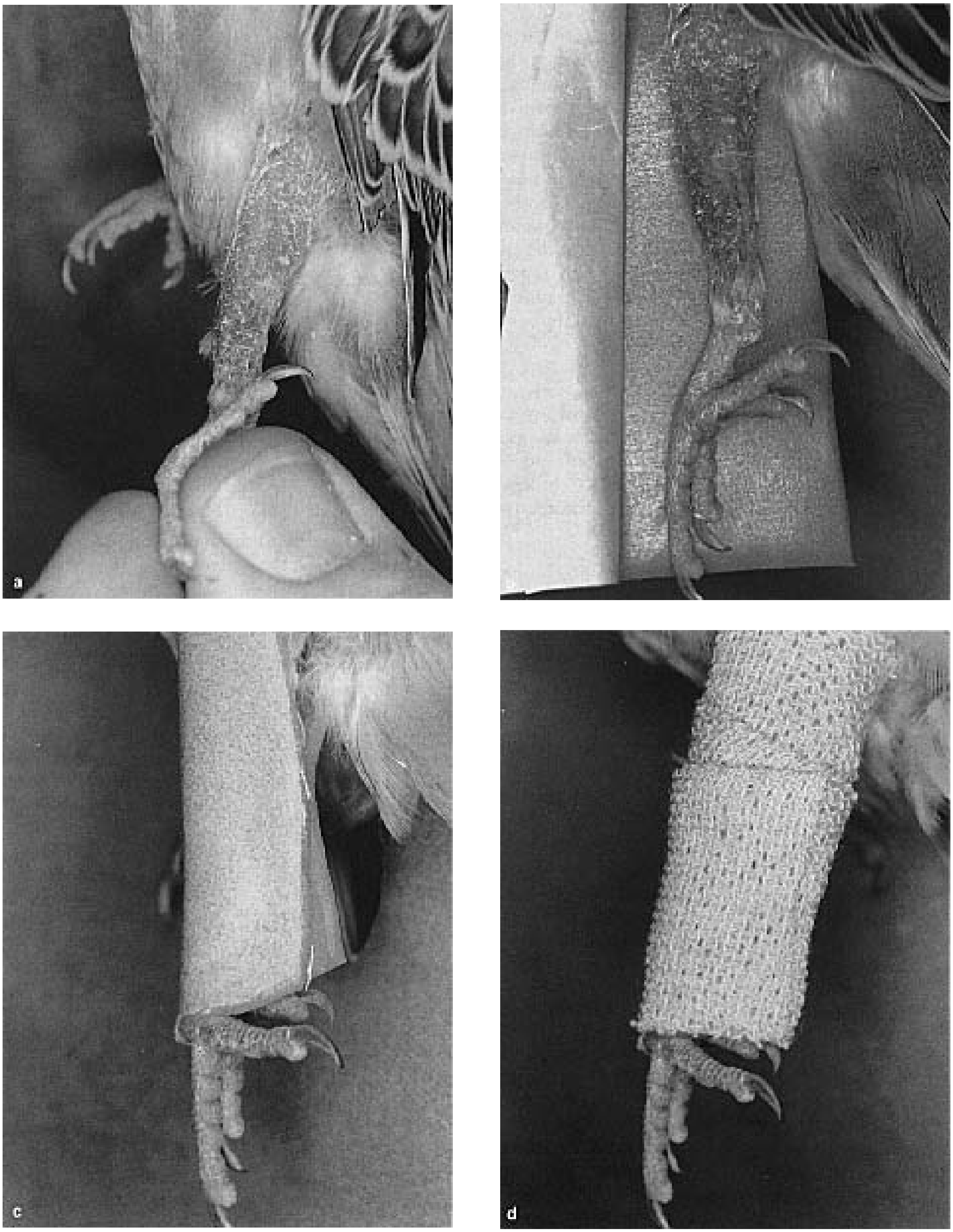

FIG 16.3 In birds that weigh less than 150 g, hydrocolloid dressings can be used as a splint material for distal tibiotarsal fractures. This material is superior to tape because it is more rigid. **a)** Note the bruising associated with this distal tibiotarsal fracture. **b,c)** A hydrocolloid dressing is wrapped around the leg incorporating the femur and the tarsometatarsus. **d)** The hydrocolloid dressing is covered with self-adherent bandage materials.

Both MVP and hydrocolloid dressings are indicated for a variety of avian wounds, but MVP dressings are more suited to areas that are impossible to bandage (eg, head wounds) because of the superior adhesive quality and flexibility of the material. The dressings are changed every two to three days initially, or more often if excessive exudate production results in fluid leakage from underneath the dressing. Once a healthy granulation bed is established, dressings can be changed weekly. Wounds treated with these dressings appear to heal more rapidly and with fewer complications compared to conventional non-adherent dressings.[11] Patient acceptance is usually very good, even with psittacine species.

Secondary Layer

The functions of the secondary bandage layer are to absorb fluids and wound exudate, pad the wound from trauma, and immobilize the wound and underlying fracture during the healing phases.[8] Conforming gauze material[l] or cast padding is most commonly used.

Tertiary Layer

The tertiary or outer layer serves to hold the other layers of the bandages in place. Most bandages consist of conforming stretch tapes with or without an adhesive. Self-adherent bandages[m] are excellent for birds because they are light-weight and breathable, are well tolerated by most birds, and the material adheres to itself cohesively without problems associated with tape residues on feathers. In cases where patient acceptance is poor, white adhesive tape, duct tape, neck braces or Elizabethan collars may be required for bandage protection.

Specific Traumatic Injuries and Their Management

Lacerations and Abrasions

Lacerations and abrasions in companion birds are commonly caused by enclosure wires, inappropriate toys, collisions during flight, other birds or household pets (Figure 16.4). Specific management of a laceration is determined by the size, location and age of the wound. In birds with breast or wing tip lacerations that result from frequent falls, additional therapy may include pulling improperly clipped wing feathers to stimulate their replacement.

Band Injuries

As useful as leg bands are for individual identification, they are not totally innocuous. Open style steel quarantine bands may cause serious problems if the band gap is large enough to allow the bird to get hung up on the cage wire. Resulting injuries may include soft tissue bruising, swelling or lacerations, leg fractures or luxations and occasionally death. Even captive-raised birds with closed bands may get their bands caught on toys, clips or enclosure wire (Figure 16.5). Inappropriately sized bands may cause soft tissue swelling and vascular compromise to the distal leg and toes if young birds outgrow bands that are too small. Some birds on a marginal diet will collect excessive quantities of desquamated skin under a band, resulting in a constrictive injury. Soft tissue swelling of the tarsometatarsus associated with fractures or other injuries may be further complicated by vascular constriction caused by the band. Large psittacines may crimp aluminum bands with their beaks,

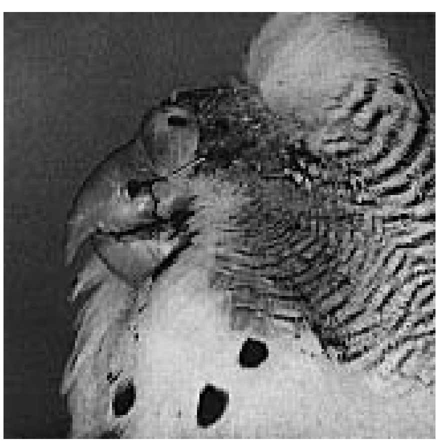

FIG 16.4 A maxilla fracture occurred in this budgerigar when it was bitten by a larger bird. Placement of a wire suture in a mattress pattern was used to oppose the maxilla. Beak injuries of this magnitude should be handled as emergencies. The sooner the damaged area is repaired, the more likely the beak is to heal.

FIG 16.5 Necrosis of the metatarsal skin in a cockatiel that caught its band in an unsafe toy. If a bird hangs by the leg for prolonged periods, microvascular damage may occur that results in necrosis 10 to 14 days post-injury. In severe cases, amputation of the most proximal joint and application of a hydroactive dressing to the stump is necessary.

causing a tight constriction of the distal limb, making band removal difficult. Abrasions and swelling underneath the band may develop when the leg is bandaged.

Band injuries should be prevented by anticipating potential problems, especially with open bands that have large gaps and with inappropriately sized bands (too small or too large). Prophylactic band removal or crimping to reduce the gap is preferable to treating a band injury (see Chapter 1). Once an injury or associated problem with a band is recognized, extreme caution should be exercised with band removal to avoid additional injury to the bird. The owner should always be warned of potential risks to the bird whenever a band is removed, even when the procedure is elective and not associated with trauma. Complications may include fractures, dislocations and lacerations. If a wound is already present, avascular necrosis may complicate the band removal procedure. Specific treatment options following band removal involve wound debridement and cleansing, surgical closure if indicated and coverage with appropriate dressing and bandaging material as needed.

Feather, Toenail and Beak Injuries

Significant hemorrhage may occur with broken blood feathers, especially broken flight and tail feathers. Direct digital pressure over the bleeding feather should be applied immediately to prevent excessive blood loss. A first-aid home procedure involves putting flour over the bleeding feather stub. This conservative treatment may be adequate in some cases, but most broken blood feathers require timely removal. The feather should be grasped at the base with a hemostat (needle-nosed pliers can be used on large birds) or fingers and pulled from the follicle while applying counter pressure to the area surrounding the follicle, to prevent tearing the skin (see Figure 15.12).

It is critical to remove the entire feather shaft from the follicle and continue to apply pressure over the follicle until the hemorrhage stops. Products intended for hemorrhage control during nail and beak trims, such as silver nitrate and ferric subsulfate powder[n] should never be used in a feather follicle to stop bleeding, due to the irritation caused by these products and the possible foreign body reaction that may occur (granuloma or feather cyst formation). Radiocautery should also not be used to blindly cauterize the interior of a follicle.

Broken or torn toenails can be managed by trimming the exposed portion with a nail trimmer to make a smooth surface, and packing ferrous subsulfate or silver nitrate into the exposed nail bed pulp cavity. If the keratin sheath of the toe nail has been pulled off to expose the underlying bone, direct pressure should be applied to control hemorrhage. The exposed bone can be protected with liquid bandage products,[o,p] or light bandaging.

Beak injuries occur most often from bites from other psittacines, or from collisions during flight. Cockatoo males often become extremely aggressive toward the females, sometimes inflicting lethal injuries (see Chapter 4). Head trauma is common with mate aggression and may be associated with beak fractures, punctures or avulsion of the maxillary or mandibular beak, in addition to soft tissue trauma. Hemorrhage may be controlled with direct digital pressure or by applying clotting products such as silver nitrate or ferric subsulfate. For specific beak repair see Chapter 42.

Self-mutilation

Many factors may induce self-mutilation behavior (see Chapters 4 and 24). A thorough diagnostic workup to rule out predisposing factors should be considered. Appropriate antibiotic, antifungal or anthelmintic treatment is combined with soft tissue wound management and protection of the wounds from further trauma. The wounds should be cleansed and debrided, and surrounding feathers carefully plucked or trimmed to prevent them from becoming matted in the wound. Aloe vera preparations may help in soothing the pain and irritation caused by massive self-trauma.

Application of moisture vapor permeable dressings is very effective in promoting rapid wound healing, and is well tolerated by most avian species including psittacines. The use of topical non-water-soluble wound medications is discouraged due to feather soiling, and is not necessary when MVP dressings are used. In severe cases of self-mutilation, an Elizabethan collar or neck brace collar may be indicated to protect the wounds from further trauma (Figure 16.6).

Burns

The most common thermal burns occur in the crop of neonates fed improperly heated hand-feeding formula (microwaved without proper stirring). Further discussion of medical and surgical management of crop burns is covered in Chapter 30. Accidental burns

FIG 16.6 A mature Quaker Parakeet was presented with a one-month history of feather picking that progressed to self-mutilation. Note the numerous emerging pin feathers that many bird owners mistakenly identify as mites. The cause of this bird's self-mutilation was undetermined.

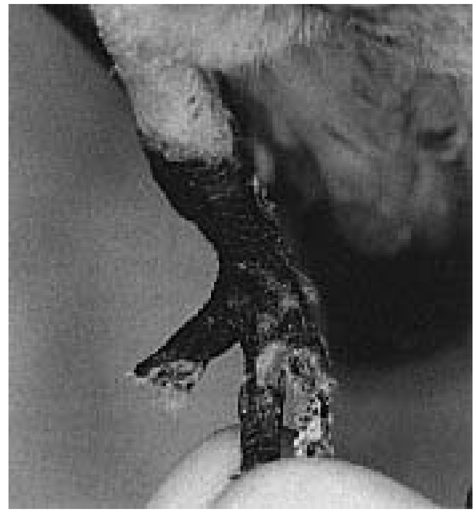

FIG 16.7 An Amazon parrot was presented four days after flying into a pot of hot liquid on the stove. The bird had been treated at home with a topical burn ointment. On presentation, several phalanges were missing, and the foot and leg distal to the mid-metatarsal region were cold, firm and black. Tissue fluids were oozing from the margin of the burned area. Because four days had passed since the initial injury, the only effective therapy was amputation of the necrotic limb. The prognosis for burn wounds is best if they are treated on an emergency basis.

may occur when pet birds come in contact with hot liquids, hot surfaces or electrical wires (Figure 16.7). The feathers provide some measure of insulation; however, the extent of the trauma depends upon the cause and the duration of exposure. Damage may range from singed feathers, ocular irritation or mild erythema of the feet or other exposed skin, to severe destruction of the toes or feet, melted beaks or death (see Color 24). Treatment action to be taken includes immediate cooling and rinsing of the affected areas, followed by supportive care, topical wound management and systemic antibiotic therapy. Topical medications may include DMSO for acute inflammation and silver sulfadiazine[c] cream for antibacterial protection.

Chemical burns secondary to contact with caustic solutions, acids or other irritants may be seen occasionally. The affected areas should be thoroughly washed and the compound neutralized by either sodium bicarbonate solution for acidic compounds, or dilute vinegar for alkaline compounds.[27]

Frostbite

Frostbite injuries are more common in cooler climates, but may occur in warmer regions during unexpected cold snaps when birds are not acclimated or do not have adequate shelter and supplemental heat. Injuries may range from mild redness, swelling and pain of the affected digit(s) or limbs, to gangrenous necrosis and death (Figure 16.8). Treatment requires supportive care including supplemental heat, fluid therapy, anti-inflammatory agents or topical DMSO, bandaging and treatment of secondary complications (see Chapter 15). Loss of soft tissue viability may be assessed by discoloration of the skin, loss of neuromuscular control, cooler skin temperature, odor, leakage of serosanguinous fluid and disruption of blood flow to distal extremities. The prognosis for saving a frozen digit or foot is extremely guarded, and amputation may be necessary if gangrenous necrosis develops.

Degenerative Joint Disease

Degenerative joint disease (DJD) is a chronic inflammatory condition involving the joint and surrounding tissues. Bony changes and reduced function in the joint may be secondary to trauma, bacterial infection, malnutrition or neoplasia. Radiographs, microbiologic cultures and biopsies are indicated to determine the cause and severity of the problem. The prognosis for successful treatment and return to normal joint function is extremely guarded, even with long-term antibiotic treatment.

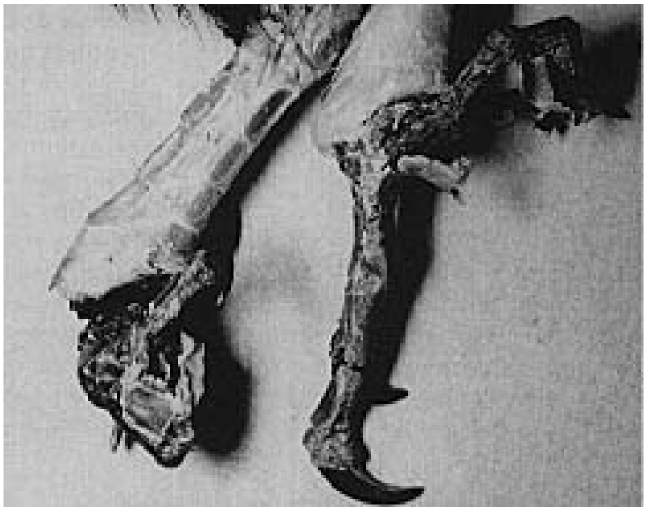

FIG 16.8 An adult toucanette hen was presented for a bilateral non-weight-bearing lameness. The bird had not been seen for several days and was presumably incubating eggs. Dry gangrene secondary to frostbite was evident in both legs distal to the tarsometatarsal joint. Temperatures the week before presentation were below freezing. The bird was euthanatized.

Bumblefoot

Bumblefoot or pododermatitis is a general term for any inflammatory or degenerative condition of the avian foot and may range from very mild redness or swelling to chronic, deep-seated abscesses and bony changes.[12,16,18,29,30] Considerations for prevention of bumblefoot include proper perches (size, shape and texture), flight pen or cage construction (wall components, substrate, perch arrangements), nutrition, general health of the bird and sanitation of facilities.

Classification and Causes of Bumblefoot

With the common occurrence of bumblefoot in companion and aviary birds, it seems appropriate to classify bumblefoot in a new manner, combining the concepts described by Halliwell[18] with subtle clinical changes that alter the management and prognosis of the disease (Table 16.1). A classification scheme grading from minor early clinical signs progressing to severe lesions is proposed (Harrison GJ, unpublished). The clinical progression of the disease varies based on the species of bird (eg, Psittaciformes, Passeriformes, raptors or Anseriformes) and the factors that contributed to the infection (Figure 16.9).

Grade I to III lesions may not be recognized in raptors that are commonly presented with Grade IV or V lesions. Older budgerigars and cockatiels (five to ten years old) may have a Grade V to VI lesion if precipitating factors are not corrected early. Bony changes and osteomyelitis may be present. Prognosis for full recovery of Grades I to IV is usually more favorable than Grade V to VI lesions.

Grade I to III lesions are common in Psittaciformes and Passeriformes that are on all-seed or over-supplemented fruit and vegetable diets, overweight, have no exposure to sunlight or are kept on improper perches (covered with sandpaper, too small or too large, no variance in size) (see Color 8).With proper husbandry and nutrition, most cases recover. Substrate perch size, shape and covering material may all influence the bird's weight distribution on the toes and metatarsal pad and the amount of skin wear on the plantar surface.[12,16,18,29] For example, a perch that is too wide and flat may cause excessive weight-bearing on the toe pads, while one that is too small may cause excessive weight-bearing on the metatarsal pads.

Bruising and abrasions on the plantar surface of the feet may develop when raptors persistently bate (jump) from a perch onto a hard surface or hang from the cage wire,[18] or when they are forced to stand on perches or cement. Any soft tissue or orthopedic injury involving one leg or foot may cause excessive weight bearing and secondary bumblefoot on the contralateral foot. Overgrown talons cause improper weight distribution on the plantar surface of the foot (especially in falcons and finches) or self-inflicted puncture wounds of the metatarsal pad.[16] Other traumatic injuries to the foot include bite wounds from prey, punctures from thorns or quills and trap inju-

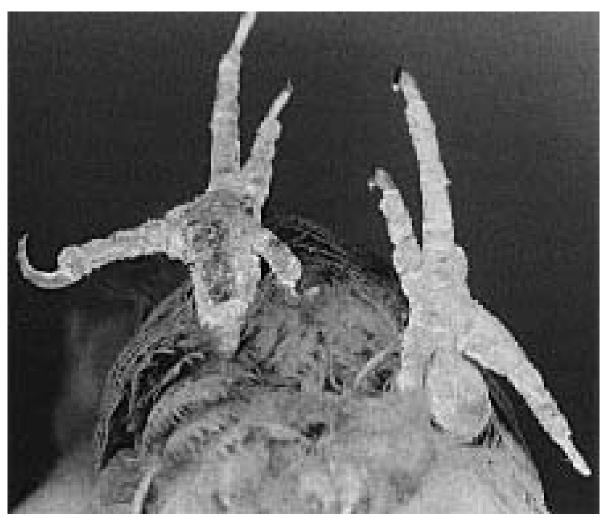

FIG 16.9 A 12-year-old cockatiel was presented with a non-weight-bearing lameness. Grade III bumblefoot is common in older inactive birds that are fed inadequate diets. Early lesions (smoothing of the plantar foot surface and hyperemia) are frequently missed, and the birds are not presented until they are lame.

TABLE 16.1 Clinical Grades of Bumblefoot

Grade I	Desquamation of small areas of the plantar foot surfaces represented clinically by the appearance of small, shiny pink areas - peeling or flaking of the skin on the legs and feet.
Grade II	Smooth, thinly surfaced, circumscribed areas on the plantar metatarsal pads of one or both feet with the subcutaneous tissue almost visible through the translucent skin. No distinct ulcers are recognized.
Grade III	Ulceration of the plantar metatarsal pads. In some birds a peripheral callus may form.
Grade IV	Necrotic plug of tissue present in ulcer. Most species with ulcers and accumulation of necrotic debris exhibit pain or mild lameness.
Grade V	Swelling and edema (cellulitis) of the tissues surrounding the necrotic debris. The digits or foot may also be edematous. Necrotic debris may start to accumulate in the metatarsal area, suggesting infection of the tendon sheaths. Severe lameness is common. The entire metatarsal pad may be affected. This is generally a chronic lesion.
Grade VI	Necrotic tendons recognized clinically as swelling in the digits and ruptured flexor tendons. Ankelosis and nonfunctioning digits usually present in recovery.
Grade VII	Osteomyelitis.

ries. Pathogenic bacteria introduced at these sites may lead to abscessation, osteomyelitis or joint changes.[31] Other causes of bumblefoot include severe poxvirus lesions with secondary bacterial infections, frostbite injuries and thermal burns.[29,30]

The precise pathogenesis of bumblefoot in various avian species remains undetermined. It is theorized that dry, flaky hyperkeratotic skin on the feet (possibly precipitated by malnutrition, environmental deficiencies and systemic disease) changes the mechanics of weight bearing on the metatarsal pads, leading to reduced circulation, micro-epithelial damage, localized impairment of the immune system and invasion of opportunistic pathogens. A bird's inactivity in an enclosure (inability to fly) may be a major precipitating factor. In one group of raptors, birds that were housed outdoors and were able to exercise did not develop bumblefoot regardless of their perching surface. By comparison, a group of raptors maintained indoors on the same diet developed bumblefoot irrespective of the perching material (Redig PT, unpublished).

Prevention and Treatment

Prevention of bumblefoot involves constant vigilance for early signs of hyperkeratosis, baldness, flaking of the skin of feet and legs, redness or swelling and correction of the underlying causes. The walls of an enclosure should be designed with vertical bars or solid barriers to minimize the tendency for hanging from the wire. Selection of proper perch size, shape and cover for a particular species of bird is very important.[29] Perches wrapped with hemp rope or covered with Astroturf work well for most raptors. Falcons do best on flat shelf or block perches covered with short Astroturf or cocoa mats. Strict sanitation of the facilities and feet is important to minimize bacterial infections. Feeding some formulated diets and providing fresh water for bathing prevents or reverses early bumblefoot in Psittaciformes (Harrison GJ, unpublished).

The goals of advanced bumblefoot treatment are to reduce inflammation and swelling, ensure an adequate diet, establish drainage if needed, begin antibacterial therapy to eliminate underlying pathogens, manage the wound to promote rapid healing and address dietary deficiencies.[29,31] Surgical excision of the abscess or amputation of a severely traumatized digit may be indicated. Treatment for Grade V to VI lesions must be vigorous, and the prognosis is guarded. Treatment for Grade IV should include drainage, irrigation and closing the wound when the infection has been resolved. The prognosis is fair. Grade I to III lesions generally respond to keeping the foot clean and correcting underlying management or nutritional deficiencies. With Anseriformes, this frequently involves changing the dimension, shape and surface of the enclosure, including the addition of adequate swimming areas.

Conservative treatment options may include changing the diet and padding the perchs, applying topical medications and, if needed, bandaging. Many topical products have been used, such as softening agents (udder balm or lanolin-based lotions) for dry, scaly feet; topical dimethylsulfoxide (DMSO) for acute inflammation and swelling;[29] hemorrhoidal ointment with live yeast cell derivative for granulating wounds;[12,23] and liquid bandage products for minor skin cracks or torn talon sheaths.[12]

Moisture vapor permeable dressings or hydrocolloid dressings should be applied topically to enhance wound healing for open, granulating wounds or postoperative incisions.[11] Bandaging of affected Psittaciformes may go on for several months until the bird responds to the new diet. Bandaging options include simple toe bandages, interdigitating bandages and ball bandages (Figures 16.10, 16.11).

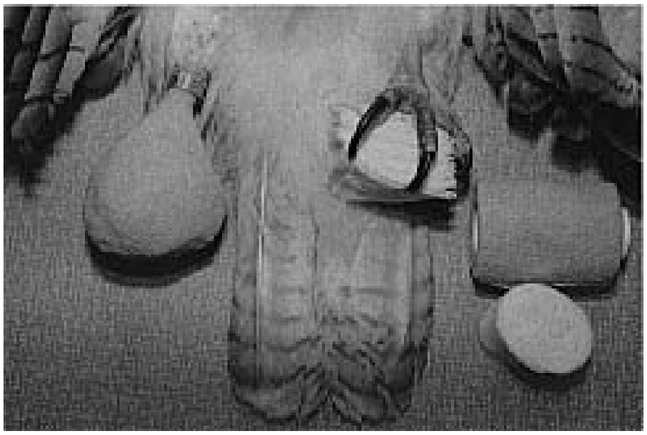

FIG 16.10 Ball bandages can be used to protect the foot while plantar lesions are healing.

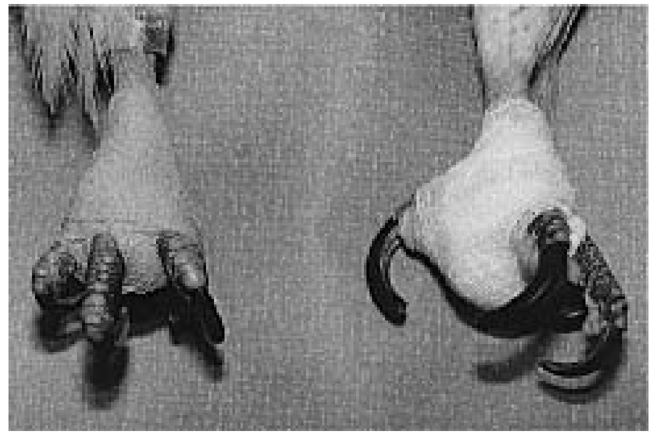

FIG16.11 Interdigitating foot bandages are used when a wound needs to be protected or padding is needed for the bottom of the foot, yet it is desirable for the bird to perch.

In raptors, therapy for Grade IV to V lesions include a DMSO preparation that is made by combining piperacillin (1 g) with dexamethasone (4 mg) and DMSO to make a 10 ml mixture. This is refrigerated and discarded after one week. Resolution of Grade IV to VI lesions is slow, and complete healing may take several months. Initial treatment also includes systemic antibiotics for seven to ten days. The entire foot should be cleaned with surgical scrub and any scabs should be soaked free without applying pressure to the wound. A swab taken from deep within the abscess should be cultured for bacteria and fungus. *E. coli*, staphylococcus and candida are commonly isolated pathogens. The wound should be flushed with copious quantities of one percent povidone iodine solution and allowed to soak for five minutes. The wound should then be flushed with large quantities of sterile saline, the defect packed with a sterile gauze 2 x 2 soaked in povidone iodine solution and a large soft bandage applied. On the second day, the flushing of the wound, gauze pack and bandaging are repeated. Most can be done without anesthesia.

On the third day, swelling may be reduced and much of the exudate gone. Any fibrotic material is removed and the foot is prepared for sterile surgery. A wide exposure of the affected area is made and the abscess wall is dissected out. Any devitalized ligaments or tendons must be removed in their entirety. A tourniquet may be required to control hemorrhage. The wound should be vigorously irrigated with povidone iodine followed by sterile saline. If hemorrhage returns after removing the tourniquet, pressure, epinephrine or selective radiocautery may be used for control, and the wound should be flushed to remove all free blood. The wound is partially sutured shut to allow for drainage, packed with a seton soaked in saline and rebandaged with a large soft wrap. If hemorrhage was poorly controlled, the bandage should be changed in four to six hours.

The bandage should be removed daily and the foot scrubbed and flushed with iodine solution and sterile saline until a "dry socket" is obtained (see Color 24). This may take a week or more. Then the bandage can be changed at two- to three-day intervals. Each time the bandage is changed, the wound should be flushed and kept open as long as there is serum seepage. Mechanical debridement of the wound with a sterile swab will prevent premature closure. The wound may be sutured closed when there is no apparent infection or drainage. Appearance of granulating tissue around the edges of the wound indicates healing is occurring, which may take up to two to five weeks. A week after closure, bandaging can be reduced to only a light wrap. After healing is complete, the foot may still be tender for several weeks. Prevention of trauma and maintaining the patient on soft footing are important to prevent recurrence. Waterfowl should be returned to water as soon as possible to prevent other problems. Modifications and compromises to this procedure may be necessary depending on the species involved and the individual situation.

Nonsurgical Immobilization of Fractures

There are many indications for bandaging avian limbs: nonsurgical immobilization of fractures, soft tissue and joint injuries, and following orthopedic fracture repair. The following bandages and splints have been developed and modified to meet specialized anatomic requirements for avian limb immobilization.[7,28] Specific indications, contraindications and application techniques will be discussed for each type of bandage or splint.

Bandaging Materials

Bandage materials used in birds should be soft, pliable and not have adhesive materials that can adhere to or damage feathers. Cast padding is an ideal base for slings, bandages and wraps. Self-adherent bandage materials are best for the outer layer. When necessary, wooden splints, aluminum rods or lightweight casting materials can be used to reinforce bandages. Some human orthopedic products have been excellent support materials for use in birds. Orthoplast[r] and Hexcelite[s] are excellent support materials for use in birds. At room temperature, these materials are firm, but when placed in hot water they become malleable and can be manipulated to conform to the shape of a bird's limb.

Fracture Stabilization

To be effective, an external coaptation device must immobilize the joint above and below a fracture. Once in place, bandages should be carefully monitored for tissue abrasions, slipping, seepage or swelling in the distal part of a limb, all of which would indicate that the bandage needs to be replaced.

Figure-of-Eight Wing Bandage

The indications for figure-of-eight wing bandages include wing fractures distal to the elbow, luxations of the elbow or carpal joint and soft tissue wounds in these areas that require bandaging and immobilization.[28] There are no rules to dictate which wing fractures can be adequately repaired with external coaptation, which fractures require surgical repair and which are simply not repairable. In general, external coaptation in the form of a figure-of-eight wing bandage can be considered for the following fractures: most closed fractures of the ulna and radius, when the fragments are relatively well-aligned (Figure 16.12); 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. It is contraindicated to apply a figure-of-eight wing bandage for a humerus fracture without also immobilizing the shoulder with a wing-body wrap.

Application of a figure-of-eight wing bandage is shown in Figure 16.13. It is important to incorporate the scapular or tertiary covert feathers in the bandage and apply the bandage as high in the axillary region as possible to prevent the bandage from slipping below the elbow. The bandage should not extend more than approximately one-half bandage width beyond the elbow joint and should not be applied too tightly. A bandage that is applied too tightly may cause vascular compromise of the wing distal to the carpal joint and sloughing of flight feathers. If the primary and secondary flight feathers have a criss-crossed appearance following bandaging (instead of lying parallel), the bandage is too tight. The bandage should not be so bulky that it causes balance problems in the patient. It may be advantageous to tape the tips of the primaries to the tail feathers in birds with long primary feathers.

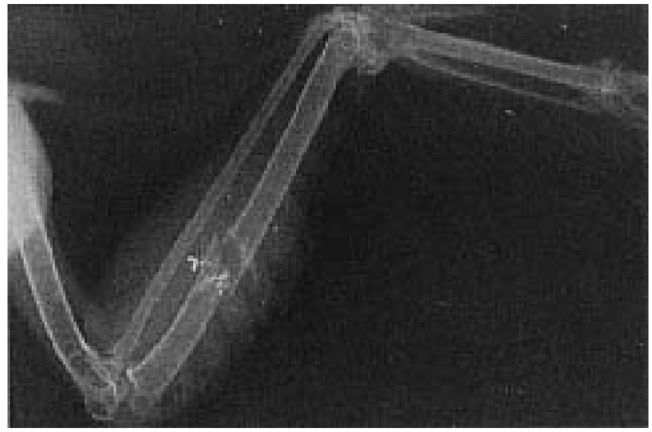

FIG16.12 Wing fractures, in which either the radius or ulna remain intact, can be successfullly managed with a figure-of-eight bandage.

The length of time a wing bandage is left on is determined by the underlying problem. Most fractures require three to five weeks of bandaging, and soft tissue wounds may require a few days to two weeks of immobilization. Complications of prolonged bandaging are joint stiffness, bony changes, disuse muscle atrophy and occasionally sloughed flight feathers.[28] Weekly bandage changes with physical therapy on the wing, proper bandage application and removal of the bandage as soon as possible after healing will minimize these problems.

Wing-Body Wrap

Fractures or luxations involving the humerus, coracoid, furcula or scapula should be immobilized with a wing-body wrap,[28] as shown in Figure 16.13. Humerus fractures are often immobilized with both figure-of-eight and wing-body wrap bandages, and most of these fractures require orthopedic repair.[7] The legs should be extended to pull the stifle joints away from the keel, and the wing should be folded in a normal flexed position and held to the body using a self-adherent bandage[m] or adhesive tape that does not harm feathers (masking tape or Durapore[q] tape). The bandage should be positioned approximately halfway between the top and bottom of the keel to avoid interference with the legs and the vent. It is important to apply the body wrap tight enough to prevent wing motion, but not tight enough to compromise respiration.

Schroeder-Thomas Splint

The use of a Schroeder-Thomas splint is limited to fractures of the tarsometatarsus and the distal one-third of the tibiotarsus[26] (Figure 16.14). Indications for these splints include fractures of the tarsometatarsus in psittacine birds in which the bone is too small to apply any form of orthopedic repair, fractures too close to the tibiotarsal-tarsometatarsal (hock) joint or foot, uncomplicated fractures in small birds, and following internal surgical fixation of distal tibiotarsal fractures. Contraindications for Schroeder-Thomas splints include all fractures of the femur and proximal two-thirds of the tibiotarsus, because the extreme flexion at the ileal-femoral joint and the wide inguinal skin web in birds results in the proximal portion of the splint acting as a fulcrum and interfering with immobilization.

The wire or rod material of the splint should be made with two right-angle bends next to the ring at the top so that the splint is parallel to the long axis of the leg (Figure 16.14). The leg should be positioned with some flexion at the hock joint, with the splint angles bent to conform to the angles of the leg. The splint should be slightly longer than the partially

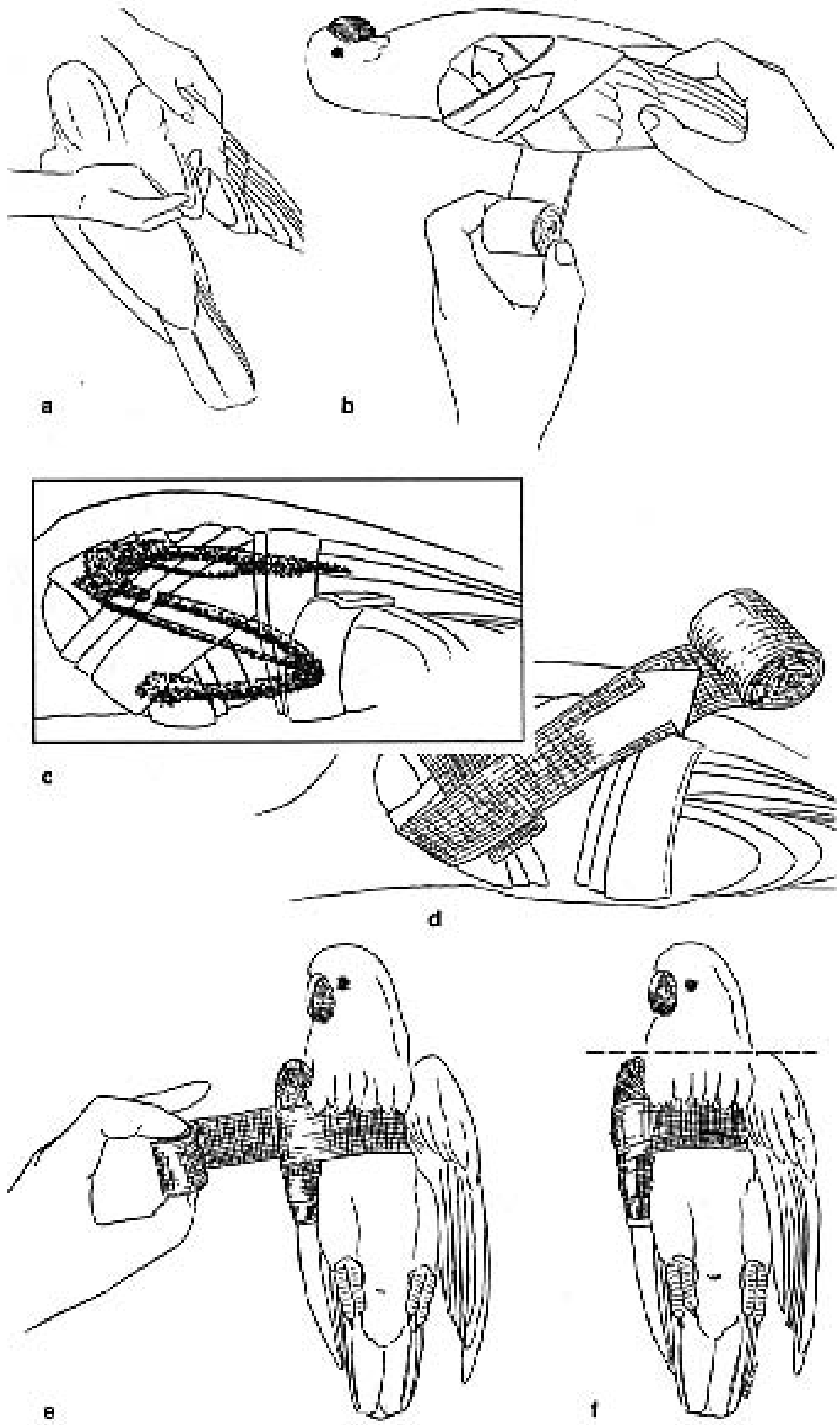

FIG16.13 **a,b,c)** Rolled cotton padding is used for the initial layer of a figure-of-eight bandage **d,e)** followed by the application of a self-adherent bandage material. **f)** If the bandage is properly applied, the carpus of the injured wing will be positioned neither higher nor lower than the unbandaged carpus. In addition, the primary and secondary feathers will be in a normal anatomic association. If the primary tips are medial to the secondary feathers, the carpus is being excessively flexed and the bandage is too tight.

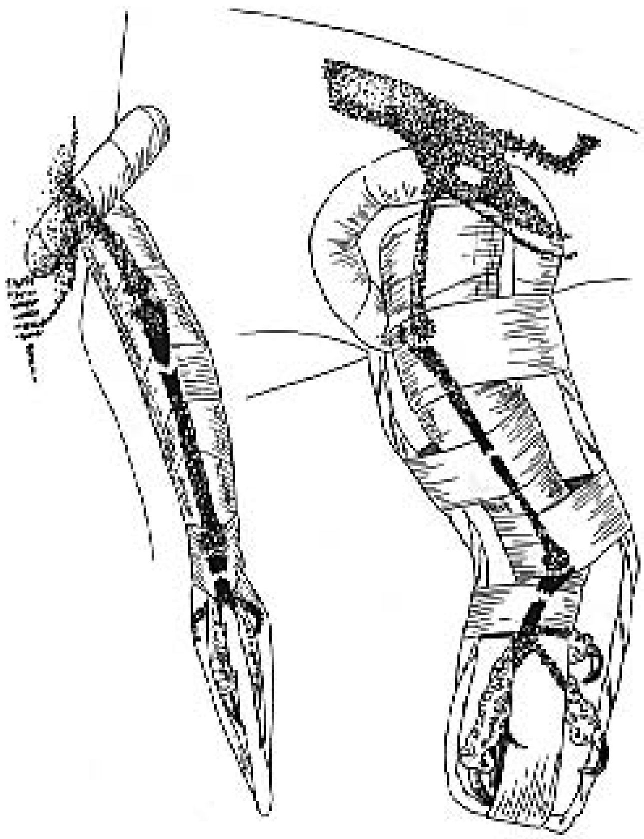

FIG16.14 Craniocaudal and lateral views of a Schroeder-Thomas splint, which can be used to temporarily stabilize fractures of the tarsometatarsus and distal tibiotarsus.

FIG 16.15 Lateral view of a Robert Jones bandage, which can be used to temporarily stabilize fractures of the distal tibiotarsus and tarsometatarsus.

flexed leg and extended toes. The leg is lightly bandaged with gauze and tape and is suspended within the splint by alternating strips of tape placed cranially and caudally with the toes extended to the end of the splint. The splinted leg is then covered with bandaging material. Weekly or bimonthly bandage changes with passive physical therapy should be conducted until the fracture heals in four to six weeks. The bird should be provided a low perch so that the splinted leg can hang below or be propped on the perch. With all leg injuries, bumblefoot lesions in the contralateral, weight-bearing foot should be prevented through the use of soft flooring materials, adequate nutrition and, in some cases, ball bandages.

Robert Jones Bandage

The Robert Jones bandage (Figure 16.15) should be limited to simple fractures of the distal one-third of the tibiotarsus and tarsometatarsus, injuries involving the hock joint, soft tissue wounds of the tibiotarsus or tarsometatarsus, or following orthopedic repair of the distal two-thirds of the leg. These heavily padded leg bandages can be used with or without additional splinting material, such as tongue depressors, aluminum splints or orthopedic casting material[r,s] (Figure 16.16). Fractures involving the tarsometatarsus should be combined with a ball bandage to immobilize the foot. The Robert Jones bandage is contraindicated for leg fractures of the femur, proximal two-thirds of the tibiotarsus and in larger birds (eg, over 500 g) because of inadequate immobilization.

A thick layer of casting material is wrapped from the top of the foot to the most proximal point of the leg. The leg is slightly flexed, conforming gauze material is tightly wrapped around the cast padding, additional splinting material is incorporated into the bandage and tape or self-adherent bandaging material is used to cover the bandage. The toes should be monitored for swelling and discoloration if they are not incorporated within the bandage.

FIG 16.16 An adult male Amazon parrot was presented for an acute onset of a non-weight-bearing lameness. The bird's wing had been improperly trimmed, and it fell from the top of its enclosure to a concrete floor. Radiographs indicated an oblique fracture of the mid-tibiotarsus. The owner chose a cast repair (right) over the application of an external fixator. In this case, with a calm bird and a minimally displaced fracture, casting was sufficient coaptation to allow bone repair.

Spica Splint

Spica splints may be used for simple, aligned fractures of the femur in smaller birds, but generally need to be combined with orthopedic fracture repair in larger birds (eg, over 300 g).[7,28] Splint material can be molded from orthopedic casting material[r,s] or padded aluminum finger splints. This splint is a modification of the Robert Jones bandage, except that the padded, molded splint extends from the tibiotarsus proximally and over the bird's pelvis in an inverted U-shape to immobilize the femur against the body of the bird.

Ball Bandage

Indications for ball bandages (Figures 16.17) include moderate to severe forms of pododermatitis (bumblefoot), toe fractures and other soft tissue injuries involving the toes or feet in perching birds.[12,29]

The toes should be conformed around a stack of gauze sponges, and wrapped snugly with conforming gauze material to form a teardrop-shaped bandage. There should be adequate padding and support around the distal tarsometatarsus to allow the bird to be able to stand upright on the bandaged foot. It is also important to make sure that the bandage is not applied too tightly around the tarsometatarsus at the top of the bandage, which can cause vascular compromise of the foot. Birds with one or both feet in ball bandages should be placed in an enclosure with a padded surface.

Other Leg and Foot Bandages and Splints

Various tape splints have been devised for immobilizing simple tibiotarsal and tarsometatarsal fractures in small birds.[26] Additional splinting material such as paper clip wire or toothpicks, balsa wood, pipe cleaners or wooden applicator sticks can be used to provide more stabilization. Such support must be properly padded over bony protuberances to avoid pressure ulcers. The joint above and below the fracture should be immobilized.

Toe fractures can be immobilized by taping two toes together, by splinting with a padded tongue depressor or cardboard in a modified "snowshoe" splint using two or more toes, or by using thermoplastic coated casting material[s] to mold a "shoe splint" to fit the entire foot (Figure 16.18). For small birds, hydrocolloid dressings can be used as splint material for tibiotarsal and tarsometatarsal fractures (see Figure 16.3). The hydrocolloid dressing should be covered by another bandage material to prevent chewing, and should be changed on a daily basis if it becomes moist. When the wound is dry, the dressing can be left in place for up to ten days.

Soft tissue wounds involving the plantar surface of the foot can be effectively bandaged with an interdigitating bandage that leaves the toes exposed for perching (Figure 16.19). It is important to avoid applying the bandage too tightly, or using too much bandaging material between cranial digits. The lightest possible bandage would be used in finches and other small birds to prevent loss of balance.

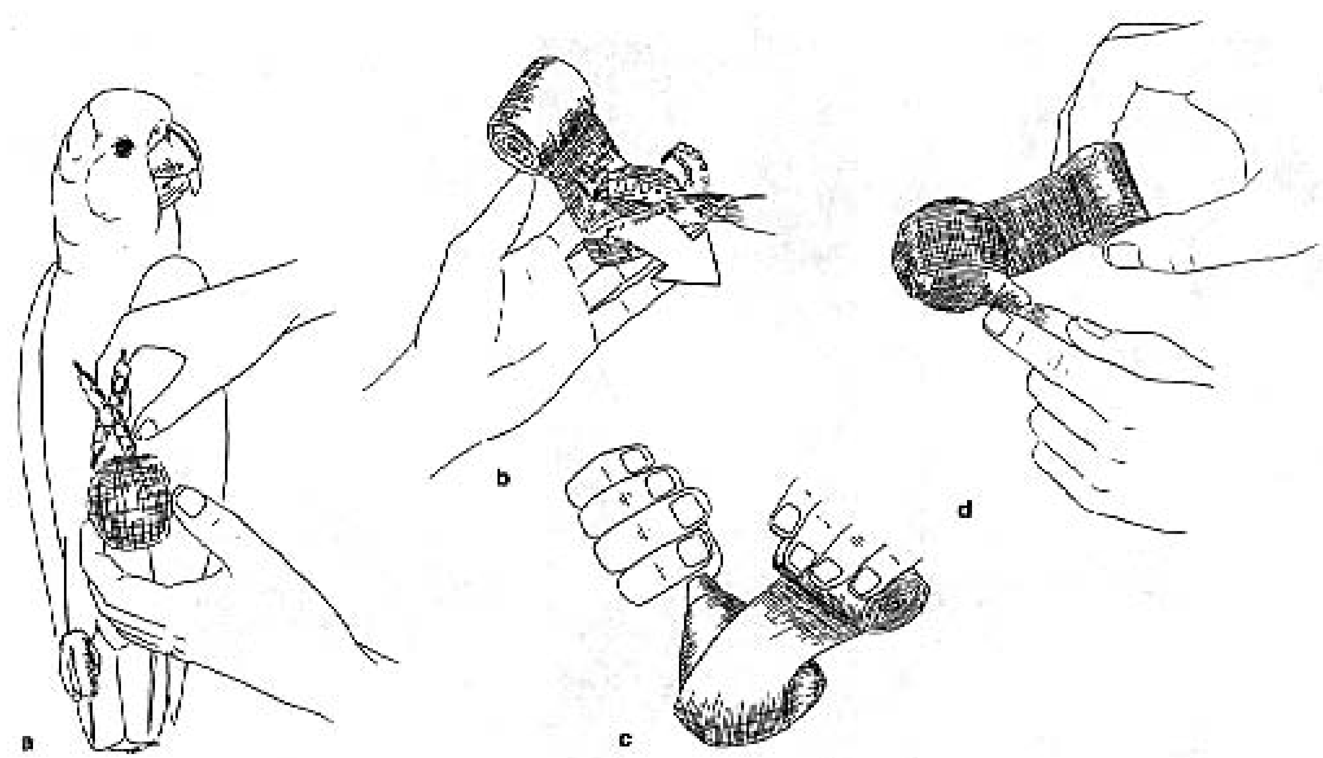

FIG16.17 Ball bandages can be used to protect foot injuries while they heal. A stack of gauze pads or a piece of cardboard cut to fit the bottom of the foot is covered with cotton padding and placed on the plantar surface of the foot. The foot is then wrapped with a layer of rolled cotton padding and covered with a self-adherent bandage material.

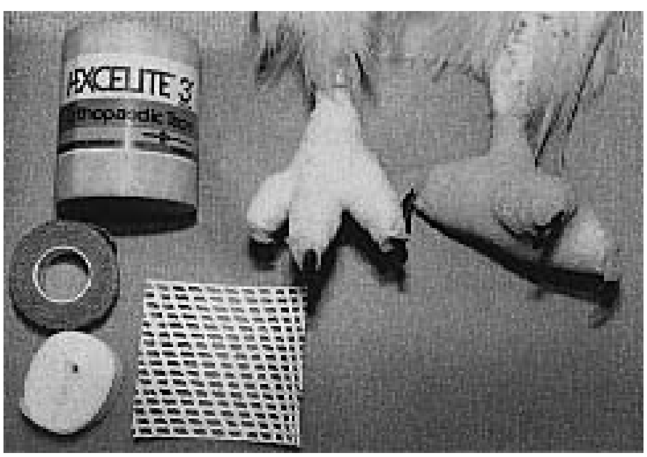

FIG 16.18 A snowshoe splint can be used to provide primary support for phalangeal fractures. The bandage is applied by wrapping the toes and foot in a protective layer of cotton padding. A "snowshoe"-shaped splint is fashioned out of Hexcelite and placed onto the plantar surface of the foot. The splint is held in place with cotton padding covered with a self-adherent bandage material.

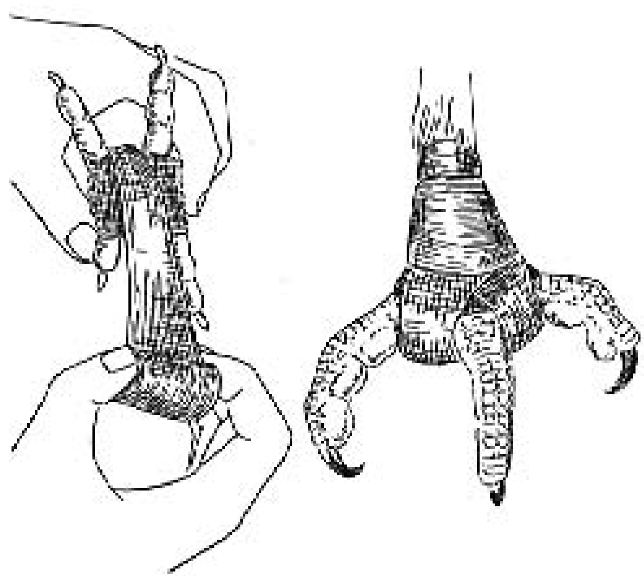

FIG 16.19 An interdigitating bandage is applied by placing gauze on the metatarsal pad and wrapping it in place with cotton padding, which is then covered with a self-adherent bandage.

Products Mentioned in the Text

a. Nolvasan, Fort Dodge Labs Inc, Fort Dodge, IA
b. Betadine, The Purdue Frederick Co, Norwalk, CT
c. Silvadene, Marion Labs Inc, Kansas City, MO
d. Preparation H, Whitehall Labs Inc, New York, NY
e. Telfa Pads, The Kendall Co Hospital Prod, Boston, MA
f. Nu Gauze Sponges, Johnson & Johnson, New Brunswick, NJ
g. Dermaheal or DuoDerm, Squibb, Princeton, NJ
h. Epi-Lock, Virbac, Inc, Lenexa, KS
i. Tegaderm, 3M Animal Care Products, St. Paul, MN
j. Op-Site, TJ Smith and Nephew, Welwyn Garden City, Herts, UK
k. Bioclusive, Johnson & Johnson Prod, New Brunswick, NJ
l. Kling, Johnson & Johnson Prod, New Brunswick, NJ
m. Vetrap, 3M Animal Care Products, St. Paul, MN
n. Kwik-Stop, Gimborn-Rich Health, Irvine, CA
o. Collodium Flexible, Humco Lab, Texarkana, TX
p. NuSkin, Medtech Labs Inc, Jackson, WY
q. Durapore Tape, 3M Animal Care Products, St. Paul, MN, USA
r. Orthoplast, Johnson & Johnson Prod, New Brunswick, NJ
s. Hexcelite, Hexcel Medical Co, Dublin, CA
t. Elastikon, Johnson & Johnson, Arlington, TX

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