Return to previous file: Part 2

Sample containers

Because the sample sizes required for haematology and biochemistry are small, it is recommended that micro collection tubes are used (Microtainers™, Becton-Dickinson). These are 0.6-mL blood tubes that are available containing lithium heparin anticoagulant (also available plain and with EDTA). Alternatively, standard collection Vacutainers™ may be used. However, these should be filled to at least half of their capacity to minimise the effects of excessive anticoagulant (Hume 1995).

Anticoagulants

With kiwi blood, it is recommended that lithium heparin anticoagulant is used for both haematology and biochemistry. **Kiwi blood shows an unusual reaction to EDTA, rapidly haemolysing after 15–30 minutes**. This reaction is similar to that of some other avian species, including ostriches (Hume 1995). For this reason, kiwi blood should not be collected into EDTA tubes.

Smears

Hume (1995) stated that the ideal technique for preparing avian blood slides is the coverslip technique. This is described as follows and shown in Fig. 10:

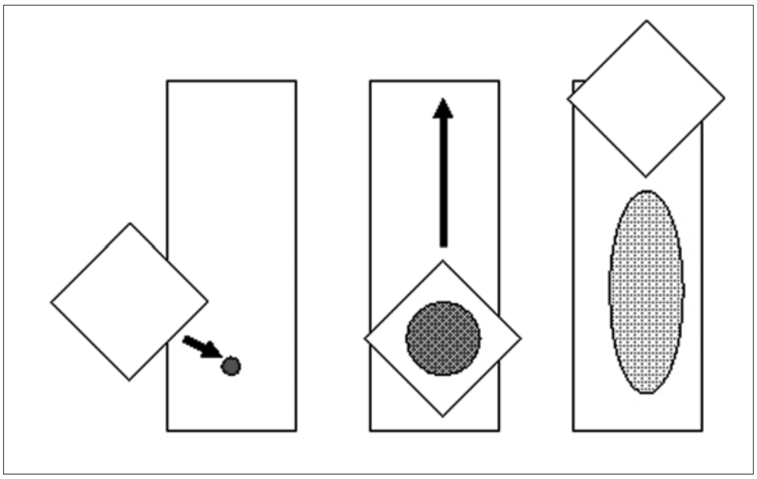


Figure 10. The coverslip method for preparation of avian blood smears. *Figure: K. McInnes, DOC.*

'A small drop of blood (without anticoagulant) is placed near one end of the slide. If the slide is frosted, place the blood drop at the frosted end of the slide. Place a coverslip on the blood, allowing the blood to fan out. Just before the blood reaches the end of the slide, the two slides should be pulled apart without lifting the coverslip. This technique greatly reduces leucocyte margination and the incidence of smudge cells' (Hume 1995).

The two-slide wedge technique, as commonly used in mammalian medicine, is the least acceptable technique for avian blood. This technique produces an unacceptable number of smudge cells (ruptured white and red blood cells) as well as margination of white blood cells (Hume 1995).

Fixing blood smears in methanol or any other fixative is not recommended. A delay between fixation and staining can result in the reduction in quality of leucocyte granule staining (Hume 1995).

4.2.2 Laboratory testing

Most commercial laboratories have standardised methods for analysing avian haematology. A selection of biochemical analytes is often offered as a routine biochemical panel for avian species. Not all of these standard panels include uric acid, and most do not include bile acids. Both of these metabolites should be requested whenever avian blood is sent for analysis, as they are two of the most important biochemical parameters for birds. Alternatives for biochemical analysis of avian blood include using a VetScan™ analyser.

Biochemical artefacts may include an increase in potassium and total plasma protein if the blood is not spun down immediately after collection (Hume 1995). This is because the erythrocytes leak potassium across their cell membranes. Glucose should be analysed within 2 hours on whole blood.

Normal haematological parameters for North Island brown kiwi (*Apteryx australis mantelli*), Okarito brown kiwi (*Apteryx rowi*) and the great spotted kiwi (*Apteryx haastii*) can be found in Appendix 3.

4.3 IMAGING

4.3.1 Radiography

Radiographs are indicated in all cases of trauma, and they are necessary as part of a routine diagnostic work-up of a sick bird. Survey radiographs should include both laterolateral and ventrodorsal views of the entire bird, and areas of particular interest can be focused on in subsequent radiographs. This ensures that injuries that are less obvious during physical examination are not missed.

Equipment and techniques

If possible, it is recommended that fine screens be used for radiographing kiwi, as these provide better detail. However, if these are not available, factors and plates used for radiography of small cats are adequate.

Mammography cassettes and film provide excellent high-detail radiographs, and may be useful for fine detail of the extremities of kiwi, or for kiwi chicks.

Restraint

In order to achieve diagnostic radiographs, to minimise stress on the patient, and to prevent exposure of veterinary personnel to radiation, it is essential that kiwi are restrained under general anaesthesia. Taking radiographs of conscious birds places them under stress and can cause further injuries. It is also very difficult to obtain radiographs that are diagnostically useful if bird positioning is not appropriate. Poor positioning is the most frequently encountered factor compromising a radiography study and hampers the interpretation of subtle lesions in avian radiographs (McMillan 1994).

Respiratory motion is largely unaffected by appropriate planes of anaesthesia, and motion artefact is eliminated by the use of relatively short exposure times (0.01–0.05 seconds) (Helmer 2006).

Positioning

It is recommended that at least two views of the bird are taken—laterolateral and ventrodorsal.

Laterolateral view Ideally, the kiwi should be positioned on the radiograph plate so that the entire bird is in the radiographic field (Fig. 11). Both legs should be pulled in a caudal direction, away from the abdomen, to avoid obscuring the visceral organs. The legs should be splayed apart, with one in front of the other, and taped to the plate using sticky tape. The cranial (forward) leg should be marked as left or right. In order to obtain consistency between radiographs, it is recommended that a system of bird positioning is developed. At the New Zealand Wildlife Health Centre, the protocol is to consistently put the bird into left lateral recumbency, always with the left leg forward. When assessing appropriate positioning for the laterolateral view, the two femoral heads should overlie one another, the legs should be pulled caudally, and the sternum should be parallel to the film (Helmer 2006).

Ventrodorsal view In the ventrodorsal view, the bird is positioned on its back with its legs pulled caudally and secured with tape (Fig. 12). Because of their lack of wings, kiwi often require support to stay in dorsal recumbency. The use of a trough for the bird to lie in, which can be fashioned from a rolled-up towel, may assist. Alternatively, the use of foam wedges should stop the bird from rolling laterally.

Correct positioning will be apparent, as the spine will be superimposed over the centre of the sternum (N.B. kiwi lack a keel), and the acetabula and femurs will be parallel (McMillan 1994).

Contrast studies

Contrast studies of the upper and lower gastrointestinal tract are often indicated if there is suspicion of a space-occupying mass, gastrointestinal ulceration, abnormalities in size or shape of coelomic organs, gastrointestinal foreign bodies, alterations in gastrointestinal motility or body wall abnormalities (Helmer 2006). Barium sulphate suspension is the most commonly used contrast media. The amount of barium sulphate solution to use may be calculated on the basis of 5 mL per kg of body weight (B.D. Gartrell, Massey University, pers. comm.). The barium solution is introduced into the bird's stomach by gavage. The quantity recommended is much less than that usually recommended for psittacine gastrointestinal barium studies, and relates to the small holding capacity of the kiwi's upper gastrointestinal tract. Care must be taken to avoid aspiration of the contrast media, especially in the early stages of the study when the liquid is in the upper gastrointestinal tract.

BIPS™ (barium impregnated polyethylene spheres) may also be used for evaluating some gastrointestinal motility. These may be a safer form of contrast media in some instances, as there is no risk of aspiration. BIPS have been used on one occasion (dose given 12 hours prior to radiographic examination under anaesthesia) to detect a gizzard impaction (unpubl. data).

Normal gastrointestinal transit time for psittacine species is approximately 3 hours (Helmer 2006). However, this varies depending on species and individual diets, and gastrointestinal transit time in kiwi is unknown. Results of contrast studies should be interpreted in light of associated clinical signs.

4.3.2 Advanced avian imaging

Ultrasonography

Ultrasonography has limited use in birds because the ultrasound waves do not penetrate the gas-filled air sac system, so that organs cannot be clearly seen (Helmer 2006). Interpretation of abnormal findings is also difficult without prior knowledge of normal structures particular to the species. In kiwi, ultrasonography has been useful in identifying yolk sac retention in kiwi chicks, and has been used to diagnose a partial intestinal obstruction in an adult kiwi (unpubl. data).

Figure 11. Lateral radiograph of a normal adult North Island brown kiwi. *Photo: B. Gartrell.*

Figure 12. Ventrodorsal radiograph of a normal adult North Island brown kiwi. *Photo: B. Gartrell.*

Endoscopy

Endoscopy has become a routine diagnostic procedure in avian medicine. Rigid 2.7-mm scopes or small flexible scopes are of use in kiwi.

Tracheoscopy Endoscopic examination of the tracheal lumen may be indicated in cases of partial tracheal obstruction, such as those caused by *Aspergillus granulomas*, changes in tracheal structure or foreign bodies (Lierz 2006). Endoscopic visualisation helps in lesion diagnosis, with the option of subsequent mechanical debridement of the granuloma using endoscopic instruments. However, the granuloma may be further down the trachea (e.g. the syrinx) than can be reached by the rigid endoscope.

Gastroscopy The use of the rigid 2.7-mm or a small flexible endoscope allows the mucosa lining the oesophagus, proventriculus and the gizzard of the kiwi to be examined. This is often indicated as part of a diagnostic work-up for upper gastrointestinal abnormalities, and for endoscopic-guided removal of foreign bodies from the gizzard.

Coelioscopy Compared with flighted avian species, the air sac system in kiwi is underdeveloped, making coelioscopic examination more difficult than that described in many avian texts. Only small numbers of kiwi have been examined using coelioscopy and normal statistics have not been developed (B.D. Gartrell, Massey University, pers. comm.).

Coelioscopy is performed using the rigid 2.7-mm endoscope, and allows examination of the serosal surface of internal organs, including the air sacs, lungs, heart, liver, spleen, pancreas, gastrointestinal tract, gonads, and ventral surface of the kidneys and associated ureters. It also allows biopsy of organs using biopsy forceps within a working channel. The biopsy can be submitted for histopathology or microbiology.

Cloacoscopy The 2.7-mm rigid scope can also be used for examination of the cloaca and its associated structures, including rectum, ureteral openings and uterus.

Computed tomography (CT) and magnetic resonance imaging (MRI)

Magnetic resonance imaging (MRI) is useful for imaging soft tissue structures, including the brain, spinal cord, coelomic organs and the upper respiratory tract (Helmer 2006). Computed tomography (CT) is best suited for evaluation of bone and air-filled structures (Helmer 2006). Computed tomography has been used to successfully diagnose an acetabular fracture in a kiwi that was not visible on a plain radiograph (Figs 13, 14,& 15) (Gartrell et al. 2006).

Figure 13. CT scanning of a rowi (Okarito brown kiwi) (to diagnose an acetabular fracture). *Photo: B. Gartrell.*

Figure 14. CT images showing fracture to the left acetabulum (arrows). *Photo: B. Gartrell.*

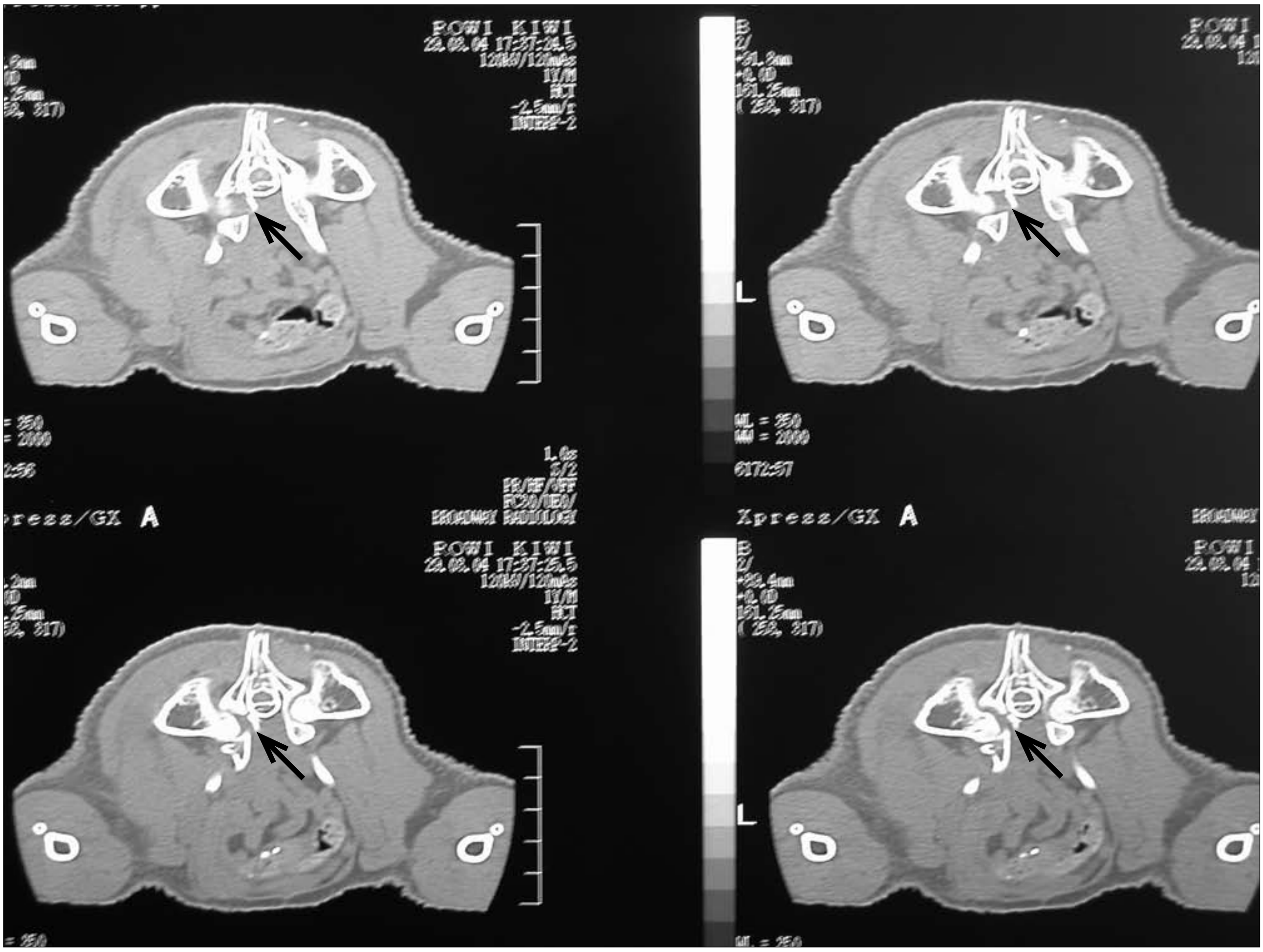


Figure 15. 3D reconstruction of images in Fig. 14 showing a comminuted fracture of the left acetabulum (white arrow). N.B. the floating radiodense objects are stones within the gizzard. *Photo: B. Gartrell.*

5. Husbandry

5.1 NUTRITION

In the wild, kiwi eat mainly invertebrates, but they will also eat some fallen fruits and, occasionally, leaves. Their main prey are earthworms, beetle larvae, cicadas, moths, spiders, weta, crickets and centipedes. The relative proportion of each dietary component varies from place to place and with season (Heather & Robertson 2000).

Captive birds are generally fed an artificial diet. The captive kiwi diet varies slightly between kiwi houses, but is mainly made up of meat (usually ox heart) and various fruits, vegetables and other ingredients (see Appendix 4). A vitamin and mineral premix supplement designed for kiwi should be added (see Appendix 5). Supplementation with invertebrates is often offered to captive kiwi as a form of environmental enrichment. Feeding solely invertebrates in captivity is difficult to sustain, as an adult kiwi has been estimated to require more than 300 native earthworms a night (S. Bassett, Kiwi Encounter, Rainbow Springs, pers. comm.).

The artificial diet is by no means appropriate, given what kiwi eat in the wild. At the time of writing, alternative captive diets which conform more closely to the natural diet of kiwi were being investigated (C. Minson, Massey University, pers. comm.).

Food requirements and methods of feeding a debilitated kiwi depend on the status of the bird, and whether it is of captive or wild origin. In the hospital situation, it will obviously be easier to initiate self-feeding in a captive kiwi that is used to eating an artificial diet than it will in a wild kiwi that is used to foraging for food. Very sick birds may require assisted feeding in the short term.

5.1.1 Intensive care and short-term feeding

The first priority in dealing with an injured kiwi is to address dehydration. A large bird such as a kiwi usually has body reserves to manage for at least 24–48 hours without food.

If the bird is not eating on its own, it may be tube-fed with a formulated diet. Hill's a/d™ may be used for this purpose (see Appendix 5). This needs to be made into a slurry with warm water and gavage-fed using a crop needle or feeding tube in the same way as oral fluids are given. The mixture temperature should be around 38°C (i.e. body temperature). Gavage-feeding food heated to temperatures ≥45°C risks oesophageal burns. The limited capacity of the upper gastrointestinal system of the kiwi limits the volume of tube-fed nutritional support that can be given. It is recommended that small amounts of food are initially fed to establish the volume appropriate for the size and status of the kiwi. Adults may be able to ingest up to 20 mL, but chicks may only be able to take 3–5 mL. There is a risk of regurgitation and subsequent aspiration, so care must be taken to deliver food slowly and in small quantities. The limited volumes of nutritional support deliverable by this method have been found to be insufficient at maintaining weight of kiwi (pers. obs.) This is probably the result of the formula having to be diluted with water to enable it to be administered by tube. Also, the stress of repeated handling for gavage feeding is likely to have a negative effect on the energy balance of the bird.

Kiwi with bill injuries may require that an oesophagostomy feeding tube be installed (Fig. 6). This allows feeding to bypass the oral cavity. However, this method is also unsuitable for maintenance of body weight, and is useful only for short-term nutritional support.

An alternative method of feeding kiwi in intensive care situations is to hand-feed the artificial captive diet. This can be rolled into small balls that are placed in the caudal oral cavity of the kiwi, which stimulates swallowing. An adult kiwi can be fed 100 g or more of this mixture at a time. Alternatively, in the very short term (i.e. no more than a few days), strips of ox heart may be used in a similar way. However, this diet is seriously nutritionally imbalanced. For example, the calcium to phosphorus ratio in ox heart is inappropriate for kiwi, and longer-term feeding of meat alone may lead to nutritional skeletal disorders, including metabolic bone disease.

5.1.2 Medium- to long-term care

Supply of a nutritionally balanced diet is imperative for medium- to long-term feeding of kiwi in order to avoid dietary deficiencies and imbalances. Many kiwi, even those of wild origin, will convert to a captive diet within days to weeks. Some remain resistant, and may require prolonged assist-feeding.

Because they are nocturnal, kiwi are inherently more active and inclined to feed for several hours at dusk. Fresh food should be offered in the late afternoon. An adult kiwi may eat 100–200 g of the kiwi artificial captive diet each night. Native earthworms may be offered in soil to encourage probing and some behavioural enrichment for the bird. Other commercially available insects that can be offered include mealworms and wax-moth larvae. Tiger worms (compost worms) appear to be unpalatable to kiwi.

A dish of water should be made available at all times.

5.2 HOUSING

Wild birds need to be appropriately housed to provide the most stress-free environment possible. They must be housed away from cats and dogs and other potential ‘predators’. Examples of avoidable stressors include human traffic, loud noise (radios, television, people talking) and excessive handling. Birds should be placed in a quiet, dark, draught-free and warm area, and they should be handled as infrequently as possible.

Housing requirements vary depending upon the situation and status of the bird.

5.2.1 Intensive care

Very sick and debilitated birds, and those recovering from general anaesthesia, should be housed in an intensive care situation. Ideally, this would be in an intensive care unit or paediatric incubator with temperature and humidity control. If this is not available, small cages with external heat sources may be used (see section 2.2.4). In many cases (e.g. trauma), it may be necessary to minimise bird movement by providing a small enclosure. In small hospital cages, a towel may be placed over the front of the cage to reduce visual stimulation and provide darkness. Similarly, incubators and intensive care units should be covered.

5.2.2 Non-critical hospitalisation

Once the bird is stablised and no longer requiring critical care, it may be placed in a larger container. This may be a specially-designed hospital cage, or simply a large cardboard box (e.g. from a refrigerator or television). These work well, as they can be used for one patient and then thrown out, and can easily be moved to quiet, warm places, away from other animals and sources of negative stimulation. The birds should be provided with a burrow, which may be made from a smaller cardboard or plastic box with an entry hole cut in the front, and turned upside down. Cardboard boxes used for burrows can be discarded and plastic tubs can be cleaned with a disinfectant (e.g. Virkon™, Trigene™) before use by other patients.

A shallow tray of water should also be provided—cat litter trays are ideal for this. Food should be provided in bowls in the enclosure. Generally, kiwi are not active during the day, and will not venture out of their burrow. In the wild, they become active at dusk for several hours for feeding, so it is important to provide fresh food in the late afternoon in preparation for this. Providing live earthworms in a dish of soil and fresh, clean, leaf-litter (with invertebrates) once or twice weekly provides an additional source of nutrition as well as environmental enrichment for the birds.

5.2.3 Longer-term care

It is not the intention of this publication to provide information on appropriate housing for longer-term care. It is advisable to refer to the The Kiwi Best Practice manual: www.savethekiwi.org.nz/InformationToolkit/Kiwi+Best+Practice (viewed January 2008) for recommendations on husbandry.

5.3 TRANSPORTATION OF KIWI

Ideally, kiwi should be transported in transport boxes specially designed for this species. Considerations when choosing an appropriate transport box include the provision of adequate ventilation, and room sufficient to allow the bird to move to reposition itself, but not to move excessively, which might worsen injuries.

Care must be taken to ensure that the bird's long bill cannot protrude from the box where it would become susceptible to trauma when the box is moved. If the box is hinged at the top, it is important to make sure that the bird cannot get its bill caught in the hinged lid as the box is closed.

Adequate ventilation must be provided via air vents—these can be covered with a fine mesh (e.g. shade cloth) to prevent protrusion of the bill. The box should be well padded with a substrate suitable for absorbing excrement. Clean towels are an ideal covering for the box substrate.

Overheating should be prevented if there is adequate ventilation and the box is not placed in direct sunlight. Small chicks should never be transported in plastic containers, as this risks overheating.

Kiwi tolerate air travel if they are stabilised prior to the flight, and this method of transporting kiwi has been carried out successfully on many occasions. It is important to ensure that the bird to be transported is rehydrated and appropriately treated first. Usually, it is recommended that debilitated birds be given a stabilisation period of at least 24 hours before transportation. Contact Air New Zealand cargo for information on air transportation of live kiwi.

Kiwi should never be transported with their legs taped together (see section 2.1.3).

Refer to the The Kiwi Best Practice manual: www.savethekiwi.org.nz/InformationToolkit/Kiwi+Best+Practice (viewed January 2008) for further information.

6. Traumatic injuries

6.1 TRAP INJURIES

Trap injuries are the cause of one of the most common presentations of injured kiwi. Leg or bill entrapment can occur when a kiwi inadvertently steps on a trap intended for possums. Traps are supposed to be placed up off the forest floor, making them inaccessible to ground-dwelling birds, but some traps are still placed on the ground.

Often, the birds are found more than 24 hours after they have become trapped in the device. Leg entrapment often involves crushing injuries to the lower tarsometatarsus or foot, resulting in contaminated, open, comminuted fractures with severe neurological and vascular compromise. As the bird moves about attempting to free itself from the trap, the nerves and blood vessels supplying the fracture site and distal limb become further damaged, and the birds often have complete loss of neurological and vascular function. Often, these birds have severe blood loss and are septicaemic as a result of heavy wound contamination.

Bill entrapment may also occur, and these injuries usually have a grave prognosis (see section 6.2).

Treatment principles for leg trap injuries include patient stabilisation as previously described. Immediate consideration must be given to aggressive fluid and antimicrobial therapy, analgesia, and appropriate wound management.

If there is no remaining vascular or neurological function to the entire distal limb, amputation or euthanasia may be the only treatment options. Euthanasia is recommended for birds with crushing injuries above the hock, with a lack of blood and/or nervous supply.

Distal limb amputee birds have only recently been released back to the wild and survival of two birds for over a year suggests a positive outcome. However, breeding has not been observed so far, and careful consideration of the long-term future of such birds must be made in consultation with the Kiwi Recovery Group and DOC (see section 1.1) before surgery is undertaken. Limb amputee kiwi have yet to be proven as breeders in captivity (B.D. Gartrell, Massey University, pers. comm.).

Toe amputations may be performed, and these birds have been successfully returned to the wild. A female kiwi with an entire digit amputation was released back into the wild. Monitoring over the following 6-month period showed that she was able to move successfully over long distances, and examination on subsequent capture for transmitter removal showed her to be in good body condition (D. King, DOC, pers. comm.).

Other methods of fixation for distal limb fractures with intact nervous and vascular supply include the placement of a modified external skeletal fixator (see Fig. 16). Complications associated with this procedure include fracture malunion, tenosynovitis and osteomyelitis.

Figure 16. Modified external fixation of an open, comminuted tarsometatarsal fracture as a result of a trapping injury. *Photo: J. Youl.*

6.2 BILL INJURIES

Bill injuries may have a variety of causes including traps (as described above), transportation and dog attacks. Bill tip injuries generally have a grave prognosis, especially if the upper bill is injured. Just how important the bill tip is to kiwi survival is becoming clear. Recent research has demonstrated that kiwi detect their buried prey using vibration- and pressure-sensitive mechanoreceptors embedded in pits in the bill tip. It is believed that these specialised structures function as a detector of movement of invertebrates during feeding (Cunningham et al. 2007). Olfaction is thought to play a minor role in prey detection but an important role in social and territorial behaviour. This finding correlates with clinical observations of a female great spotted kiwi which had an upper bill tip amputation after a transport box injury. This bird failed to feed on her own after more than 24 months in captivity (Fig. 17) (pers. obs). Euthanasia should be seriously considered in any bird with a bill tip amputation.

An injury to the proximal upper bill, or to the lower bill, may have a slightly more favourable prognosis than an upper bill tip injury. A sub-adult female North Island brown kiwi injured by a muzzled dog was presented to the New Zealand Wildlife Health Centre. It had multiple fractures of the proximal mandible. The mandible was repaired using a modified external skeletal fixator (Figs 18, 19). The growth plates of the mandible were affected. As the kiwi continued to grow, it developed an undershot lower bill, which prevented it from probing naturally for food. However, the bird is able to eat the captive diet well, and has now been included in the captive breeding programme.

Figure 17. Fractured tip of the bill of a female great spotted kiwi. The distal 10 mm of the bill was broken off during a transportation injury.
Photo: B Gartrell.

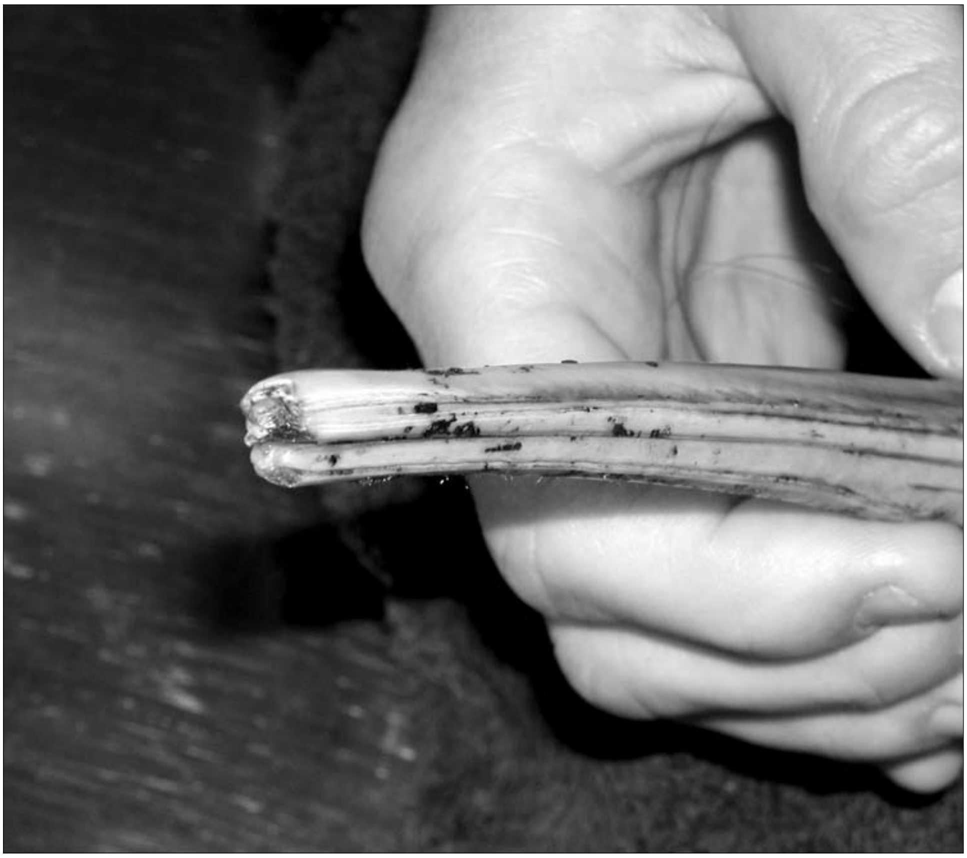
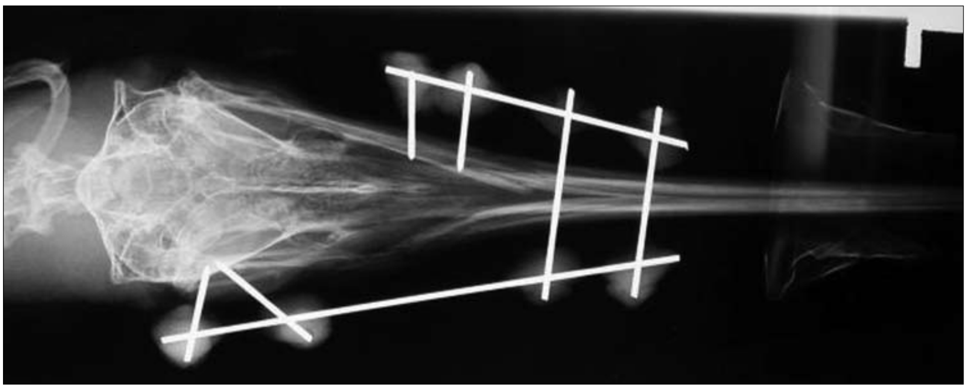


Figure 18. Lateral radiograph of a North Island brown kiwi with multiple mandibular fractures.
Photo: K. Morgan.

Figure 19. Ventrodorsal radiograph of kiwi in Fig. 18 after placement of a modified external skeletal fixator in the mandible.
Photo: K. Morgan.



6.3 MOTOR VEHICLE ACCIDENTS

Motor vehicle accidents are another common cause of injuries to kiwi, and birds may present with limb fractures, bill injuries, pelvic and spinal fractures, and internal injuries.

Again, treatment relies upon stabilisation of the patient, as previously described. Once the bird's condition has stabilised, radiographs can be carried out. These may reveal limb fractures and other internal injuries. Pelvic and spinal fractures are more difficult to diagnose, and often require ancillary diagnostics such as CT scans (see section 4.3.2). Myelography (an X-ray examination using contrast material to highlight the spinal cord) has been described in the avian patient (Harr et al. 1997; Naeini et al. 2006). However, it has limited use in clinical situations, because of lack of familiarity with the technique, fear of iatrogenic injury to the spinal cord, and concern about potentially fatal complications with the procedure (Harr et al. 1997; Naeini et al. 2006). In birds, the fused lumbar and sacral vertebrae and pelvis (the synsacrum) allows accessibility to the atlanto-occipital space only (Harr et al. 1997; Naeini et al. 2006). In many species, the atlanto-occipital space overlies a large venous plexus (Harr et al. 1997) and the myelography procedure may be fatal. MRI should be strongly considered as an alternative to myelography, if feasible (Helmer 2006).

Due to the anatomic location of the lungs and kidneys, birds with pelvic and spinal fractures will often have associated renal and pulmonary contusions. The kidneys lie in a fossa within the fused synsacrum, making them susceptible to damage during trauma to the overlying structures.

Continue to next file: Part 4