Case Report

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Diagnosis of Coxofemoral Joint Luxation in a Whooper Swan (*Cygnus Cygnus*) Using Computed Tomography and Radiography

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Abstract A wild Whooper swan (*Cygnus Cygnus*) with limping due to an injured left pelvic limb in an accident was rescued on the seashore and transferred to the Jeju Wildlife Rescue Center on November 23rd, 2020. On physical examination, its body condition score was 1 out of 5 due to starvation and dehydration. The left coxofemoral joint was also examined by careful palpating and estimating the damage. Moderated soft tissue swelling and crepitus surrounding the hip joint were confirmed. Radiography and computed tomography (CT) were used together for an accurate diagnosis of the joint. By radiographs readings, it was difficult to accurately confirm the condition of the proximal femur due to superimposition of the synsacrum and internal organs. However, signs such as avulsion fracture of the femoral head and a few fragments around the joint were revealed by CT imaging. Besides, through three-dimensional (3D) image analysis of CT, the dislocated area and condition of the left hip joint could be accurately and easily confirmed. The diagnostic process showing in this paper could be used as a good reference for diagnosing coxofemoral joint luxation in wild swan.

Key words computed tomography, coxofemoral joint, luxation, radiographs, whooper swan.

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Introduction

The Whooper swan (*Cygnus Cygnus*) is one of large waterbirds classified under the Anseriformes Anatidae. It is a winter migratory bird that breeds in Siberia after spending the winter in South Korea. It is registered as Natural Monument and designated as the 2nd grade endangered species in Korea.

Most rescued swans were caused by collisions with cars, lead poisoning by gunshot wounds, ingesting foreign bodies, and wounds caused by fishing lines or hooks (3). A whooper swan with limping due to injury to the left pelvic limb in an accident was rescued on the seashore in Jeju Island. This is the first case of a leg injury of the swan rescued at Jeju Wildlife Rescue Center.

In general, radiographs are basically performed to confirm fractures or dislocations of rescued wildlife. As a result, radiographic data on fractures and dislocations of wild birds are generally readily accessible. However, data from computed tomography (CT) scans related to dislocation and fracture of wild birds are relatively limited compared to abundant radiographic data. Therefore, techniques for radiographs and CT scans were used together to accurately diagnose hip dislocation and fracture. A better diagnosis was made by comparing radiographs and CT scans of the dislocation of the bird's femur.

Case Report

A wild whooper swan was found limping on the seashore. It was transferred to the Jeju Wildlife Rescue Center at Jeju National University on November 23rd, 2020. When externally observed, no serious trauma was identified. However, a slight tremor of the head was confirmed. Using Avian influenza virus antigen rapid kit (Anigen Rapid AIV Ag; BioNote Inc., Korea), results were negative for avian influenza virus. The initial measured weight of the swan was 6,040 g, which was much lower than its normal weight. Body condition score to evaluate the bird's general health status was 1 out of 5 due to starvation and dehydration. During physical examination by carefully palpating the left hip, left coxofemoral joint damage was estimated. Mild swelling and crepitus were found around the injured joint.

Blood was collected from the medial metatarsal vein to perform a basic blood test. Results of the blood test were as follows: packed cell volume (PCV), 20%; total protein (TP), 26 g/l; ionized calcium, 2.03 mmol/L, which was lower than the normal range; and glucose, 10.54 mmol/L, which was within the normal range. Its uric acid level was 1,338.3 mmol/L, which was higher than the normal range. As a result of measuring blood lead concentration using a blood lead test kit (LeadCare®; ESA Biosciences Inc., USA), it was measured to be 0.087 μmol/L (normal < 0.9652 μmol/L), which was in the normal range. Based on these blood test results, extreme starvation, anemia, and muscle damage were considered.

To accurately diagnose the damaged left hip joint of the swan, radiography and CT (Canon medical systems Korea Co., Ltd.; Seoul, Korea) scans were performed. During imaging examination, inhalation anesthesia was performed to minimize body movement. The bird was under anesthesia using isoflurane (Ifran®; Hana Pharm, Korea) with a face mask. It was induced with 5% isoflurane and maintained with 2-3% isoflurane in 100% oxygen 2 L/minute. Radiographs in dorsoventral view (Fig. 1A) and right lateral view (Fig. 1B) were taken. As a result of the symmetrical comparison of the left and right sides in the dorsoventral view of the radiograph, the position of the femoral heads on both sides was different. It seems to be the left femur head dislocated cranially. The head of the left femur is superimposed by the synsacrum and internal organs. CT scans were taken with sternal recumben-

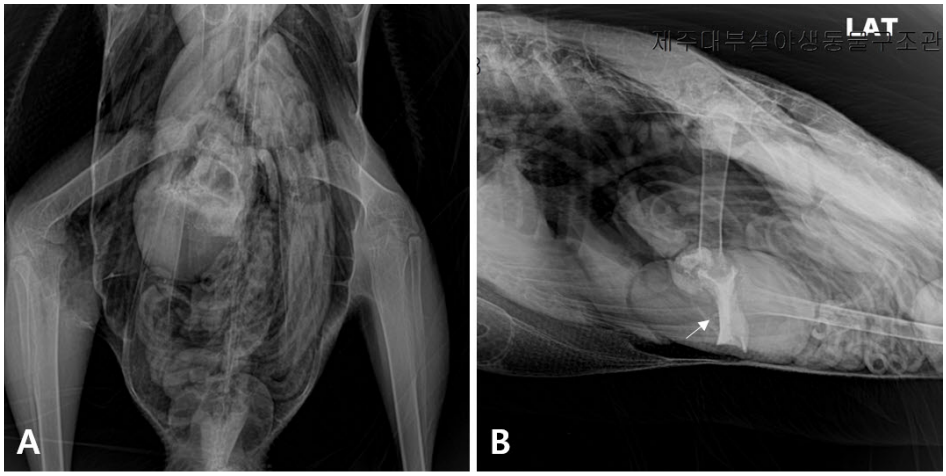

Fig. 1. Dorsoventral view (A) and right lateral view (B) of whooper swan radiograph showing luxation of the left coxofemoral joint. The proximal of the left femur is superimposed by the gastrointestinal tract. It seems to be dislocated cranially (A). The head of the left femur is superimposed by the synsacrum and internal organs. The grit of ventriculus (arrow) (B).

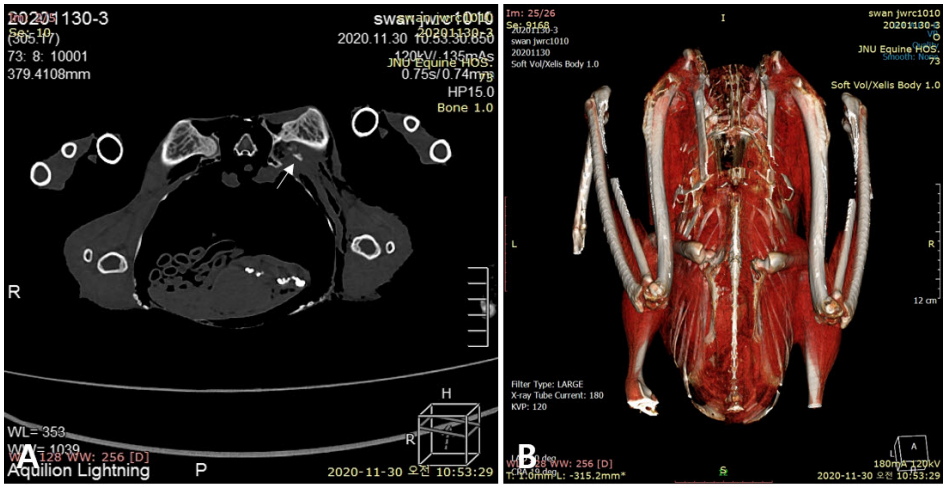

Fig. 2. Computed tomography of whooper swan in sternal recumbency, bone window; left femoral luxation and avulsion fracture of femoral head with emphysema and soft tissue swelling surrounding the hip joint. A few pieces of small fragments (arrow) (A). Dorsal view of the three-dimensional model of whooper swan. On a 3D image, the left coxofemoral joint was accurately confirmed to be a craniodorsal dislocation (B).

cy (Fig. 2A). The swan was scanned with axial, 2 mm-thick, contiguous slices at 120 kV and 135 mAs. These slices for the body, lung, and bone window as well as those reconstructed in 3-dimension were viewed (Fig. 2B). Computed tomography showed left femoral dislocation and femoral head avulsion fracture, and a few pieces of small bone fragments were identified around the left hip joint. It was confirmed that the soft tissue around the left coxofemoral joint had emphysema and swelling. The 3D image confirmed that the left hip joint was dislocated in the craniodorsal direction.

Discussion

The structure of the hip joint in a bird is different from that in a mammal. Most mammalian hip joints are in the form of a ball-and-socket joint. However, in birds, those are mostly in the shape of gliding-hinge joints except that cursorial species (ratite birds) have ball-and-socket joints (1,8). For these reasons, when treating a dislocation, it is difficult to return it to its original location. Thus, it is necessary to treat it through surgery. Hip dislocation in birds usually occurs to the craniodorsal side (8). This rescued swan also had a dislocation of the left hip joint toward the craniodorsal part.

Hip joints of birds consist of a coxocapital joint and a coxotrochanteric joint (7). The function of these joints is to restrict leg abduction and reduce bending pressure on the femur (4). Because of these differences, hip joints of birds are more stable than those of mammals. However, because birds have only two legs, when dislocation occurs, it becomes a relatively serious survival situation for a bird like a large swan in the wild compared to that of mammals.

The ventriculus of a swan is called gizzard. There are tiny stones called grits in the stomach (5). Due to the presence of these grits, a dense material is shown on radiographs and CT scans. In particular, it can be misunderstood as a foreign material like a heavy metal fraction through a three-dimensional model of CT scans. Therefore, reading and understanding the image correctly will be of great help for diagnosis.

Technique of radiography is most commonly used to diagnose fractures and dislocations because it provides good images. However, reading radiographs is often hampered by superimposition with internal organs, other bones, and artifacts (6). When reading radiographs, since respiratory diseases like Aspergillus often superimpose with internal organs, it is very difficult to read radiographs clearly. In such case, using CT scans can help make a more accurate diagnosis.

Densitometry is very helpful for identifying bone structures and soft tissues in CT scans. The density of the image of the CT scan is represented by various gray values called Hounsfield units (HU). Water measures 0 HU. Air measures –1,000 HU. Soft tissues measure +100 HU (9). Blood measures 50 to 100 HU (3), and bone measures +1,000 HU (2). Densitometry was performed to read the image of CT scans of the swan in the body window. As a result, the average density of the femur showed 80 to 340 HU and the average density of the emphysema around the femoral dislocation was –900 HU. The exact cause of the subcutaneous emphysema was unclear. It was presumed to come from very small lacerations of internal muscles or air sacs caused by the impact. Damaged muscles around the left hip joint showed opacification compared to other normal area muscles. HU was measured for an accurate comparison between damaged muscles and normal ones. The average HU of normal muscles around the right hip was 50 to 60, but that of muscles around the dislocation of the hip was 10 to 30. The HU of the damaged muscle was lower than that of the normal muscle and palpated swelling in the dislocated

joint, indicating that there might be bleeding or exudate due to muscle damage.

Although it is not difficult to confirm that there is an abnormal condition in the hip joint area by radiography, there are many shortcomings in evaluating the exact condition of the hip dislocation area and making a treatment plan. If these deficiencies and shortcomings are compensated for through technique of CT scans, it will be of great help in setting up plans for accurate diagnosis, surgery, and treatment.

Conclusions

Technique of radiation is often used to diagnose fractures and dislocations in wild animals. However, there are many difficulties in reading radiograph accurately due to superimposition with internal organs, other bones, and artifacts of radiographs. However, CT scans can be used to accurately diagnose not only the condition of the dislocated joint, but also the condition around the damaged soft tissue by comparing values of HU. Besides, with the benefit of a correct analysis for the condition of the damaged hip joint using a three-dimensional model of CT scans, more accurate diagnosis and treatment can be performed.

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Conflicts of Interest

The authors have no conflicting interests.

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