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Plastic strings as the cause of leg bone degeneration in the White Stork (*Ciconia ciconia*)

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ABSTRACT: Between 2001 and 2004, we examined white stork *Ciconia ciconia* chicks whose legs had become tangled in plastic strings used by their parents to improve nest structure. The juveniles were in poor condition, usually with broken wings and/or legs, so they were delivered to wildlife rehabilitation centres where they were diagnosed radiologically. Out of 94 white storks examined, 20 individuals (21.3 %) had legs partly destroyed by plastic strings during the nestling period. The proportion of tangled chicks delivered to rehabilitation centres was significantly higher than the proportion of such chicks in the local population ($P < 0.0001$). All legs were tangled above the tarsometatarsi. In most cases the tangle resulted in leg autoamputation.

KEY WORDS: *Ciconia ciconia*; autoamputation, diagnosis; mortality; pathological lesions

STRESZCZENIE: Plastikowe sznurki przyczyną deformacji i autoamutacji kończyn u bociana białego *Ciconia ciconia*. W latach 2001–2004 w trakcie kontroli gniazd bociana białego Wielkopolsce i na Ziemi Lubuskiej odnotowywano przypadki zaplątywanie się piskląt bocianów białych w plastikowe sznurki. Sznurki te, podobnie jak wiele innych elementów konstrukcji gniazda, przynoszone są z okolicznych pól i łąk przez dorosłe bociany. Część spośród zaplątanych w sznurki piskląt, zwykle w słabej kondycji, ze złamanymi skrzydłami i nogami, trafiała do ośrodków rehabilitacyjnych, gdzie była poddawana standardowej diagnostyce weterynaryjnej, a część z nich także diagnozowana przy wykorzystaniu aparatu RTG. Spośród 94 zbadanych bocianów, aż u 20 osobników (21,3%) bezpośrednią przyczyną zmian patologicznych i uszkodzeń kończyn było zaplątanie w sznurki. Proporcja osobników zaplątanych wcześniej w sznurki, a trafiających do centrów rehabilitacyjnych była istotnie wyższa niż odnotowana wśród piskląt w lokalnych populacjach ($P < 0{,}0001$). Bardzo często

zaplątanie w sznurki kończy się trwałym uszkodzeniem, a nawet samoamputacją kończyn. W pracy przedstawiono dokumentację radiologiczną tego procesu.

SŁOWA KLUCZOWE: *Ciconia ciconia*; autoamputacja, diagnostyka weterynaryjna; śmiertelność; zmiany patologiczne

Introduction

In strongly changed habitats, animals often meet new problems. This occurs also in species well adapted to human settlements and agricultural landscapes. The white stork *Ciconia ciconia* is a characteristic example, nesting close to humans for many generations. In recent times, some white stork populations have declined markedly. At least a part of this decrease is supposed to be related to both indirect and direct effects of human activity, such as changes in farming practice, collision with electric lines, or nestling mortality (Jakubiec, 1991). Analyses of nestling mortality suggested that plastic strings, which are used to improve nest structure, may play an important role. This plastic may be dangerous to chicks, both because it may be eaten, causing problems with digestion, and because chicks' legs become damaged by strings (Jakubiec, 1991; Ptaszyk, 1994). Not all contacts with plastic strings ended with death of nestlings; at least some of them fledged successfully. However, as terrestrial locomotion is important to foraging storks (van Coppenolle & Aerts, 2004), even a minor leg damage can handicap birds and negatively affect their chances of survival. This is even more significant for young inexperienced birds. Moreover, plastic objects can be dangerous for foraging storks also after fledging, but more often such problems occurred in juveniles (Peris, 2003). As a consequence, a number of problems, especially those affecting immatures, have been encountered by rehabilitators (cf. Höfle et al., 2003).

In this paper we examined the impact of plastic strings on leg injuries in white stork chicks. Basing on radiological diagnostics, we also described the processes of leg trauma due to strangulation with plastic strings.

Materials and methods

Over four breeding seasons, 2001–2004, juvenile white storks in a poor condition, mainly with broken wings and/or legs, were collected in two wildlife rehabilitation centres in West Poland: at Stary Kisielin (near Zielona Góra town) and in the Wielkopolska Zoological Gardens (in Poznań city). Here they were handled in open aviaries. The birds were mainly delivered in September and originated from the Wielkopolska region, where they breed at high densities (up to 17 breeding pairs per 100 km^2; Tryjanowski et al., 2005).

Some birds had to be euthanized due to the severity of their acute traumatic lesions. Legs of these euthanized birds were used for diagnostic radiography by means of a Siemens Monodoor ERG 85/150Õ with a photo cell Foton Rentgen XS-1 (size 18 × 24 cm, polyester background). White stork legs were radiographed in a 46kV tube, with exposure time 1/60 s and intensity 25 mA. The objects were

photographed both in a lateral and an antero-posterior position (Beregi et al., 1999a; 1999b).

Results

Proportion of tangled chicks

Between 2001 and 2004, a total of 94 juvenile white storks arrived in both rehabilitation centres. A veterinary inspection revealed that 20 (21.3 %) of the birds had their legs partly destroyed by strings during the nestling period.

Over the same period in the same study area (i.e. the Wielkopolska region), only 8 (1.8 %) white stork chicks were found tangled in plastic strings during ringing (n = 446). The proportion of tangled birds differed significantly between white storks received by rehabilitation centres and ringed in nests ($\chi^2 = 48.4$; $P < 0.0001$).

In all cases white stork legs were tangled above the tarsometatarsal joint.

Description of the trauma process

The factors causing leg injury and autoamputation in the white stork were plastic strings in all cases studied. The birds tangled into strings when they were nestlings. All the analysed cases show that young birds tangled bits of string on legs above the tarsometatarsi (ankle bones). The pressure due to the ligature of the string caused necrosis of skin tissues, haemolymphatic system failure, and oedema (Fig. 1) This resulted in bone osteolysis, which led to autonomous breaks in the

Fig. 1. Early effects of plastic strings tangled on the femur bone: inflammation involving the soft tissues, oedema and the first stage of osteolysis

bones. This process (autoamputation) appeared to be irreparable, even when the plastic string was removed. The whole process took approximately 21 days. After bone autoamputation the stump healed by overgrowth of connective tissue, to prevent bacterial infection. In some cases, fragments of the bone stump underwent necrosis (Fig. 2). Nevertheless, in the majority of cases, gangrene set in and the birds died of bacterial infection.

In case of autoamputation of one leg, the young bird experienced also an excessive exertion of the ankle articulation in the other leg. Due to this, tibiotarsal and tarsometatarsal joints degenerated in that leg. Further degeneration caused interruption of articular capsule, leading to arthritis (Fig. 3). That could be partly due to poor osteofeeding (Fig. 4).

A separate category suffered degeneration of the digit articulation. In the area of metatarsi, swelling caused venal stasis, which could cause bumble foot (bacterial dermatitis and pus with subsequent changes in other tissues). This could result in the bird being unable to assume a standing position.

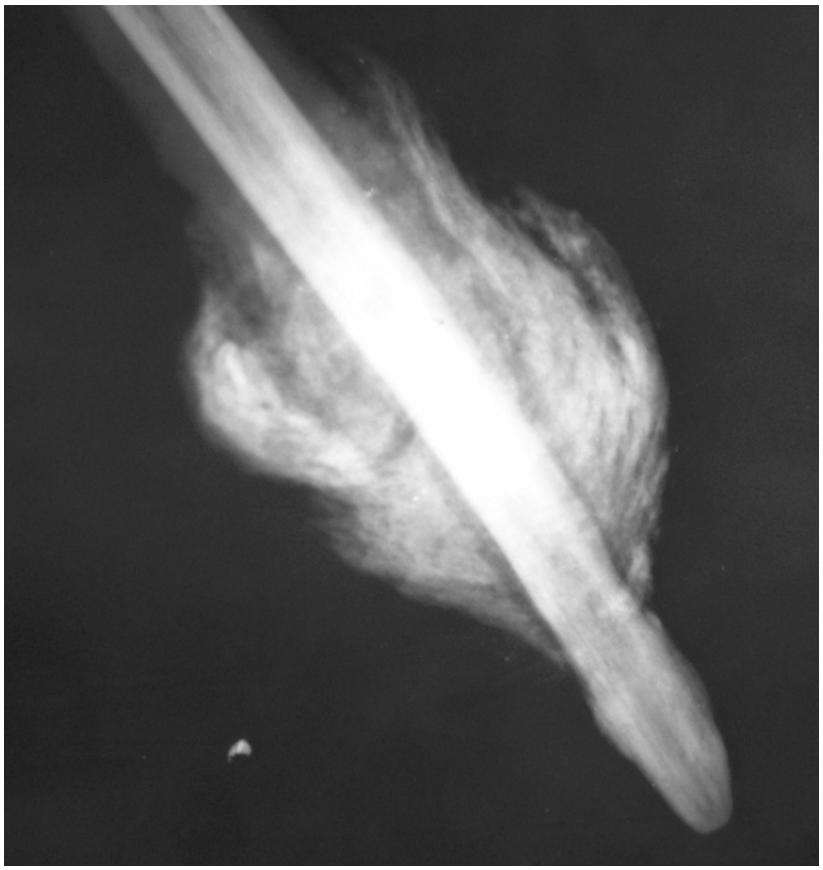

Fig. 2. Late effects of plastic strings tangled on the femur bone: autoamputation and scarring of wounds and connective tissues

Fig. 3. Degeneration of the ankle articulation due to inflammation caused by tangling in plastic strings

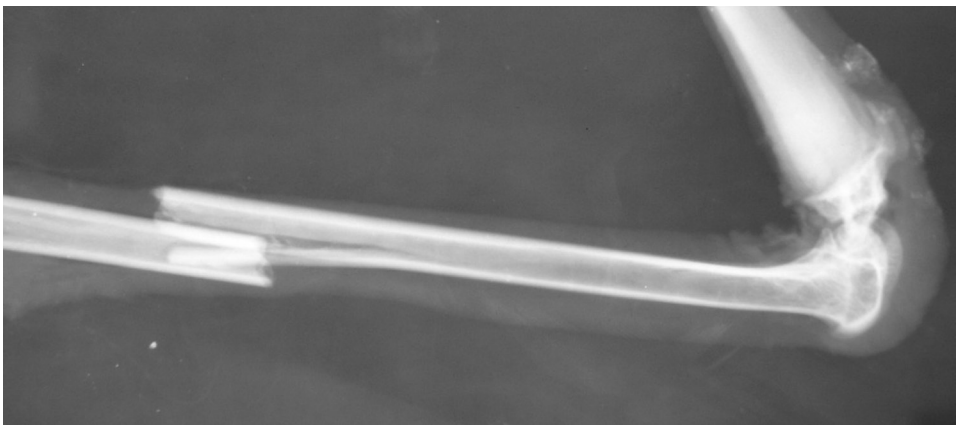

Fig. 4. Fracture of the femur bone, caused by tangling in plastic strings

Discussion

Plastic strings appear to be a serious problem influencing white stork mortality (Ptaszyk, 1994; Dolata, 2003). Death was not necessarily due to the direct influence of string, but might also result from indirect events, such as sibling competition or selective parental infanticide caused by the poor body condition of the affected chicks. Killing of nestlings by throwing them out of nest (parental infanticide) is common in the white stork, although it is seldom observed in other bird species

(Zieliński, 2002). Unaggressive competition between siblings can be observed when food is brought by parents. The adult birds regurgitate food onto the bottom of the nest, and nestlings individually take food (Zieliński, 2002). However, the weakest nestlings, for example those with one autoamputated leg, may be unable to reach food, and sooner or later the parents may throw them out of the nest for this reason. This seems to be confirmed by the higher proportion of birds with legs tangled in plastic strings in rehabilitation centres than in the general population.

All tangled storks had their bones destroyed above the tarsometatarsus. The reason for this is that until they are 49 days old, chicks move inside the nests using their tarsi (Profus, 1986). If only one leg became tangled, the chick used the other one, which subsequently became deformed, too.

Tangled juveniles, even when plastic strings are removed, have problems with bone development due to an increased probability of bacterial infection, bone deformations after being broken, and problems with insufficient movement of minerals and vitamins into leg structures (cf. Wolf et al., 2001). Our results suggest that even if a chick survived to the fledgling stage and/or was taken from the nest by humans and brought to a rehabilitation centre, its chances of survival in the wild were very low. The reason is that white storks require both legs for their survival. This corresponds with the general principle that even small handicaps can have very severe fitness implications in wild animals (van Cappenolle and Aerts, 2004).

Skeletal measurements reveal that both the tibiotarsus and tarsometatarsus (i.e. the functionally most important long bones of the leg in birds) of white storks (and other members of the genus *Ciconia*) are about 30% longer than estimated from allometric equations that relate bone dimensions to body weight (Cubo and Casinos, 1998; van Cappenolle and Aerts, 2004). Therefore a very practical conservation action should focus on improving chick survival and condition in the nest by promoting measures to remove plastic strings from agricultural land, including farmer awareness/education programmes and the voluntary collection of plastic strings, thus improving the local environment for white stork populations (e.g. Ptaszyk, 1994; Dolata, 2003).

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