ATROPHIC NONUNION – A RADIOLOGICAL CASE STUDY

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Abstract

This paper reports a rare case of complications following the forearm fracture in a female Italian greyhound aged 8 months. The radiographic examination showed a fracture in the distal one-fifth of the radial bone diaphysis, and a double fracture of the ulna at the distal one-fifth and one-fourth of the diaphysis. Owing to the incidence of other traumas, no improvement in the clinical state, and the persistent motility of the fractured bone fragments, subsequent radiographs were taken after 3, 5, 6, and 18 months after the first examination. Within the 18-month follow-up, no bone union was recorded. The last follow–up examination revealed advanced bone atrophy. The radial bone was severely narrowed and shortened by 50% as compared to the primary length. The ulna bone had nearly atrophied completely.

Key words: dog, forearm, fracture, atrophic nonunion.

The normal healing of a bone fracture is likely to be disturbed by a number of factors. The most common causes include an inadequate or impaired nutritive blood flow in the area of the fracture site, as well as the implementation of inappropriate procedures for bone fragment stabilisation. Furthermore, damage to the osteogenic cell sources (haematoma, periosteum, endosteum) or the introduction of agents compromising their proliferation, cause complications to develop which are manifested by the disturbed and delayed healing process (6). One of the complications observed most frequently in toy-breed dogs is atrophic nonunion, whose aetiology still remains unclear. Decreased blood supply in the regions of the metaphyses and in the fracture gap (compared to large dog breeds) is considered to be a potential cause for incidences of atrophic nonunion. However, the studies performed have revealed that the vascularisation of such bones does not differ from that of fractures showing the proper healing response; it only appears to be delayed (8). Small sized bones, a tendency for main bone fragment displacement in the case of transverse and oblique fractures, the excessive development of persistent cartilage, and an inhibited osteogenesis process have been mentioned as the most likely causes for the occurrence of this disturbance (3, 7). Atrophic nonunion has been frequently reported in the external stabilisation of fractures and in the intramedullary nailing application (1).

The objective of this research was to present a radiographic evaluation of atrophic nonunion as recognised in an Italian greyhound female dog aged eight months.

Case report

An eight-month-old female Italian greyhound was presented to the Laboratory. The clinical examination showed forearm fractures in both of the thoracic limbs. The post-traumatic bone changes occurred due to the animal falling from a height. To recognise and accurately describe the injuries, a radiological examination was performed after an external stabilisation had been applied.

The radiographs of the left thoracic limb showed the presence of a transverse fracture of the radial and ulna bone in the distal 1/4 of the diaphysis. The ulna bone was also broken at the distal 1/5 of the diaphysis. The main bone fragments were at angles to each other (Fig. 1).

The right limb also showed some transverse fractures in the distal 1/5 of the diaphysis of both the forearm bones, with a slight lateral displacement of both the main fragments.

Due to the subsequent traumas, the animal was radiologically studied twice, as there was a clinical suspicion of the occurrence of new fractures. Two months after the first radiological evaluation, radiographs of the right thoracic limb were retaken. They showed a fracture whose defect was localised 0.5 cm above the previous trauma site. Within the first fracture area, no signs of bone healing were observed.
Fig. 1. The radiograph of the left thoracic limb.

Fig. 2. Follow-up examination after 3 months.

Fig. 3. Follow-up examination after 5 months.

Fig. 4. Follow-up examination after 18 months.
The next study was performed a month later, investigating the left thoracic limb. The defect site of the first fracture did not show any signs of the bone uniting. During the healing process, a reduced area of the formed external and internal callus was observed. The main bone fragments, partly stabilised by a stainless metal device, were at angles to each other. Furthermore, there was noted the presence of a new fracture at proximal 1/4 of both the forearm bones’ diaphysis, with a visible fracture of 3 mm length in the distal fragment of the radial bone, and a small lateral and longwise dislocation of the main bone fragments (Fig. 2).

The healing response of the right limb was considered proper, and the animal showed complete functional restoration. No control radiograph was taken. However, the left extremity displayed no improvement in the clinical state and the persistent motility of the bone fragments, so the animal was referred for a radiological evaluation 5 and 6 months following the first traumatic event. This showed the malunion of the ulna bone and radius at the distal 1/4 of the diaphysis, as well as the nonunion in the proximal part with a concurrent sclerosis of the main bone fragment edges, and a marrow cavity closure on the fracture gap (Fig. 3).

The examination performed after 6 months additionally revealed smooth fracture surfaces and the considerable narrowing of the ulna bone diaphysis between the fracture’s ends.

The last follow–up examination was performed 18 months after the first traumatic event (Fig. 4).

No evidence of bone union was recorded. Both the radial and ulna bone in the site between the two fractures had substantially narrowed and shortened by 50% compared to the primary state. The phalanx and metacarpal bones had also shortened. Advanced osteopenia in the forearm bones was also observed (Table 1).

### Discussion

According to the Weber-Cech classification, nonunions are divided into two groups according to the bone fragment vascularity and the amount of callus formed during the healing process (1, 2). A biologically active form, usually developed due to bone fragment instability, includes fractures with a prolific to poor callus formation. This group consists of hypertrophic, slightly hypertrophic, and oligotrophic nonunions. The first two complications usually result from simple transverse and oblique fractures treated with external stabilisation or intramedullary pins. As for oligotrophic nonunions (with the absence of callus, or a very small amount), they are described as avulsive fractures that require conservation management. The other group (biologically inactive, non-viable, nonunions) includes complications arising not only from inadequate stabilisation, but also from several additional factors that may be predisposed to nonunion, such as necrotic, unvascularised bone fragments (in the case of necrotic and dystrophic nonunion), or the presence of a significant loss of bone in the fracture site (defect nonunion) (1).

Atrophic nonunion is an exception to this group due to its rare number of occurrences and only occasional references in the veterinary literature concerning the complicated healing process of fractures of unknown aetiology. It has been reported in toy-breed dogs, as have slightly hypertrophic and oligotrophic nonunions in the case of simple fractures of the radial bone, as well as of the radial and ulna bones (1). Such distal antebrachial bone fractures occur most frequently in dogs, and constitute 8.5%-17% of all post-traumatic changes in the skeletal system (9). This fracture type is often observed in toy-breed dogs, which have undergone a relatively slight trauma (3, 9). Generally, they are associated with an animal falling from a height, e.g. failed attempts to jump down off the owner’s arms (4). The most common localisation of such fractures appears to be the distal 1/4 of the radial bone diaphysis, and this type of injury may result in a very high percentage of complications, which can be as high as 75% if external stabilisation is applied (3, 4). Regarding fractures of both the antebrachial bones, it is estimated that in 40%-60% of the cases predisposed to complications, a nonunion is commonly recognised, mostly in animals aged one year or over (5, 9).

The reported case of atrophic nonunion was most likely to arise from the presence of multiple fractures within one limb area, not only in its distal part. This statement is supported by the fact that, although three months after the first injury of the dog under

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discussion, no bone uniting symptoms were observed. It is important to note that any atrophic changes had developed in the skeletal system within this period. However, the subsequent two follow-up examinations performed after new trauma events showed severe changes taking place in the skeletal system structure as compared to the previous examination.

Atrophic nonunion is characterised by a process of progressive bone loss without radiological and clinical evidence of signs of the fracture healing. Some of the rare data depicting radiological images indicate that atrophic nonunion is characterised by the absence or a small amount of callus in the fracture defect, and thus the fracture line is well visible and the fracture surfaces sharply demarcated. Both bone fragments in the fracture site display an osteosclerotic closure of the marrow cavity.

In the case reported, little internal and external callus was formed three months after the fracture in the distal 1/4 of the radial bone diaphysis, and the double fracture of the ulna bone in the distal 1/4 and 1/5 of the shaft. This fracture united over time. However, the other trauma, i.e. in the proximal 1/4 of the forearm bone’s fracture, no callus was formed. Within the period of six months following the second fracture, there was observed main bone fragment sclerosis with the closure of the marrow cavity, and the rounding of the bone ends. A survey of the literature concerning atrophic nonunion reports that this complication is usually associated with bone demineralisation and soft tissue atrophy of various degrees of severity, as well as very frequent atrophy of the ulna bone, even in the cases of the subsequent union of the radius (1, 10). The present research highlighted the development of atrophic lesions and concomitant bone demineralisation in all of the antebrachial bones. The ulna bone was shortened by 4 cm and narrowed by 2 mm within two months, with a concurrent rapid atrophy of the radial and metacarpal bone. The most pronounced changes in bone length and width were noted between the visible fracture defect and the previous united fracture in the distal 1/4 and 1/5 of the shaft, involving both the antebrachial bones.

References