Surgical induction of metacarpal synostosis for treatment of ectrodactyly in a dog

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Summary
Ectrodactyly is a rare developmental anomaly of the distal part of the forelimb. It is characterized by the presence of an abnormal longitudinal soft tissue and osseous separation or cleft between the digits and the metacarpal bones. It can be associated with hypoplasia, aplasia and malformation of one or more bones of the antebrachium, carpus, metacarpus and digits. Unilateral ectrodactyly and moderate lameness were diagnosed in a young female dog. The dog was treated surgically with reconstruction of soft tissues and stabilization of the metacarpal bones by two nylon cerclage sutures. After three years a mild residual lameness was present. Radiographic signs of synostosis between the metacarpal bones II, III and IV with presence of a cleft between carpal bones II and III were observed.

Introduction
Ectrodactyly or 'lobster claw deformity' is a rare dysostosis of the appendicular skeleton in dogs. This malformation consists of a cleft or separation of the soft tissues and bones of variable extent of the distal part of the forelimb (1). The separation can extend from the digits to the metacarpal bones, the carpal joints and the antebrachium. The metacarpal pad can be also affected (2). The abnormalities arise during embryonic development and can be associated with other deformities like syndactyly, hypoplasia and aplasia of one or more bone elements of the carpus, metacarpal bones and digital rays. The disease is usually unilateral and, to the authors’ knowledge, there are only two cases of bilateral malformation reported in the veterinary literature (3, 4).

In dogs ectrodactyly has been reported in the Dobermann Pinscher, Chow Chow, Cocker Spaniel, Irish Setter, Labrador Retriever, West Highland White Terrier, Siberian Husky and crossbreed (2, 3, 5-11). Such an abnormality has also been observed in various other mammalian species including human beings, cats, sheep, cattle, and buffaloes (12-16).

A Canadian study found that ectrodactyly in humans occurs in approximately 0.51 out of 10,000 births; the condition can be isolated or in combination with other congenital abnormalities such as uranoscisis, and can be a heritable trait or be caused by a de novo mutation (17, 18). In cats, ectrodactyly seems to be an inherited trait (13). In dogs the condition is more commonly observed in the isolated form and a heritable aetiology has not been reported, except for one report of bilateral ectrodactyly and vertebral malformation in a dog (4, 10).

In the dog, the malformation becomes more evident during loading because it is often associated with lameness, which varies in relation to the severity of the deformity (10).

In dogs ectrodactyly is characterized radiologically by the presence of axial separation of the metacarpal bones and the carpal bones; the abnormal cleft can also extend between the radius and ulna through the antebrachio-carpal joint and along the antebrachium. Moreover, shortening of the ulna, luxation of the ipsilateral elbow, and the absence of some bone segments can be associated with ectrodactyly (2, 3, 5-11, 17).

Conservative treatment is possible in cases with mild malformation that causes barely perceptible lameness (1). Surgery can improve the function of the limb in more severe cases. The reported surgical therapies are ulna osteotomy or ostectomy, partial or pancarpal arthrodesis, reconstruction of the soft tissues of the manus, fusion podoplasty technique, and amputation only in extreme cases (2, 6, 7, 11, 19).

The present report describes a dog with ectrodactyly in which stabilization of the separated metacarpal bones by nylon cerclage sutures and reconstruction of the soft tissues was performed.

Case report
A mix-breed three-month-old female dog was referred for the complaint of right forelimb lameness. At the physical examin-
ation, the animal showed a moderate lameness on the right forelimb; a valgus deviation of the carpus and a cleft of the right manus between the digits II and III were more evident when the limb was under load. The lesion extended to the whole metacarpal region proximally to the carpal joint, with involvement of the metacarpal pad that was abnormally divided into two portions (Figure 1).

The radiographic examination of the limb, in a dorso-ventral projection, showed a cleft of the manus and digits between metacarpal bones II and III, between carpal bones II and III, and the radial and ulnar carpal bones. Abnormal anatomy of the carpometacarpal and middle carpal joints, with fusion of carpal bones I and II were present. In addition underdevelopment of metacarpal bone III, lateral subluxation of metacarpal bone IV, and medial deviation of the phalanges of digits III, IV and V were also observed. The lateral projection showed altered conformation of the carpal bones and cranial dislocation of metacarpal bones I and II (Figure 2).

Thus the radiographic examination confirmed the diagnosis of ectrodactyly.

The surgical therapy, performed two months after diagnosis, consisted of stabilization of the metacarpal bones and reconstruction of the soft tissues.

For the surgery, the premedication consisted of the administration of midazolam\textsuperscript{a} (0.15 mg/kg IM) and fentanyl\textsuperscript{b} (0.002 mg/kg IV). The induction of general anaesthesia...

\textsuperscript{a} Midazolam Ibi: Pharma Hameln GmbH, Halmen, Germany
\textsuperscript{b} Fentanest: Actavis Italy S.p.A., Nerviano, Italy
was performed with propofol\(^c\) (3 mg/kg IV) and maintained by isoflurane\(^d\). Analgesia was provided by fentanyl (constant rate infusion: 0.005–0.008 mg/kg/h). Immediately after the induction, ampicillin and sulbactam\(^e\) (20 mg/kg IV) were administered.

After wide detachment of the soft tissues by a periosteal elevator, stabilization of the metacarpal bones was obtained by two parallel double-stranded cerclage sutures of 35 kg test fishing nylon line\(^f\) with a diameter of 0.50 mm and sterilized by ethylene oxide \(20, 21\). The sutures were positioned in the middle third of metacarpal bones II and IV, not including metacarpal III since it was hypoplastic. The first cerclage suture was placed through two holes of 2 mm of diameter drilled in metacarpal bone II and IV, while the second cerclage suture was positioned around metacarpal bones II and IV (\(\uparrow\) Figure 3). The two cerclage sutures were tightened with a self-locking knot after the positioning of a number 4 scalpel handle as a temporary spacer between metacarpal bones II and III to maintain their physiological position \(22\). The reconstruction of the soft tissues was obtained by suture closure of skin between the two compartments of the manus,

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\(\uparrow\) Figure 3
Intra-operative images: the two double nylon cerclage sutures are visible, the proximal one is positioned around metacarpal bones II and IV, the distal one passes through the holes made in metacarpal bones II and IV (A); dorsal view (B), postoperative dorsal image of the soft tissue reconstruction. The separation of the metacarpal pad persists (C).

\(\uparrow\) Figure 4
Dorso-palmar (A) and medio-lateral (B) postoperative radiographic views of the right manus. In the dorso-palmar projection, the holes for the nylon cerclage suture are evident (A). The reduction of the luxation and the cleft between the metacarpal and the proximal carpal bones was achieved, while the second carpal bone line remains dislocated (A). Cranio-caudal alignment of the carpus and metacarpal bones has not been obtained. Metacarpal bones I and II are located proximally and dorsally together with the fused first-second carpal bone (B).
keeping the metacarpal pads divided. The interdigital skin, at the level of the cleft (between metacarpal bones II and III), was removed and the dorsal edges and the ventral edges were apposed by horizontal mattress sutures (Figure 3).

After surgery, a Robert Jones bandage was applied to the limb until removal of the skin sutures. Postoperative analgesia was provided by a constant rate infusion of fentanyl (0.002–0.003 mg/kg/h IV) for 24 hours, followed by the administration of carprofen (4 mg/kg SID OS, then 2 mg/kg SID OS) for five days.

The surgical treatment resulted in a good reconstruction of the soft tissues of the manus and a satisfactory stabilization of the metacarpal bones, even without obtaining the correct reduction of the carpal bones (Figure 4). In the immediate postoperative period the dog put weight on the reconstructed limb and after two months lameness was attenuated, maintaining the same degree of the carpal valgus.

Two months after surgery a radiographic examination was performed and a periosteal reaction of metacarpal bones II, III and IV was evident (Figure 5). After three years, the animal showed a mild clinically evident lameness, carpal valgus, slight palmar-grade stance and signs of pain on the manipulation of digit III (Figure 6). The radiological examination showed synostosis between metacarpal bones II, III and IV, a recovery of the alignment of the bones in the proximal row of carpal bones, as well as the persistence of a cleft between carpal bones II and III. Furthermore, the presence of an arthropathy and medial subluxation of the metacarpophalangeal joint of digit III were observed (Figure 7). In spite of the satisfaction of the owner with the surgical result, the dog showed a moderate degree of lameness after intense activity.

**Discussion**

Ectrodactyly is a congenital defect that usually causes a progressive lameness due to secondary conditions like muscular contractures, dysmorphoses of single bones or of the entire limb, elbow luxation, carpal supination and osteoarthritis (1, 3, 5, 6, 23-25). For this reason, in cases of moderate to severe malformation, an early surgical therapy can prevent secondary complications (23).

Different therapeutic options are available to treat ectrodactyly and the choice depends on the type and severity of the malformation. As a consequence every case must be carefully evaluated to find out the most adequate treatment, considering also that the literature about the management of this abnormality is composed of few case reports. For slight malformations, conservative treatment is possible. In very young animals, splinting of the limb can prevent axial deviation and support the limb during the gait (23, 26). Soft tissue reconstruction can be an option to stabilize a simple cleft between the digital rays or the metacarpal bones and could be applied if no major derangement or axial deviation of the carpal or antebrachio-carpal joints is present.

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Rimadyl: Pfizer Service Company, Zaventem, Belgium
A valgus deviation (A) and the permanent cleft of the metacarpal pad are evident (B).

**Figure 6** Three years postoperative follow-up examination images of the dog showing the dorsal (A) and palmar (B) aspects of the right manus. A valgus deviation (A) and the permanent cleft of the metacarpal pad are evident (B).

**Figure 7** Dorso-palmar and medio-lateral radiographic projections of the right manus at the three years postoperative follow-up examination. Arthropathy and medial subluxation of the metacarpophalangeal joint of digit III are present. Synostosis between metacarpal bones II, III and IV was obtained. Persistence of the cleft in the carpal joint, as well as persistence of the dorso-palmar malalignment of the carpus are evident. Degeneration of the fused carpal bones I and II and lateral subluxation of digit V are visible.

Ulnar osteotomy or ostectomy can be used when axial deviation or elbow incongruity are present. Partial and pancarpal arthrodesis are considered as salvage procedures with few outcomes reported in the literature regarding ectrodactyly (10, 27). Usually there is reluctance to perform this static stabilization in growing animals.

In our case, considering the presence of all the bone segments in the region of the manus, the integrity of the elbow joint, the normal length of the ulna and the young age of the patient, it was decided not to perform a carpal arthrodesis, at least as the first surgery. Instead stabilization of the metacarpal region by nylon cerclage sutures was performed to improve carpal stability during development. Moreover, this choice allowed the bones of the manus to develop and the joints to maintain their mobility.

Two double nylon cerclage sutures were used to distribute the forces widely on metacarpal bones II and IV, in order to avoid complications such as the cheese-wiring effect or metacarpal fractures in the proximity of the cerclage holes.

During the surgery it was not possible to completely correct the alignment of the carpus. Only later there was a clinical improvement, with a partial recovery of the manus due to the fusion of the metacarpal bones and rearrangement of the proximal row of carpal bones. The complete synostosis between metacarpal bones II, III and IV was not expected, but it was probably promoted by the extensive use of the periosteal elevator in a young dog. This result could probably be comparable to what would have been obtained by an arthrodesis, but in this case the mobility of the joints was maintained. In the reconstruction of the soft tissues, a good result was achieved in the immediate postoperative period with a satisfactory functional recovery, especially in regards to the metacarpal pads, an essential element for the function of bearing weight of the manus. Three years afterwards, although there was still a cleft in the carpal bones, stabilization of the metacarpal bones was obtained. The subluxation and arthropathy of digit III and the degeneration of the fused first and second bones of the carpus probably contributed to the residual lameness.
The surgical technique used in this case was less invasive than those previously described and could be combined with other techniques if the clinical result is not as expected or a second surgery, such as carpal arthrodesis is required.

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Conflict of interest
None declared.

References