Surgical treatment of a type III Monteggia fracture in a ring-tailed lemur (Lemur catta)

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SUMMARY

A 12 year old female Ring-Tailed Lemur (Lemur catta) was diagnosed with a type III Monteggia fracture associated with a wound on the mediodorsal side of the forearm. Surgical treatment included repair of the fracture using an intramedullary pin inserted in retrograde fashion associated with a capsular prosthesis made of suture attached to two periarticular screws, and second intention healing of the wound. Monteggia fractures are rare, representing 1 to 2% of human forearm fractures. Although many reports of such fractures exist in the veterinary literature, their true prevalence is currently undocumented in all animal species. Surgical treatment in domestic carnivore species usually includes ulnar fracture repair and radio-ulnar fixation that impairs or limits pronation and supination. The surgical technique described in this case enabled good stabilisation and healing of the fracture, without compromising pronation and supination, which is valuable for primate species. To the authors’ knowledge this is the first description of a Monteggia fracture in a lemur species.

Keywords: Fracture, Lemur catta, Monteggia, radius, Ring-Tailed Lemur, ulna

Case Report

A 12-yr-old female Ring-Tailed Lemur (Lemur catta) was presented for a wound on the mediodorsal side of the left forearm. A few minutes before, the animal was found with its forearm stuck in a fence separating it from the rest of the group and trying to force itself free. The forearm could be manually released from the fence. Palpation revealed an ulnar fracture. The lemur was anesthetized for wound examination and care, and radiographs of the forearm were carried out. The wound caused moderate tissular damage and neither the radius nor the ulna were exposed. Impairment of the vascularisation was suspected as the tip of the limb was cold. Lateral and antero-posterior radiographs of the forearm revealed a type III Monteggia fracture, with lateral luxation of the radius and diaphyseal ulnar fracture (Fig. 1). Debridement and flushing of the wound with a 10% dilution of an iodine solution (Vetedine solution®, Vétoquinol S.A., 70204 Lure Cedex, France) were performed. The wound was covered with an enzymatic ointment (Elase® Pommade, Pfizer, 78490 Paris, France) and bandaged, and the animal received cefalexin (Rilexine® Injectable, Virbac France, 06517 Carros, France; 30 mg/kg i.m. b.i.d. for 14 days), buprenorphine (Buprecare®, Axience SAS, 93500 Pantin, France; 15 µg/kg i.m. b.i.d. for 7 days) and meloxicam (Meloxidyl®, Ceva Santé Animale, 33500 Libourne, France; 0.1 mg/kg s.c. s.i.d. for 14 days). Local care on the wound was repeated under general anaesthesia twice daily for two days until completion of the inflammatory phase of healing, and setting of a clean granulation tissue.

RESUME

Traitement chirurgical d’une fracture de Monteggia de type III chez un maki catta (Lemur catta)

Une fracture de Monteggia de type III est diagnostiquée chez un maki catta (Lemur catta) femelle de 12 ans, en association avec une plaie au niveau de la face médiodorsale de l’avant-bras. Le traitement chirurgical a consisté en une cicatrisation par seconde intention de la plaie, et une réparation de la fracture par enclouage centromédullaire rétrograde, en association avec une suture en 8 ancrée sur deux vis pérarticulaires sans fixation radio-ulnaire. Les fractures de Monteggia sont des fractures rares qui représentent 1 à 2% des fractures de l’avant-bras chez l’homme. Bien que ces fractures aient été rapportées à de multiples reprises dans la littérature vétérinaire, aucune étude n’a à ce jour rapporté sa prévalence chez une espèce animale. Chez les espèces domestiques, le traitement consiste le plus souvent en une ostéosynthèse ulnaire associée à une fixation radio-ulnaire qui empêche ou limite les mouvements de pronation et supination. La technique chirurgicale décrite dans ce cas a permis une bonne stabilisation et cicatrisation de la fracture, sans compromettre la pronation et la supination, très importantes chez les primates. À notre connaissance, il s’agit de la première description d’une fracture de Monteggia chez un lémurien.

Mots-clés : Fracture, Lemur catta, Monteggia, radius, maki catta, ulna

Figure 1: Lateral (A) and antero-posterior (B) radiographs of a 12-yr-old female Ring-Tailed Lemur’s left arm showing a type III Monteggia fracture. Note the diaphyseal ulnar fracture and the lateral luxation of the radial head.
On day 4, surgery was performed. The animal was anesthetized and placed in right lateral recumbency. Surgery was performed via a lateral approach of the left elbow. The skin incision extended from the distal third of the humerus to the middle of the ulna. The antebrachial fascia was incised and a complete inspection of the lesions was made. The radial nerve appeared oedematous. The radial head was luxated laterally but the articular surfaces were still intact. The annular ligament and the lateral collateral ligament were disrupted. The ulnar fracture was reduced with a 1.5 mm intramedullary pin in retrograde fashion. The reduction of the radial head was difficult. It was accomplished by placement of a point-to-point reduction forceps on the radial head, as the elbow joint was extended and the distal radius distracted. The lateral collateral ligament was shredded and could not be re-apposed with sutures. A prosthetic replacement of the lateral collateral ligament was performed by placing two 2.0 mm screws (Synthes®, 25461 Etupes, France) : one screw in the distal humerus and one screw in the radial neck. A heavy nonabsorbable polyester suture (Ethibond® excel USP 0, Ethicon SAS, 92130 Issy-les-Moulineaux, France) was then looped over each screw in a figure of eight pattern. The elbow was tested in all range of motions and showed good stability. A routine closure was performed.

Post surgery radiographs revealed a good reduction of the fracture (Fig. 2). The mediadorsal wound was flushed with saline solution and covered with a hydrocolloid ointment (Algoplaque®, Laboratoires Urgo, 21300 Chenôve, France) and a Robert Jones bandage was placed on the distal arm, elbow, and forearm. The animal was kept in a hospitalization cage and the bandage was changed every other day unless it was soiled or removed before, for control and topical treatment of the wound.

![Figure 2: Lateral (A) and antero-posterior (B) radiographs of a 12-yr-old female Ring-Tailed Lemur’s left arm showing surgical repair of a type III Monteggia fracture with a 1.5 mm intramedullary pin in the ulna, and two 2.0 mm screws, in the distal humerus and in the radial neck. Note the Robert-Jones bandage.](image)

Healing of the wound continued uneventfully although scar tissue filling of a depression on the wound’s medial side was a little longer to occur. Twenty-three days post surgery it was completely closed.

Amyotrophy of the left forelimb was also noticed several days post surgery and had developed from mild to severe. Motility of the elbow was not impaired. Two weeks after the surgery, the Robert Jones bandages were stopped in order to encourage mobility of the elbow and reduce amyotrophy. Neurologic evaluation revealed nociception of the limb, but motricity of the distal limb, including fingers was uncertain. The animal received strychnine (Strynervene®, Laboratoire TVM, 63370 Lempdes, France; 0.049 mg s.c. s.i.d. for 5 days) but no improvement was noticed soon after the treatment and the left arm was not used, resting most of the time on the elbow. Abnormal bearing of the elbow, in abduction and semi-flexion was also observed.

Eighteen days post surgery a new wound was noticed on the elbow, facing the olecranon, with a slight protrusion of the ulnar pin. It was assumed to be caused by a compression of the skin facing the pin as the arm frequently rested on the elbow. Topical treatment included flushes with a diluted chlorhexidine solution (Hibitane® 5%, Intervet, 49071 Beaucouze, France), hydrocolloid ointments as described above, and pressure-relieving bandages. The wound remained clean, and the bandages were changed every 4 to 5 days, but complete closure of the wound was only achieved after pin removal, within 2 days.

Thirty-four days post surgery the animal first used its fingers to grasp the fence of its cage, during physical restraint. Two days later, it was moved to the Ring-Tailed Lemurs’ house, in an isolated cage with visual, olfactive and auditive contact with its conspecifics. The animal immediately started using its left arm during locomotion, although support was intermittent and not pronounced. Two months post surgery it used its left hand while eating, for the first time. Control radiographs were performed. Twenty-three days post surgery, they showed 2 splinters, but a callus was formed and reduction was still good. Forty-eight days post surgery they showed a good consolidation of the callus and no evidence of septic complication. Removal of the intramedullary pin was first considered at that time but was finally delayed, despite the elbow wound, because of the strong forces and pressure supported by the forearm during locomotion.

Eighty days post surgery the pin was removed and new radiographs performed. A small area of non-calcified cartilage within the callus was visible and there was still no evidence of septic complication.

One hundred days post surgery another control was performed. Motility of the elbow was excellent and radiographs showed a completed healing of the fracture, with an almost invisible callus.

One year post surgery, ultimate control radiographs were taken (Fig. 3). No evidence of degenerative joint disease of the
elbow was noticed. The bone density was slightly decreased around the radial screw and a mild osteoproliferation was observed on the proximal part of the radius. The animal showed excellent use of its left arm, with normal support on it. Pronation and supination were preserved.

**Discussion**

Monteggia fractures are rare fractures of the forearm that were first described in the 19th century [2, 16]. They are defined as the combination of an ulnar fracture, a radiohumeral dislocation, and a radio-ulnar disjunction [1, 6, 16]. They represent 1 to 2% of human forearm fractures [1] but no retrospective study has evaluated their prevalence in veterinary medicine yet.

Most frequently reported aetiologies in domestic carnivore species are road traffic accidents and falls (78%), bites (12%), and firearms (6%) [2]. Clinical diagnosis relies on orthopaedic and radiographic examinations. Mild tumefaction and haematoma can be noticed near the fracture site, as well as pain and crackling. The elbow is generally held in light flexion and abduction. The luxation can be diagnosed via palpation of the radial head, which can also mask the ulnar fracture as abnormal lateral mobility can be interpreted as a result of the luxation only. Therefore radiographs, with 2 perpendicular incidences, are necessary to confirm the diagnosis, classify the fracture, and prepare the surgery [2].

In 1967, Bado classified Monteggia fractures in 4 types, according to the direction of the radial luxation and angulation of the ulnar fracture [1]. Type I fractures involve cranial luxation of the radial head with cranioproximal angulation of the ulnar fracture [1, 6, 16]. They are the most frequently encountered [1, 6] as a consequence of a trauma at the back of the elbow when it is held in extension [1]. Type II fractures correspond to a caudal luxation of the radial head, and caudal angulation of the ulnar fracture. Type III fractures involve lateral luxation of the radial head and caudal angulation of the ulnar fracture, and type IV denotes both radial and ulnar fractures, with radial head luxation, generally in a cranial direction [1, 6, 16].

In this case the lateral luxation of the radial head and the caudo-lateral angulation of the ulnar fracture matched a type III fracture that is generally caused by a trauma on the medial side of the forearm [16], which corresponds to the localization of the wound in our case and involves simultaneous adduction and angulation with rotation forces [2, 10]. Type III fractures, which represent 20% of human Monteggia fractures, are the second most frequent type after type I fractures, which account for 60% [1]. Two retrospective studies also report type I fractures as the most frequent in veterinary medicine [2, 12]. According to the one with more cases (59), types III and IV are the second most frequent, accounting for 12% cases [2].

In human medicine, orthopaedic treatment of Monteggia fractures is discouraged because of the frequent complications for the joint [16]. In the case of small carnivores, the recommended treatment is surgical and includes open reduction of the ulnar fracture and stabilization of the radio-ulnar disjunction via a unique lateral approach. Reduction of the radial head luxation should not need any specific treatment since reduction of the radio-ulnar disjunction spontaneously reduces the radial luxation [16] in case the annular ligament is intact. This can be checked during the procedure with a lateral approach between muscle extensor carpi radialis and muscle extensor digitorum communis.

Reduction of the fracture should be performed as soon as possible, otherwise it is more difficult to achieve because of the muscular spasm, soft tissue inflammation, callus organization, and hypervascularisation [2, 3].

Treatment of the ulnar fracture requires a good stabilization and is generally performed with a conventional plate for large dogs [3, 6, 8, 13, 15] and pins or tension-band wires for small dogs and cats [3, 4, 6]. Stabilization of the radio-ulnar disjunction is most commonly performed via permanent proximal transfixation of the radius and ulna with screws, pins, or tightropes [2, 3, 4, 11, 13, 15]. However, transfixation of the radius and ulna prevents pronation-supination movements of the forearm [12]. Some authors therefore recommend removal of the screws 4 to 6 weeks post surgery [6, 11, 16]. Another possibility is to use a circle wire loop, which enables correction of the radio-ulnar disjunction, and still preserves a relative mobility between the radius and the ulna [5]. In case of annular or collateral ligament rupture, suture or replacement with a synthetic prosthesis can be performed [7, 9, 13].
In this case, repairing of the fracture using an intramedullary pin in retrograde fashion associated with a suture prosthesis knotted around two periarticular screws was motivated by the small size of the ulna, the need to preserve pronation-supination movements, so valuable for primate species, and the unstable reduction of the radial luxation because of the ruptured annular and lateral collateral ligaments. Although complete recovery of the forearm and hand motility were long, pronation-supination movements were preserved and this technique seems to give good, satisfactory results for repairing type III Monteggia fractures in lemur species.

Another notable feature of this case is the long interval between surgery and pin removal. Intramedullary pin removal generally occurs 6 to 10 weeks after surgeries, and was initially planned 7 weeks post surgery in this case. The elbow wound, with little protrusion of the pin, represented a risk of septic complication. Nonetheless, because of the important forces and pressure applied on the forearm during locomotion, the authors decided not to remove the pin until 80 days post intervention, given the nice aspect of the wound that was regularly inspected and cleaned, the good general evolution, and the absence of any sign of septic complication. Radiographs were regularly performed to monitor bone healing and absence of osteomyelitis. Fear that the forces applied on the surgical implants could compromise the efficiency of the surgical treatment also explains the long hospitalization time of the animal before it returned to the group.

Nervous recovery took 7 to 11 weeks. A neurapraxia or axonotmesis of the radial nerve explains the neurologic deficits the authors observed and their recovery. The radial nerve can be stretched by the luxated radial head, or compressed between the radius and the ulna, following the fracture [14, 16]. Therefore, manual reduction of the luxation is discouraged, and a pre-operative neurological examination including assessment of the radial nerve is recommended [2, 16]. Other nervous lesions reported with Monteggia fractures include interosseous and ulnar nerves palsies [14].

In order to reinforce the solidity of the surgical repair and diminish the forces applied on the forearm, the Robert Jones bandage was left for two weeks whereas it is generally recommended to remove it as soon as possible, to avoid ankylosis [16]. Nevertheless, no ankylosis of the elbow was noticed in this case. Another option would have been to use a caudal splint, recommended for 3 to 4 weeks postoperatively [6].

General complications of surgical repairs of Monteggia fractures include ankylosis and/or degenerative joint disease of the elbow, lameness of the forearm, residual instability, and osteomyelitis [2, 16]. Only 2 retrospective studies of more than 2 cases of Monteggia fractures are available in veterinary medicine. In 1984, 81% of ankylosis and/or degenerative joint disease were reported [12] but treatment consisted in suturing the annular ligament, which is less efficient than other techniques [16]. However, follow-up evaluations revealed good to excellent results in 10 of the 16 cases according to Schwarz & Schrader [12]. In the second retrospective study, radiographic signs of degenerative joint disease were absent or negligible in 97% cases, but control radiographs were generally taken only 8 weeks post surgery [2].

Clinical prognosis of the surgical treatment is quite good, as persistent lameness of the affected arm is absent in 83,3% cases reported in cats and dogs [2].

Residual instability of the elbow and/or recurrence of the luxation or subluxation accounted for 56% cases with a good follow-up in one study [12], while it was reported only for 5% of the treated fractures, and 7,1% of the cases with a good follow-up in another study, where radio-ulnar transfixation was frequently used [2]. Loss of mobility, particularly in flexion, is also reported [2].

In domestic carnivore species (cat and dog), comparative analysis of complication rates indicated that radio-ulnar transfixation is the method of choice in most cases : lameness was reported only in 36,7% cases, instability/subluxation in 6,5% cases, ankylosis in 16,1% cases, and elbow incongruence in 8,3% cases while these complications respectively represented 75%, 25%, 50%, and 25% of cases with annular ligament suture [2]. However the necessity to preserve pronation and supination movements led the authors to choose another technique.

In our case stabilization of the radio-ulnar disjunction was achieved only by the prosthetic replacement of the lateral collateral ligament. It should be emphasized that the Robert-Jones bandages, used for 2 weeks post surgery, and the long cage hospitalization time certainly also played an important role in the healing process. No clinical signs were noticed one year post surgery, and the only radiological signs we observed were a slight decrease of the bone density around the radial screw, and a mild osteoproliferation on the proximal radius. Ulnar osteosynthesis, associated with humero-radial stabilization, enabled an excellent functional recovery, without impairing pronation and supination.

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MONTEGGIA FRACTURE IN A RING-TAILED LEMUR


