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Fixed bilateral endo-exo prostheses in feline femur – case report

[*Endo-exoprótese bilateral fixa em fêmur de felino – relato de caso*]

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ABSTRACT

The use of endo-exo prosthesis is an alternative to improve the quality of life of amputees, allowing correct distribution of body weight, reducing skin problems and pain related to the implant, and reducing lameness. The aim of this paper is to report the use of a fixed bilateral endo-exo femur prostheses in a cat with amputation prior to treatment. The endoprostheses were made with titanium and the exoprostheses were made with 3D printing technology. A longitudinal craniolateral surgical approach was used and the skin incision was made over the knee-joint, then fascia lata incision, followed by biceps femoris and vastus lateralis muscles retraction, incision through the joint capsule to expose the tibiofemoral joint, disarticulation, and tibia and fibula removal. Afterwards, a femoral leveling osteotomy and insertion of the implant in the medullary canal were performed, being attached in the cis and trans cortical bone. The patient was evaluated in the immediate post-operative and periodically thereafter, showing satisfactory results, without macroscopic signs of rejection, wound dehiscence or infection, fracture, or injury of limbs, and presented adapted walking. Furthermore, it was observed the return to common behaviors for the species.

Keywords: orthopedic surgery, walking, orthopedics

RESUMO

O uso de endoexoprótese é uma alternativa para melhoria na qualidade de vida de pacientes amputados, permitindo distribuição correta do peso corporal, redução de problemas de pele e dor ligadas ao implante e redução da claudicação. Este trabalho objetivou relatar a utilização de endoexoprótese bilateral fixa em fêmur em felino com amputação prévia ao atendimento. Foram modeladas endopróteses em titânio e exopróteses projetadas e impressas em 3D. O acesso cirúrgico, em ambos os membros, foi realizado por incisão craniolateral transarticular da pele, incisão da fáscia lata, rebatimento dos músculos bíceps femoral e vasto lateral, incisão da cápsula articular para exposição da articulação femorotibial, desarticulação e remoção cirúrgica da tíbia e da fíbula. Em seguida, realizou-se osteotomia niveladora femoral e inserção do implante no canal medular, sendo esse fixo nas corticais cis e trans. O paciente foi avaliado no pós-cirúrgico imediato e posteriormente de forma periódica, demonstrando resultados satisfatórios, sem sinais macroscópicos de rejeição, deiscência ou infecção da ferida cirúrgica, fratura ou lesão de membros, e apresentava deambulação adaptada. Além disso, foi observado o retorno de comportamentos comuns da espécie.

Palavras-chave: cirurgia ortopédica, deambulação, ortopedia

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INTRODUCTION

Complete limb amputation is commonly used as a form of treatment in veterinary orthopedics and performed in cases of neoplasms, severe trauma, peripheral neuropathies, ischemic necrosis, irreversible orthopedic infections, or congenital deformities (Phillips *et al.*, 2017). Although many patients can adapt to ambulation after this procedure, it occasionally leads to reduced mobility, weight gain, fracture of another overloaded limb, chronic pain, or premature euthanasia (Mich, 2014; Jarrel *et al.*, 2018).

As an alternative to amputation, prostheses can be used, such as socket prostheses or osseointegrated implants, which are successfully used in human and veterinary medicine (Phillips *et al.*, 2017). Osseointegration is based on the direct anchorage of the implant to the bone with the growth of tissue around it without the formation of fibrous tissue. The attachment of the osseointegrated prosthesis has advantages, such as greater patient comfort and facilitated direct load transfer between the prosthetic and the bone (Lundborg *et al*., 1996).

The endo-exo prostheses use an osseointegrated implant that extends to the outside of the limb in which an external prosthesis is attached to replace the previously amputated limb, the exo-prosthesis (Rego, 2019). Its use offers many advantages, such as the correct distribution of body weight, the reduction of skin and pain problems related to the implant, and lameness reduction (Hagberg *et al.*, 2008; Rego, 2019). Furthermore, there is improved quality of life and welfare of the patient, maintaining the social, exploratory, predatory, and playful behavior of the animal (Rego, 2019).

Despite the benefits, some post-surgical complications may occur. The major problem is the development of infection, as there is an inability to directly attach the skin to the implant, leading to its failure (Jeyapalina *et al*., 2017). Other possible complications are periprosthetic tissue necrosis, implant fracture or implanted bone fracture (Mendonça and Fernandes, 2019).

Therefore, this study aims to report the use of bilateral endo-exoprostheses after hindlimb amputation in a feline.

CASE REPORT

A five-year-old male cat of undefined breed was received at Ortovet Clinic with previous bilateral amputation of the tibiotarsal joint due to tissue necrosis and unsuccessful prostheses implant, both performed in another veterinary medical service. On clinical examination, the animal showed muscle atrophy and difficult ambulation. It was decided to perform a bilateral implantation of intramedullary endo-exo prostheses (BioFix 3D, Brazil). The planning of all implant components was performed in a 3D, CAD, modeling software using a locked titanium intramedullary implant.

Preanesthetic medication consisted of 5mg/kg of Ketamine hydrochloride 10%, intramuscular, associated with 0.3mg/kg of Midazolam Hydrochloride 0.5%, intramuscular, and 0.2mg/kg of Methadone Hydrochloride 1%, intramuscular. Anesthesia was induced with 2mg/kg of propofol, intravenous, and it was maintained with isoflurane in 100% oxygen. Besides, an epidural block was performed with 0.25ml/kg of Bupivacaine Hydrochloride 0.5% associated with 0.1mg/kg of Morphine Sulfate 1%.

For the preparation of the limbs, an appropriate trichotomy was performed. The patient was placed in the supine position and the surgical site was aseptically prepared with chlorhexidine alcoholic 0.5%. The animal was covered with a sterile drape. A craniolateral approach was made with the skin and fascia lata incision, and retraction of the biceps femoris and vastus lateralis muscles. An incision of the joint capsule was performed to access the femorotibial joint followed by disarticulation and surgical removal of the tibia and fibula. Then, a leveling osteotomy of the femoral condyles was performed to expose the cancellous bone, with the milling of the tissue until 80% of the implant diameter was obtained. The implant was inserted into the medullary canal using a Jacobs chuck perforator in a retrograde manner (Fig. 1A).

A Kirschner wire of 1.5 mm diameter was, then, introduced into a hole at the end of the implant and fixed in the cis and trans cortices, to block it and allow osseointegration (Fig. 1B). Cerclages were performed preventively to avoid bone fissure. However, it was removed from the right

limb during the transurgical procedure because there were no signs of bone microfissures. In the left limb the cerclage was maintained (Fig. 2) because a microfissure was observed during the procedure. The muscles were closed using 2-0 mononylon in a simple interrupted suture pattern, as well as the skin. This procedure was done on both limbs. The patient was radiographed postoperatively to confirm the correct positioning of the prostheses in the medullary canal of both limbs (Fig. 2A). Radiographs were solicited once every 30 days postoperatively, during 6 months. Due to the financial incompatibility of the owner, the procedure was only carried out for 4 months in sequence and one radiography eight months after the surgery.

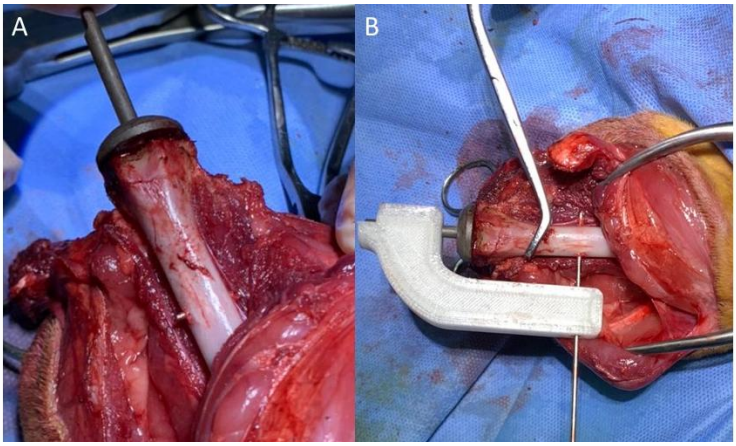

Figure 1. Steps of the osseointegration surgery. A – Titanium prosthesis implanted in the medullary canal of the femur. B – A 1.5mm Kirschner wire used in the end of the implant in the femur.

Figure 2. Ventrodorsal radiographic views of bilateral endo-exo prosthesis fixed in the femur of the feline patient, male, five years old. There are no signs of infection, fracture, or injury to the limbs. A – Immediate postoperative; B – A month after the procedure; C – Three months after the procedure; D – Eight months after the procedure.

For the post-surgical period, the patient received 8mg/kg of Cefovecin Sodium, subcutaneously, every 15 days for 90 days; 12mg/kg of Tramadol Hydrochloride, orally, BID, for 10 days and 0.1mg/kg of Meloxicam 0.5mg, orally, SID, for 5 days.

The patient was periodically evaluated and presented satisfactory results. There were no macroscopic signs of implant rejection, and the ambulation was adapted from abduction and adduction movements of the limbs. There were no signs of dehiscence, infection, fracture, or injury to the limbs. The results demonstrate the feasibility of the implant in the patient, bringing greater comfort and quality of life (Fig. 3).

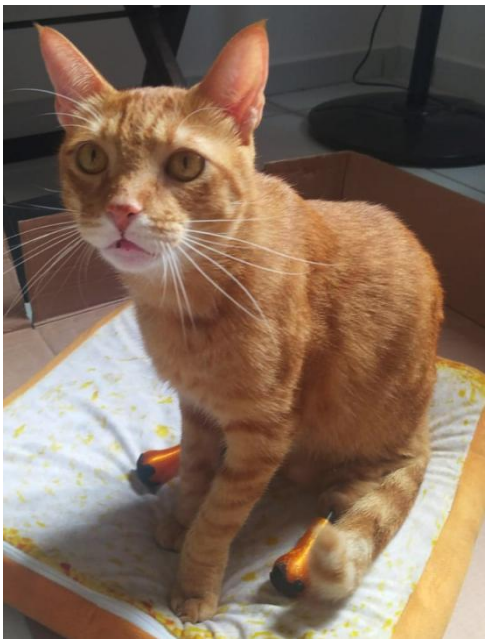

Figure 3. Feline patient, undefined breed, 5 years old, with endo-exo prostheses fixed in the femurs.

DISCUSSION

The amputation of one or more limbs can lead to difficult conditions that are harmful to the welfare of the patient, such as reduced mobility, weight gain, fracture of the remaining limbs or chronic pain (Mich, 2014; Jarrel *et al*., 2018). The patient treated in the present report had a reduced ability to walk and atrophy of the muscles of the limbs due to the bilateral amputation of the hindlimbs.

In this species, the hindlimbs are of great importance for locomotion and behavior, since on a smooth surface they present higher propulsion force than deceleration, the opposite of the forelimbs (DeCamp, 1997; Mendonça and Fernandes, 2019). Therefore, bilateral amputation of these limbs in a feline patient, as well as planning the surgical implant procedure, are challenging decisions.

Regarding the reconstruction in amputees, the osseointegration surgery is a technique in which it is implanted a metal to the residual bone and a prosthetic limb is attached using a transcutaneous connector through an opening in the skin of the patient (Jeyapalina *et al*., 2017). According to the literature, the use of endo-exo femur prosthesis was performed for the first time in human medicine in 1999 (Aschoff *et al.*, 2009). The use of this prosthesis enables the correct distribution of body weight, reduces skin problems and pain related to the implant, as well as reduces lameness and consequent development of musculoskeletal disorders. It also enables proprioception, as the implant is directly attached to the bone (Hagberg *et al.*, 2008; Rego, 2019). Therefore, for the present report, the choice was

made to provide greater comfort to the patient, allowing the return of effective ambulation.

For the success of the technique, the implant and the external prosthesis need the exact measurements, adjusting to the specifications of each patient (Popov Jr. *et al.*, 2019). The endoprostheses used in the patient consisted of an external stem, a collar, and an intramedullary stem. For its confection, it is necessary to evaluate the case, history, amputation level and the health of the patient. In the present case, it was made of titanium and based on measurements of the medullary canal, the base of the bone after leveling osteotomy and the amputation level. The diameter of the intramedullary stem was made according to the smallest diameter of the medullary canal and its height was based on the anatomy of the canal. The collar diameter used the bone base after osteotomy as a parameter, keeping the base completely supported on the implant avoiding bone resorption. The external stem was measured based on the amputation level and weight of the animal.

Regarding the exoprostheses, the amputation level, region of surgery, and necessary angulation were evaluated. It was modeled and 3D printed to allow natural ambulation (Fig. 4). The prostheses had a rounded base to facilitate limb support in all directions. According to Popov Jr. *et al.* (2019), 3D printing is widely used in automotive and aerospace industries and in biomedicine, but in veterinary medicine there are still limitations around its use and few scientific publications about it, demonstrating the relevance of the present report.

The material chosen for the 3D printing of the exoprostheses was polyethylene terephthalate glycol-modified (PETG), which has rigid characteristics, high ductility and elastic deformation compatible with the load applied on the exoprostheses. This corroborates with reports of Rodrigues (2013), who states that polyethylene is the most used polymer in orthopedic routines. For the base of the prostheses, rubber was used for shock absorption and anti-slip effect, bringing comfort and grip to the animal.

Figure 4. The 3D model of the exoprostheses used in the patient

The surgery was successful as the patient presented satisfactory results during the post-operative period, with no macroscopic signs of implant rejection and with adapted ambulation. There were no signs of surgical wound dehiscence or infection, fracture, or limb injury. The return of the social, exploratory, predatory, and playful behavior of the patient was also observed.

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