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Autogenous Implant of Rhinotheca in Blue-and-Yellow Macaw (*Ara ararauna*, Linnaeus, 1758)

Implante Autógeno de Rinoteca em Arara Canindé (*Ara ararauna*, Linnaeus, 1758)

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Resumo

O objetivo do presente estudo foi descrever a técnica de implante de bico autógeno em um macho de arara canindé adulta que havia sofrido avulsão total da parte superior de seu aparelho bucal. A cirurgia foi realizada para reestabelecer as funções anatômicas e fisiológicas, sendo a primeira relatada na literatura a reabilitar uma arara que seria sacrificada por acusa da ausência de bico. Foi utilizada a parte superior de um bico de ave doadora, proveniente do Centro de Reabilitação de animais Silvestres (CRAS). O implante do bico foi realizado utilizando-se adesivo de cianoacrilato, resina acrílica autopolimerizável e fixação com três parafusos corticais na rinoteca e ossos do crâneo. Após a cirurgia, a arara foi observada ao longo de 12 meses avaliando-se, semanalmente, seu comportamento alimentar, movimentos de escalada com o bico e sua socialização com as demais araras presentes no recinto. O implante não apresentou sinais de abrasão, rejeição ou fraturas na região de intervenção, possibilitando que a arara se adaptasse ao ambiente sem dificuldades. O método de implante utilizado mostrou-se adequado ao modo de vida da arara, favorecendo seu bem-estar animal. A técnica cirúrgica utilizando implante autógeno com parafusos e resinas é inovadora e pode ser indicada para uso em traumas graves como o deste estudo, elevando a expectativa de vida da ave atendida.
Palavras-chave: Reabilitação Animal. Inovação. Próteses. Abordagem Cirúrgica.

Abstract

The aim of this study was to describe the technique of implanting an autogenous beak in a male adult blue-and-white macaw that had suffered a total avulsion of the upper part of its mouthparts. The related approach was performed to reestablish the anatomical and physiological functions, being the first reported in the literature to rehabilitate a macaw that would be sacrificed because of the lack of beak. The upper part of a donor macaw's beak was used, from the Wild Animal Rehabilitation Center (CRAS). The beak was implanted using cyanoacrylate adhesive, self-polymerizable acrylic resin and three cortical screws in the rhinotheca and skull bones. After the surgery, the macaw was observed for 12 months, evaluating weekly its feeding behavior, climbing movements with its beak and its socialization with the other macaws present in the enclosure. The implant did not show signs of abrasion, rejection, or fractures in the intervention region, allowing the macaw to adapt to the environment without difficulties. The implant method used proved to be suitable for the macaw's way of life, favoring its animal welfare. The surgical technique using autogenous implantation with screws and resins is innovative and can be suitable for use in severe traumas such as the one in this study, raising the expectation of life of the bird under care.
Keywords*: Animal Rehabilitation. Innovative. Prosthesis. Screw Fixations. Surgical Approach.*

1 Introduction

The order Psittaciformes, which includes Psittacides and Cockatoos, is the group of birds that stand out for their great intelligence, color and easy adaptation to captivity, a factor that places them in a duality, as a flagship species for conservation with high capacity for adaptation in captivity (Guedes *et al*., 2021). This ability makes them one of the most popular groups to serve as pets and consequently makes them the target for the trafficking of wild animals (Souza, 2022).

These birds were already requested since antiquity by the Greeks, Romans and during the Middle Ages for adornment, for offering to the gods, but, above all, as companion animals with which they liked to be with portrayed, appearing in fine arts and cartography, since 1500 BC (Papavero *et al*., 2016).

The Psittacidae family comprises about 330 species, 148 in the New World and 184 in the Old World and Australia. Most parrot species are threatened or having their wild population decreased, making them vulnerable to extinction, due to a combination of factors such as capture for the international trafficking of wild animals, habitat suppression and urbanization, and a reduction in reproductive success (Tinoco *et al*., 2022).

The Cerrado and Pantanal biomes make up a large part of the territorial space of Mato Grosso do Sul (MS) state with a great diversity of fauna, mainly with the group of parrots, attracted by the availability of food resources (Brum, 2022). However, the 79 state municipalities are served by a single rehabilitation center for wild animals-CRAS (Cazati *et al*., 2021), located in the state's capital, Campo Grande, where a great diversity of fauna is served with blue-and-yellow

macaws accounting for 62% of emergency care requirements (S.I.R.I.E.M.A.). Despite the veterinary care, most of these received birds, presenting beak fractures, were usually sacrificed because difficulties of feeding, recovery, and their rehabilitation to nature (Cazati *et al*., 2023).

The beak is formed by an epidermal structure keratin derived, anchored in the bone structure of the face. The upper part is the maxilla (rhinotheca), and the lower part is the mandible (gnathotheca), both form the structure technically called as ramphotheca (King *et al*., 1984). Different surgical approaches can be used in the effective reconstruction of the beak of these birds, considering that their eating habits are characterized by varied consumption, including fibrous and hard fruits, such as coconuts, to access its nuts.

This study describes the success of a surgical technique applied to implant an autogenous beak in an injured Blue-and-yellow macaw (*Ara ararauna* Linnaeus, 1758) that was lost its rhinotheca.

2 Material and Methods

In 2020, a young Blue-and-yellow macaw (*A. ararauna* Linnaeus, 1758), of undetermined sex, initial weight of 670g, was sent to Wild Animal Rehabilitation Center CRAS by the State Environmental Military Police. The officers reported that they answered a call, with the main complaint of a Blue-and-yellow Macaw hit on a public road with severe bleeding in the head, and unable to fly. In the emergency veterinary care, severe bleeding was observed in the head region, with total avulsion of the bird's rhinotheca (Figure 1).

Figure 1 - Blue-and-yellow macaw (*Ara ararauna*, L. 1758), without the upper part of the beak (rhinotheca), 12 days after arriving at CRAS in Campo Grande, MS, Brazil. The tissues in the margin of the rhinotheca have started healing

Source: the authors.

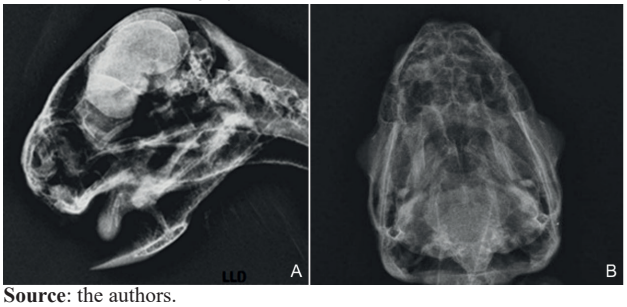
Due to the injury, the bird was hyper-excited, making physical examination difficult. So, the animal was sedated with the multimodal protocol (Cazati *et al*., 2021), using Zoletil® (Tiletamine Hydrochloride 125mg/ml associated with Zolazepan Hydrochloride 125mg/ml, Virbac, Brazil) at a dose of 10mg/kg/IM, associated with Tramadon® (Tramadol Hydrochloride 125 mg/ml, Cristália, Brazil) 5 mg/kg intramuscularly.

After physical examination, procedures were started for pain control protocol: 0.5 ml/kg of the association of Dipyrone (25mg/kg/IM, IBASA, Brazil), Maxican® (Meloxicam 0.2%, Ouro Fino, Brazil) injectable (Carpenter; Mashima; Rupiper, 2001). After the animal sedation and in lateral recumbency, it was possible to stabilize the bird and establish the treatment and prognosis.

The bird was kept in quarantine and monitored for 12 days, for daily antisepsis with 2% chlorhexidine and monitoring the clinical evolution. During this adaptation period, the macaw had difficulty feeding but, after the initial control-pain therapy, it showed the ability to feed itself a special developed diet and showed significant signs of behavior improvement, including vocalizations demonstrating defensive instinct during daily manipulation. In view of the evident clinical evolution, the patient was referred to the Diagnostic Imaging Sector of the Federal University of Mato Grosso do Sul (UFMS), for radiographic examination.

For the examination procedure, the macaw was pharmacologically restrained to reduce stress and improve the quality of the images (Silverman; Tell, 2010) to perform radiographic studies of the skull region in the ventrodorsal and right laterolateral views. The technique used was radiological exposure 200 mA, time 0.8 and 65kV, and the images showed the total absence of the rhinotheca, with no involvement of the nasal bone (Figure 2).

Figure 2 - Skull radiographic image of a blue-and-yellow macaw (*Ara ararauna*, L. 1758) in the right laterolateral projection (A), and ventrodorsal view (B). Both images reveal the absence of rhinotheca and no injury on the nasal bone



Source: the authors.

Following the image exam, which confirmed that the facial framework was uncompromised with favorable bone conditions, the macaw was referred for the surgical procedure to implant the autogenous prosthesis (Prazeres *et al*., 2013), from the other macaw that was perished months ago at the same CRAS.

For the implant procedure, a multimodal anesthetic protocol was used. As preanesthetic medication (PAM): Cetamin® 20 mg/kg (ketamine hydrochloride 10%, Syntec, Tamboré-SP, Brazil) and midazolam (1 mg/kg, Hipolabor ind. Farmacêutica, Belo Horizonte-MG, Brazil) were administered both intramuscularly. After 3 minutes of PAM, orotracheal intubation was performed to supply isoflurane (Vetflurane®, 1000 mg/g, Virbac do Brazil, São Paulo, SP) through a universal vaporizer, diluted in 100% oxygen (Cassanego *et al*., 2022).

The surgical maneuver for fixation and stabilization of the implant followed the precepts of osteosynthesis (Schönegg *et al*., 2022). Cyanoacrylate adhesive (Super Bonder®, Henkel Ltda., Itapeví, São Paulo, Brazil) was applied to the edges of the prosthesis between the two surfaces (Fecchio, 2021) and, after, three screws were fixed (two lateral n° 2.7 x 06 mm and one superior n° 2.7 x 10 mm) favoring partial fixation of the prosthesis. Eventually a self-curing acrylic resin was applied (VIPI Flash®, polymethylmethacrylate, Vipi Produtos Odontológicas, Pirassununga, SP, Brazil) in the edges of the implantation (Bizinoto *et al*., 2021), to fill small residual fissures, thus reinforcing the total fixation of the autogenous prosthesis between the contact surfaces. The entire procedure lasted 50 minutes (Figure 3).

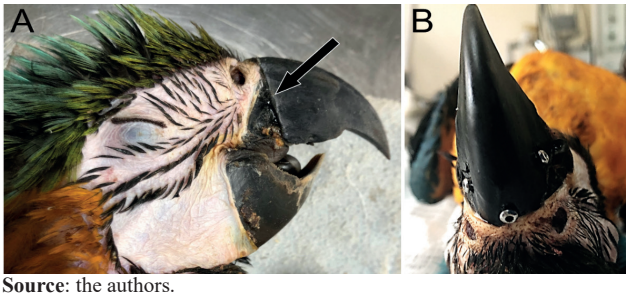
Figure 3 - Schematic representation of autogenous prosthesis implantation in a blue-and-yellow macaw (*Ara ararauna,* L., 1758). A) Sizing adjustment between donor rhinotheca, to recipient. B) and C) drilling performed in the left lateral region, contralateral and upper hole for passage and partial fixation with screws of the nozzle. D) fixed and fitted prosthesis

Source: the authors.

4 Results and Discussion

The new rhinotheca implant has tensile strength, with no apparent gaps or asymmetry (Figure 4).

Figure 4 - Portrait of anesthetized blue-and-yellow macaw (*Ara ararauna,* L., 1758) illustrating: A) insertion area of autogenous rhinotheca fixed with cyanoacrylate adhesive on the surface edges. The arrow indicates the area of contact between the beak and the bony part of the face. B) Portrait showing the position of the fixation screws inserted after the cyanoacrylate adhesive had cured



Source: the authors.

The use of unconventional materials for surgery in wild animals is becoming more and more frequent, especially in birds. These materials proved to be satisfactory to repair beak segments, as both the cyanoacrylate and the dental resin used were decisive in the fixation of the patient's prosthesis, corroborating Fecchio (2021) who defend the use of that material to fix these kind of beak lesions.

After the surgical procedure, a radiographic examination was performed to verify the fixation of the screw to the bone structure (Figure 5).

Figure 5 - Radiographic image of a Blue-and-yellow Macaw (*Ara ararauna,* Linnaeus, 1758) with transplanted rhinotheca, illustrating the screws anchored in the facial bone

Source: the authors.

In the case of this patient, the applicability of prostheses made in a 3D printer was ruled out, considering the high cost of the printer and its printing, in addition to the synthetic material offering less resistance against higher density foods, making this option unfeasible. Another factor that can lead to the rejection of synthetic materials from 3D printing is the presence of toxic nanoparticles emitted by the printer, which can cause an acute inflammatory response and graft rejection (FARCAS *et al*., 2019). Being a free-living bird, it is preferable that an implant be durable, free from irregularities, and have the same biological structure, weight, color, and appearance as the original lost beak. Thus, an autogenous prosthesis can meet these specifications.

After surgery, the animal was restrained weekly, or as needed, for mechanical assessment of the prosthesis adhesion, as well as checking for the presence of possible infections resulting from contaminating food residues between the prosthesis and the bone.

Over 12 months observations were performed of their feeding behavior towards different food, with different hardness, their climbing movements using the beak and their socialization with the other macaws present in the enclosure. At the end of the adaptation and observation period, the implant showed no signs of abrasion at the fixation site and the macaw have adapted to the environment without difficulties in feeding, climbing, or socializing, allowing its perfect reintegration into its habitat when, eventually, it was

sent to a conservationist breeder.

This work is a contribution to the scientific community of animal sciences and preservation groups demonstrating the efficiency of materials, as it is light and resistant to replacing the damaged bird's beak. The technical procedure used was relatively simple, cheap, and efficient, performed by qualified veterinary surgeons, but with great repercussions for the avian fauna as it can be used for the rehabilitation of animals that would otherwise be doomed to euthanasia or death after long suffering from starvation.

4 Conclusion

The autogenous rhinotheca implant fixed with cyanoacrylate adhesive, dental resin and fixation screws was efficient for the recovery of the mutilated animal, allowing its normal living.

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