

# **Surgical Management of Femorotibial Joint Luxation with Hinged Transarticular External Fixation in a Blue-and-Gold Macaw (*Ara ararauna*): A Case Report**

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## **Abstract**

This case report discusses hinged transarticular external fixation to manage femorotibial joint luxation in a blue-and-gold macaw (*Ara ararauna*), emphasizing the relative infrequency and complexity of this orthopedic challenge in avian medicine. An 11-year-old macaw was presented to the exhibit with acute non-weight-bearing of the right leg and associated joint swelling for three days following trauma. Conservative management alone was inadequate to restore joint stability and function due to anatomical factors, necessitating surgical intervention. The surgical technique utilizing a Fixateur Externe du Service de Santé des Armées (FESSA) hinged linear transarticular external fixator (HLTEF), was appropriate for the femorotibial joint's anatomical and biomechanical aspects of the avian species. Providing stabilization of the femorotibial joint and restricting the range of motion is crucial for preserving joint and muscle function. After the surgery, the macaw showed a good recovery without complications. The external fixator remained stable, enabling the bird to perch. The external fixator was removed after three weeks. Six months postoperatively, the macaw demonstrated normal utilization of its leg, with no evidence of recurrent joint dislocation and full functional recovery.

**Keywords:** Avian, Orthopedics, Transarticular, External fixation

# รายงานสัตว์ป่วย: การใช้การตรึงภายนอกแบบบานพับที่ระหว่างข้อต่อเพื่อรักษาข้อเคลื่อนหลุดบริเวณข้อเข่าในนกแก้วบลูแอนด์โกลด์มาคาว์

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## บทคัดย่อ

รายงานกรณีศึกษา นำเสนอแนวทางการรักษาภาวะข้อเข่าเคลื่อนหลุดในนกแก้วบลูแอนด์โกลด์มาคาว์ ด้วยการตรึงภายนอกแบบบานพับที่ระหว่างข้อต่อ โดยนกมาคาว์เพศผู้ อายุ 11 ปี ได้เข้ารับการตรวจรักษาเนื่องจากอาการไม่สามารถลงน้ำหนัก ขาขวา ร่วมกับอาการบวมของข้อ ซึ่งเกิดขึ้นภายหลังการเกิดอุบัติเหตุเป็นระยะเวลา 3 วัน การรักษาเบื้องต้นด้วยวิธีการประคบประคอง อันประกอบด้วยการดึงข้อให้เข้าที่ การพัก และการให้ยาต้านการอักเสบ ไม่สามารถฟื้นฟูการทำงานและความมั่นคงของข้อต่อได้ จึงพิจารณาให้ทำการรักษาด้วยวิธีการผ่าตัด ในการผ่าตัด ได้เลือกใช้อุปกรณ์ Fixateur Externe du Service de Santé des Armées (FESSA) ร่วมกับอุปกรณ์ตรึงภายนอกแบบบานพับ เพื่อให้สอดคล้องกับลักษณะทางกายวิภาคและชีวกลศาสตร์ที่จำเพาะของข้อเข่าในนก วิธีการดังกล่าวนี้ มุ่งเน้นการสร้างความมั่นคงให้แก่ข้อต่อ พร้อมทั้งคงไว้ซึ่งช่วงการเคลื่อนไหวที่เหมาะสมระหว่างการฟื้นตัวของข้อ ภายหลังการผ่าตัด นกมีการฟื้นตัวที่ดี โดยไม่พบภาวะแทรกซ้อนที่รุนแรง เครื่องยึดติดภายนอกมีความมั่นคงและช่วยให้สามารถเกาะคอนได้ มีการถอดเครื่องยึดติดภายนอกเมื่อครบ 3 สัปดาห์ และภายหลังการผ่าตัดเป็นเวลา 6 เดือน พบว่า นกมาคาว์สามารถกลับมาใช้งานขาได้เป็นปกติ โดยไม่มีภาวะข้อเคลื่อนหลุดซ้ำ

คำสำคัญ: นก สัตยกรรมกระดูก ระหว่างข้อต่อ การตรึงภายนอก

## Introduction

In avian species, the femorotibial joint serves as the weight-bearing element of the stifle, facilitating flexion and extension of the crus with restricted rotation (Harris et al., 2007). Femorotibial joint luxation is prevalent in avian species (Azmanis et al., 2014). Luxation, or dislocation, refers to the complete displacement of a bone from a joint with no contact between the two articular surfaces (Simonis et al., 2024). In avian species, femorotibial joint luxation typically results from trauma; specifically, direct injury to the surrounding soft tissues compromises its stabilizing structures, leading to abnormal adduction or rotation of the limb (Bowles and Zantop 2002). Moreover, the muscular contraction frequently noted after dislocation may obstruct its rectification. Injury to muscles and nerves can result in paresis or paralysis of the limb, causing difficulties with ambulation, perching, or gripping (González 2009).

The therapeutic modalities for femorotibial joint luxation include external coaptation and surgical intervention. External coaptation alone carries significant disadvantages. In many species, especially psittacine birds (Simonis et al., 2024), the presence of the inguinal web, located in the ventral region of the thigh where the leg joints the body at the femur, complicates the procedure as it nearly reaches the level of the stifle (González 2009). This restricts the external coaptation's ability to extend proximally over the femorotibial joint, leading to a bandage that functions as a fulcrum if improperly positioned (Simonis et al., 2024). Therefore, these limitations often necessitate surgical intervention.

Surgical intervention in avian species predominantly employs external skeletal fixation utilizing a FESSA system. The FESSA (Fixateur Externe du Service de Santé des Armées) is a lightweight external skeletal fixator intended for intricate fractures of the hands and feet in human

medicine (Hatt et al., 2007). The hinges comprise two separate elements connected by a screw. The maximum attainable angle is 180 degrees, whereas the minimum is roughly 40 degrees (Azmanis 2011). Consequently, the FESSA system was suitable for avian species.

The previous example reports used external fixation with open joint reduction and co-fixation. One, the blue-and-gold macaw described an open femorotibial joint reduction stabilized with transarticular pins from the proximal tibiotarsus to the distal femur, secured with bone cement as a bridging bar, resulting in arthrodesis of the right femorotibial joint and an acceptable outcome (Simonis et al., 2024). Another study, the surgical approach for the pigeons right femorotibial joint, involves fixing the artificial lateral collateral ligament, followed by applying the FESSA hinged linear external skeletal fixator (Azmanis 2011). Postoperative outcomes and complications, including intracapsular and soft tissue damage leading to osteoarthritis and lameness, contribute to pododermatitis (Azmanis 2011).

The lack of data evaluating hinged external fixation as a standalone treatment highlights the need for further research to assess its efficacy and safety in different clinical settings. This case report presents the outcomes of using hinged transarticular external fixation as a primary surgical approach for managing femorotibial joint luxation in a blue-and-gold macaw, including preoperative management, surgical technique, postoperative care, and long-term follow-up. This study aims to contribute to the limited body of knowledge for this technique and explore its potential as a simple, minimally invasive, and effective treatment with favorable outcome.

## Case description

### Presentation and clinical findings

An 11-year-old, 1.1 kg male blue-and-gold macaw (*Ara ararauna*) was presented with a history of acute non-weight bearing on the right leg (Figure 1), with progressive joint swelling for three days following a suspected fall. The bird was reluctant to perch and demonstrated visible discomfort upon manipulating the affected limb.

Clinical examination revealed the right femorotibial joint to be swollen, with crepitus and instability upon manipulation, pain on palpation, and a positive deep pain

response. Radiographs revealed laxation of the right femorotibial joint with complete anterior dislocation, without any associated fractures, accompanied by soft tissue swelling (Figure 2).

The blood profile revealed that the morphology of red blood cells was normal. The morphology of white blood cells showed heterophil toxic granules present at a level of 1+ (100% toxicity). The estimated white blood cell count was  $41.6 \times 10^6/\text{L}$ . The packed cell volume was 36, the plasma protein level was 4.9, and the plasma exhibited a clear color (Table 1).



**Figure 1.** The macaw exhibited non-weight bearing on the right leg.



**Figure 2.** Radiographs depicting craniocaudal (A) and mediolateral (B) views reveal laxation of the right femorotibial joint (white arrow). The mediolateral view showed complete right femorotibial joint dislocation with cranioproximal luxation of the tibiotarsus with no associated fracture, accompanied by soft tissue swelling.

**Table 1.** The pre-operative blood profile included white blood cell counts and serum biochemistry results.

White blood cell counts		
Parameter	Result	Reference range*
Band heterophil	0	0 %
Segmented heterophil	85	50-75 %
Lymphocyte	12	23-53 %
Monocyte	3	0-1 %
Eosinophil	0	0 %
Basophil	0	0-1 %
Blood chemistry		
Parameter	Result	Reference range**
AST	1733	105-324 U/L
BA	< 35	7-60 umol/L
CK	5074	101-300 U/L
UA	5.0	2.9-10.6 mg/dL
GLU	2477	225-330 mg/dL
CA	10.5	8.2-10.9 mg/dL
PHOS	5.4	2.0-12.0 mg/dL
TP	4.2	2.6-5.0 g/dL
ALB	2.5	1.1-2.5 g/dL
GLOB	1.7	0.8-1.9 g/dL
K <sup>+</sup>	6.1	2.0-5.0 mmol/L
NA <sup>+</sup>	157	140-165 mmol/L

Note: \*Reference ranges for white blood cell counts from the exotic animal formulary, 5<sup>th</sup> edition; \*\*Reference ranges of serum parameters analyzed by VETSCAN VS2 Chemistry Analyzer.

Abbreviations: AST, Aspartate aminotransferase; BA, Bile acid; CK, Creatine Kinase; UA, Uric acid; GLU, Glucose; CA, Calcium; PHOS, Phosphorus; TP, Total protein; ALB, Albumin; GLOB, Globulin; K<sup>+</sup>, Potassium; NA<sup>+</sup>, Sodium.

### Initial management attempt

The bird had a normal appetite and vocalization, but activity levels decreased due to difficulty bearing weight on one limb. Evaluating the bird's degree of lameness assessment using a standardized scale ranging from 0 to 5 (Table 2) (Anderson et al., 2002), evaluating pain at preoperative, postoperative, and post-fixator removal

time points. In this case, the bird was assigned a grade of 5 before surgical intervention.

An initial closed reduction attempt under sedation failed to maintain joint stability, leading to a decision for surgical intervention using a FESSA hinged linear transarticular external fixator (HLTEF).

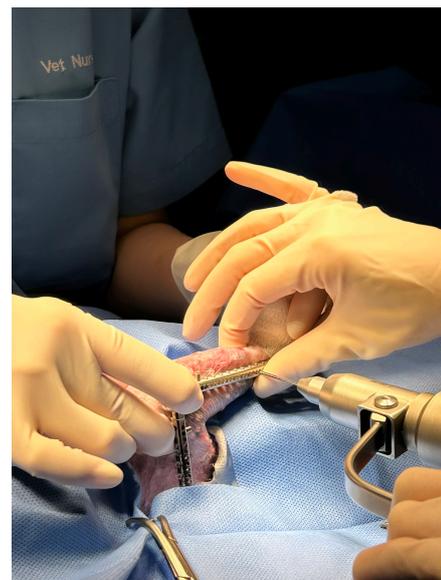
**Table 2.** Modified lameness grading (Anderson et al., 2002).

Score	Degree of lameness
0	Normal leg or wing function
1	Subtle, intermittent weight-bearing lameness or wing droop
2	Subtle, consistent weight-bearing lameness or wing droop
3	Obvious weight-bearing lameness or wing droop
4	Intermittent non-weight bearing lameness or wing droop
5	Consistent non-weight bearing lameness or wing droop

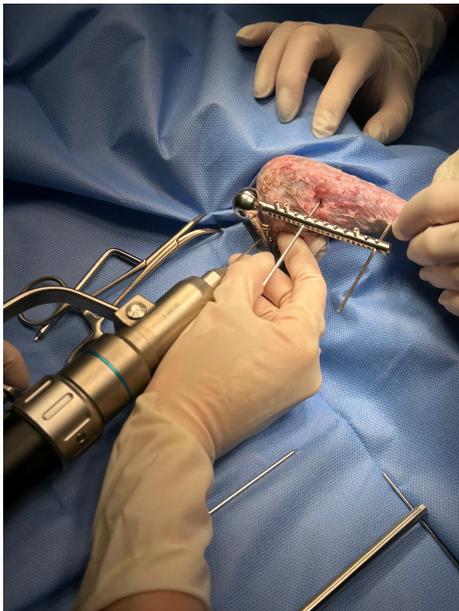
### Anesthesia and surgical procedure

Midazolam, butorphanol, and ketamine were administered as a singular intramuscular injection. Midazolam was administered intramuscularly at a dosage of 3 mg/kg (Carpenter and Marion 2018) for sedation and anxiolysis. Additionally, butorphanol was administered intramuscularly at a dosage of 0.2 mg/kg for analgesia (Carpenter and Marion 2018). Ketamine was also administered intramuscularly at a dosage of 5 mg/kg to induce anesthesia (Carpenter and Marion 2018). Isoflurane was administered via a size No. 5 endotracheal tube to sustain the anesthetic state.

The dislocated joint was manually reduced in a sterile manner prior to stabilization with a hinged transarticular external fixator while the patient was positioned in dorsal recumbency (Figure 3). A hinge was connected to two FESSA tubes controlling flexion at 70° and two 75 mm FESSA fixators compatible with 8 mm hinges and screws. A pin was inserted into the tibiotarsus, with the hinge aligned at the same elevation as the femorotibial joint. The initial 1.5 mm stainless steel pin was inserted distally into the tibiotarsus (Figure 4). Subsequently, a second pin was inserted proximally into the tibiotarsus. Two trans cortical pins were inserted into the femur, one proximally and one

**Figure 3.** A surgical position in dorsal recumbency.**Figure 4.** Place a pin at the distal tibiotarsus and position the hinge at 70°. The hinge was positioned at the same level as the femorotibial joint.

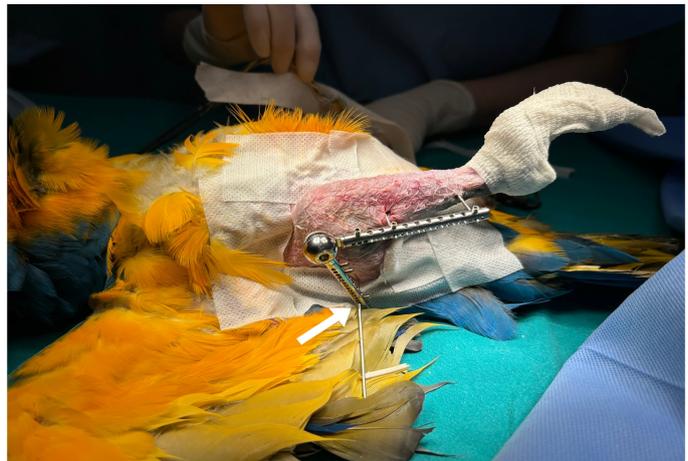
distally (Figure 5). All pins were interconnected through a FESSA tube system equipped with a unidirectional hinge, secured with screws, to ensure controlled joint stability and mobility.



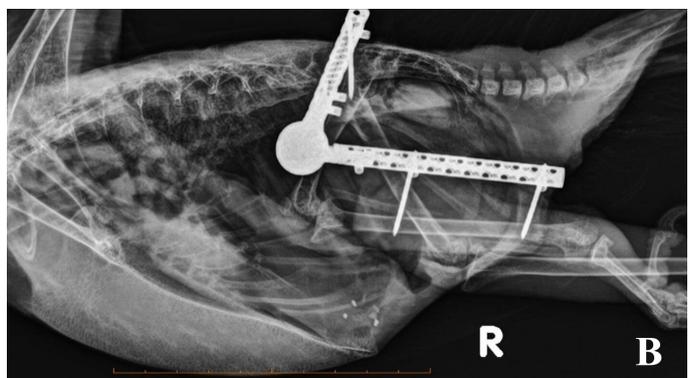
**Figure 5.** Proceeding with femoral pin insertion.

### Post-operative verification

Radiographic verification of the proximal femur pin should be acquired (Figure 6) to confirm that the pin insertion depth is adequate prior to performing the pin cut and to confirm proper bone alignment (Figure 7).



**Figure 6.** The proximal femur pin (white arrow) should be placed to ensure that the pin insertion depth is appropriate prior to executing the cut on the pin.



**Figure 7.** Postoperative craniocaudal (A) and mediolateral view (B) radiographs showing the realignment of the right femorotibial joint after hinged external fixation.

### Postoperative care/outcome

A ceftiofur crystalline free acid (Excede®, Zoetis) dose of 50 mg/kg was administered intramuscularly every 4 days for infection control. This treatment was continued for two injections. For pain control, a robenacoxib dose of 10 mg/kg was administered intramuscularly every week.

Postoperative care involved placing the bird in a restricted enclosure with perches in cage rest, and a collar was applied to prevent biting at the external fixation site (Figure 8). The postoperative management plan included limiting the bird to cage rest with a perch. Magnetotherapy, which is a non-invasive alternative medicine technique that uses magnetic fields, was administered twice daily for one week to reduce soft tissue inflammation and pain, and weekly wound examinations were conducted. One week postoperatively, the bird displayed a normal appetite and

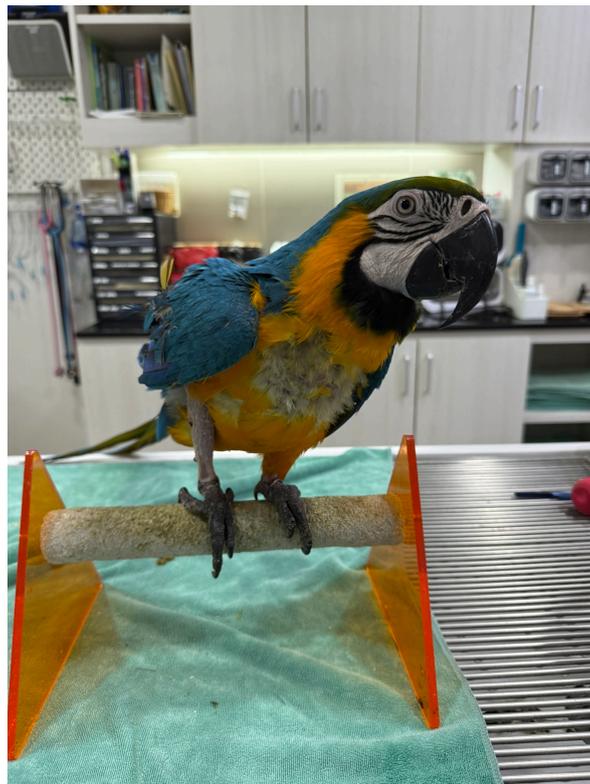


**Figure 8.** Postoperatively, the bird was placed in a restricted enclosure with a perch for cage rest and was fitted with a collar.

was able to grasp the perch in a typical position; however, it exhibited subtle and intermittent weight-bearing lameness, which was assessed as grade 1 on the lameness scale. There was no evidence of inflammation at the wound and no pin site infection (Figure 9). By the second week, the macaw was partially weight-bearing, stable in perching, and had a lameness score of 1. At the follow-up three weeks after surgery, the external fixator was removed in the third week (Figure 10), the lameness score remained at 0, indicating complete recovery. Subsequently, the bird regained full limb function with no recurrence of femorotibial luxation. Postoperatively at six months, the bird demonstrated the ability to grasp fruit and perch in a normal position, indicating functional recovery and a favorable outcome (Figure 11).



**Figure 9.** One week postoperatively, the bird was able to grasp the perch in a normal position.



**Figure 10.** Three weeks postoperatively, the bird was able to grasp the perch in a normal position after the removal of the external fixation.



**Figure 11.** Six months postoperatively, the bird demonstrated the ability to grasp fruit (A) and perch in a normal position (B), indicating functional recovery.

## Discussion

Luxation of the femorotibial joint in birds generally results from trauma (Bowles and Zantop 2002). There is limited clinical experience with the surgical management of luxation or dislocations of the femorotibial joint (Orosz et al., 2023). The luxation occurs craniolaterally, craniomedially, caudolaterally, and caudomedially with concomitant damage to the collateral and cruciate ligaments, while meniscal damage is rarely diagnosed (Azmanis et al., 2014).

The FESSA system was initially developed for complex fractures in human medicine and has been successfully adapted for use in veterinary practices, particularly in small animals like dogs, cats, and rabbits (Hatt et al., 2007). Hinge can be connected to two FESSA tubes, resulting in a FESSA hinged linear transarticular external fixator (Azmanis et al., 2006).

Immobilization of the legs aims to achieve periarticular fibrosis and stabilize the femorotibial joint (Luparello et al., 2011). Periarticular fibrosis may develop within three days following injury, potentially impeding complete recovery from the luxation and increasing the risk of joint ankylosis (Azmanis et al., 2011). In addition, it is crucial to employ precise surgical techniques to prevent permanent ligamentous laxity resulting from improper anatomical repositioning or inadequate relaxation of surrounding tissues (Azmanis et al., 2011). Surgical intervention as soon as possible after injury is crucial to optimize the prognosis and ensure favorable outcomes.

The normal standing angle for avian species remains critical in surgical recovery. Perching-joint angles varied between birds of the same species. Thus, the radiographic perching-joint angles observed in our study are guidelines to approximate joint angles before surgery (Bonin et al., 2007). In another study, the femorotibial angle was evaluated in the healthy male eclectus parrot, resulting in a measured angle

of 60 degrees from lateral standing radiographs (Harris et al., 2007). Although in the blue-and-gold macaw there was no standardized reference for the normal femorotibial joint angle. In this study, it was feasible to approximate this angle based on the proportional dimensions of a normal limb.

Several surgical techniques are available for correcting femorotibial joint luxation, depending on the severity of the injury, patient size, and different complications. Relevant studies include one that found conjoined intramedullary pin placement in a Solomon Island eclectus parrot increased the risk of trauma and osteoarthritis (Harris et al., 2007).

Furthermore, a documented case involved a 3-month-old umbrella cockatoo (*Cacatua alba*) with a right medial femorotibiotarsal subluxation, using a modified lateral extracapsular suture technique, incorporating a self-tapping cortical screw in the lateral femoral condyle and a hole through the proximal tibiotarsus (McRee et al., 2017). Radiographic evaluations 209 days postoperatively revealed severe osteoarthrosis of the femorotibial joint and persistent implant migration. After removing the screw, however, ankylosis had already developed at a physiologic perching angle (McRee et al., 2017). In this case, an essential aspect of transarticular external skeletal fixation alone is to avoid penetrating the joint to minimize the risk of osteoarthritis. The joint should remain unopened, and the reduction should be maintained to prevent the development of osteoarthritis and ankylosis.

However, using hinged transarticular external fixation in small birds is a limitation. The small size of these birds makes the placement of the fixation device challenging, which may lead to additional trauma. Additionally, the weight of the fixation apparatus may be excessive. Therefore, the size of the birds affects the surgical procedures.

Establishing the appropriate joint angle was crucial, as improper fixation in an overextended or overflexed position can impair normal limb function, alter biomechanics, and increase the risk of complications such as pododermatitis (McRee et al., 2007). Other complications include pin site infection, muscle contraction, and muscle atrophy. Moreover, the role of the tibial and fibular nerves in femorotibial joint injuries can lead to temporary or permanent dysfunction, affecting mobility and perching ability (Chinnadurai et al., 2009). Stabilizing a reduced femorotibial joint luxation with a transarticular external skeletal fixation at a normal perching angle until periarticular fibrosis occurs can result in a more enhanced restoration of limb usage than external coaptation alone (McRee et al., 2017). In this case, we did not observe pododermatitis, any pin site infections, or signs of nerve damage. Limitations of this case report include a singular case, the absence of histological assessment of the joint or ligaments, and a brief follow-up period despite a 6-month evaluation.

In conclusion, this case demonstrates that hinged external fixation can provide joint stability and functional recovery in large psittacine birds, with minimal complications, suggesting it is a promising alternative to more invasive or immobilizing surgical techniques. Further research should focus on refining these interventions, determining the normal standing angle for avian species, assessing long-term joint mobility after hinged fixation in different avian species, and expanding our understanding of orthopedic care in avian species to enhance outcomes significantly.

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