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Application of Hinged Transarticular External Skeletal Fixator (HTAESF) for Proximal Tibial Physeal Fracture in a Dog

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Abstract : An 8-month-old, 3.5 kg intact female Toy Poodle was presented for non-weight-bearing lameness on left hindlimb. In radiological testing, left proximal tibal type II Salter-Harris physeal fracture and fibular fracture were seen. Following open reduction, the fracture was stabilized with cross-pins, tension band wires, and a hinged transarticular external skeletal fixator (HTAESF). The range of the HTAESF was increased to 25° at 7 days post-surgery and to 70° at 14 days post-surgery. The HTAESF was removed 3 weeks after surgery. At 6 weeks post-surgery, the fracture was successfully healed with no complications and the patient recovered a normal gait. Seven months post-surgery, the patient had a normal gait and a normal stifle joint range of motion compared to the contralateral normal limb. This is a case in which the combined use of cross-pins, tension band wires, and HTAESF was successful for treatment of a proximal tibial physeal fracture in a dog. It is thought that these methods are beneficial for stability of fracture site and recover of joint's normal range of motion through early joint movement.

Key words **:** hinged, transarticular, external skeletal fixator, physeal fracture.

Introduction

Physeal fractures occur frequently in young animals due to the relative weakness of the cartilaginous growth plates compared to the bones (4). Physeal fractures account for 30% of all long bone fractures, with proximal tibial physeal fractures accounting for 3.7% of all physeal fractures (11).

Proximal tibial physeal fractures usually occur due to the contraction of the quadriceps muscle group against stifle flexion (12), resulting in a proximal distractive force on the tibial tuberosity. The proximal physis fragment (in proximal tibial physeal fractures) is commonly displaced in cranioproximal-caudodistal angulation of the proximal tibial plateau, resulting in a high tibia plateau angle (6,12). This situation may put the animal at high risk forarupture of cranial cruciate ligament, if the fracture is not repaired (14). For this reason, surgical repair is recommended (6,14).

To repair a fracture of the proximal tibial physis, 2-3 K-wires and tension band wire are generally used. However, wire breakage and pin bending could occur if patient activity is not controlled (7). For these reasons, addition stability may be needed for a successful surgical outcome.

Immobilization, such as a rigid transarticular external skeletal fixator or an external coaptation, can be used to add more stability. However, this may restrict the joint's range of motion, damage the articular cartilage, reduce muscle mass, and delay recovery of the patient's normal range of motion (1,3).

To resolve these problems, a hinged transarticular external skeletal fixator (HTAESF) can be used to add stability to the periarticular fracture and aid in the recovery of the joint's range of motion (5,8). HTAESFs provide joint stabilization while maintaining relative freedom of joint movement (2). This permits supported healing of the damaged structures, while at the same time avoiding the deleterious effects of prolonged joint immobilization (8).

In this case, we report the successful use of conventional K-wire, tension band wire, and a HTAESF for stability and maintenance of the joint's range of motion in the repair of a proximal tibial physeal fracture.

Case

An 8-month-old, 3.5 kg intact female Toy Poodle was presented for non-weight bearing lameness on her left hindlimb after trauma caused by falling from the owner's shoulder 17 days previously. Upon physical examination,

the patient had pain when the left hind limb was palpated. Neurologic and blood tests were normal. In radiologic tests, a left proximal tibal type II Salter-Harris physeal fracture and fibular fracture were seen (Fig. 1A and B). It was considered that, as the patient was active, conventional cross-pinning using K-wire and tension band wire could be broken during the recovery period. Therefore, in addition to the two conventional methods, HTAESF was used to add stability to the periarticular fracture and limit the range of joint motion in order to

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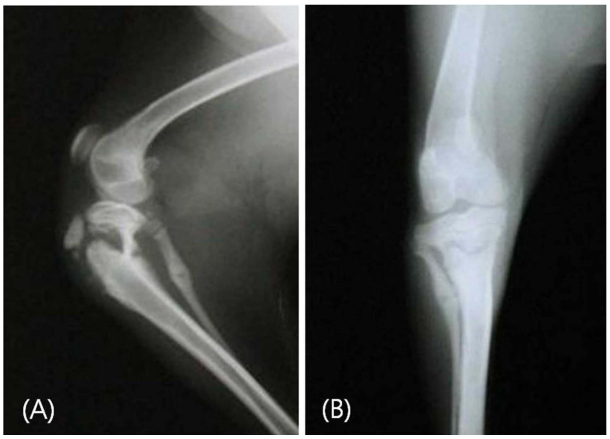

Fig 1. A pre-operative radiographic view showing the proximal tibal type II Salter-Harris physeal fracture and the fibular fracture, along with the cranioproximal-caudodistal angulation of the proximal tibial plateau. Mediolateral view (A), craniocaudal view (B).

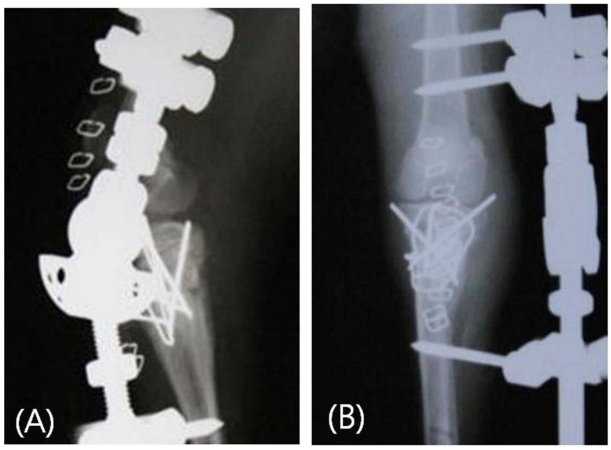

Fig 2. Immediate post-operative radiographic view showing that the fracture site was adequately reconstructed and that the hinged transarticular external skeletal fixator (HTAESF) was well applied. Mediolateral view (A), craniocaudal view (B).

enhance the recovery of the normal range of joint motion.

Prior to surgery, cefazolin 22 mg/kg and tramadol 3 mg/kg were given by IV, and butorphanol 0.2 mg/kg was given by IM. Epidural anesthesia was done, and the patient was clipped. Using a cranio-medial approach, the fracture site was revealed and a fibrin clot in the fracture gap was removed. The fracture was gently reduced. Three K-wires were inserted in the cross-pinning, and tension band wires were placed routinely. Two positive profile end-threaded pins were placed on the lateral aspect of the femur and tibia. The HTAESF frame was then placed. In post-operative care, 22 mg/kg cefazolin, 0.1 mg/kg meloxicam, and 1 mg/kg ranitidine were given for approximately 1 week.

In the immediate post-operative radiographic tests, the fracture was adequately reconstructed and the HTAESF was well applied (Fig 2). At the 3-week follow-up examination, the implants were well-maintained and, to provide more joint mobility, the HTAESF was removed. After 6 weeks, the fracture appeared to be healing well, and the implants were removed (Fig 3A and B). Seven months after surgery, radiographic tests showed that the fracture site was completely healed (Fig 3C and D), and the patient had a normal gait and did not have any surgery-related complications.

Discussion

In proximal tibial physeal fractures, the plateau angle tends to elevate because of the caudo-lateral displacement of the proximal fragment (14).

If the proximal physeal epiphysis reunites to the tibia in a caudo-laterally displaced position, the increased tibial plateau slope that results will place greater strain on the cranial cruciate ligament (14). Therefore, surgical repair is recommended. In one study, the normal plateau angle of dogs was shown to be about 22.6 ± 4.5° (13). The plateau angle of the contralateral normal limb is 25° and the affected limb is 50°. The corrected plateau angle of the affected limb is 20° (Table 1), and

Table 1. Change of tibial plateau angle

Limb	Pre-op	Immediately post-op	7-months post-op
Affected	50°	20°	20°
Contralateral	25°	25°	25°

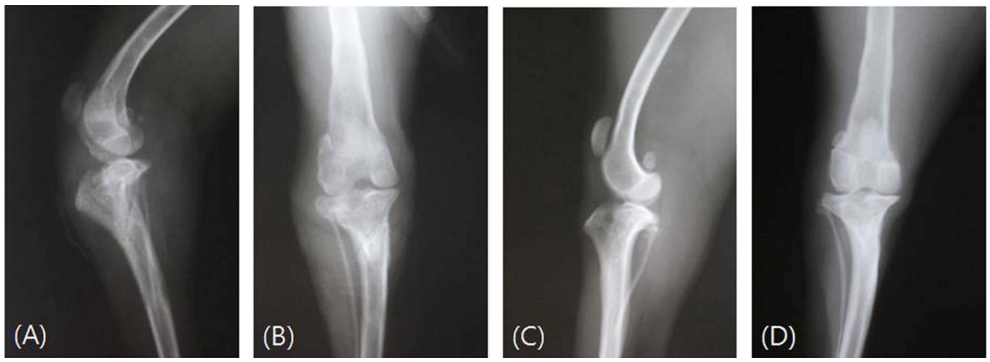

Fig 3. Post-operative radiographic view after 6 weeks. The fracture was healing well and the implants were removed (A and B). After 7 months, the fracture site was completely healed and the physis was closed (C and D).

we believe that sufficient surgical correction was archived to prevent any rupture of the cranial cruciate ligament. The patient now has a normal gait and there have been no cranial cruciate disease related complications.

To place the HTAESF, two or three positive profile end-threaded pins were inserted on the lateral aspect of the femur and tibia. Then, through the passive range of motion of the stifle joint, we decided that the plane of motion of the stifle joint and the pointed centre of rotation that has zero velocity during the passive range of motion of stifle joint parallel to the plane of motion. We visualized the joint parallel to the plane of motion in order to identify the approximate axis of the joint's rotation. The rotational center of the HTAESF was positioned on this point (9).

The normal stifle range of motion is known to be 140° (10). The contralateral stifle joint's range of motion was 160° in full extension and 40° in full flexion in this patient. It is known that as little as 10° of movement in a joint promotes preservation of articular cartilage health (9), therefore, we set the range of the HTAESF at approximately 15° so as to recover a fuller range of motion more quickly. The range of the HTAESF was increased to 25° at 7 days post-surgery and to 70° at 14 days post-surgery. After 21 days, the HTAESF was removed. The extension angle was recovered to normal, but the flexion angle recovery was only 80% of the normal flexion angle at 35 days post-surgery. This is likely because the restriction of the stifle flexion prevented deviation of proximal tibial fragment by contraction of the patella tendon. Seven months after surgery, the patient recovered a full range of motion compared to the contralateral normal stifle joint.

This paper describes the combined use of cross-pinning, tension band wire, and a HTAESF for the treatment of a proximal tibial physeal fracture in a young, active dog.

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개의 근위 경골 성장판 골절에서 경첩 관절경유 외고정의 적용

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요 약 : 8개월령, 3.5 kg의 중성화하지 않은 토이 푸들이 왼쪽 다리의 체중 부중을 하지 않는 파행으로 내원하였다. 방사선 검사에서, 왼쪽 경골 근위부의 Salter-Harris II 형 성장판 골절과 비골 골절이 발견되었다. 교차핀, 긴장철사와 경첩 관절경유 외고정을 통해 근위 경골의 성장판 골절을 정복 하였다. 수술 후 1주째까지 경첩관절경유 외고정의 관절 가동변위를 25°, 수술 후 2주째까지 70° 까지 증가 시켰으며 수술 후 3주째 경첩 관절경유 외고정을 제거하였다. 수술 후 6주차에 골절은 합병증 없이 성공적으로 치유되었고 환자는 정상보행을 회복하였다. 수술 후 7개월째 환자는 정상적으로 보행을 하였으며, 반대쪽 정상다리와 비교하였을 때 관절의 가동범위는 동일 하였다. 본 증례는 근위 경골의 성장판 골절이 있는 미성숙견에서 교차핀, 긴장철사 및 경첩 관절경유 외고정을 이용하여 성공적으로 치료한 사례이다. 이러한 방법은 수술 후 골절정복의 안정성 및 조기 관절운동을 통한 정상 관절범위의 회복에 유용하게 사용 될 수 있을 거라 사료된다.

주요어 : 경첩, 관절경유, 외고정, 성장판 골절