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Tibial Tuberosity Advancement for Partial Rupture of Cranial Cruciate Ligament in Two Dogs

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Abstract : Two dogs (Case 1 weighing 27 kg, Case 2 weighing 42 kg) were referred with hindlimb lameness. On physical examination, there was moderate pain on stifle joint testing and mild cranial translation on cranial drawer testing in Case 1. This translation was obvious when the patient was under general anesthesia. Case 2 showed discomfort during hyperextension of the stifle joint, but no significant cranial translation under general anesthesia. Joint effusion was detected on radiography in both cases. Based on physiologic and radiographic examinations, cranial cruciate deficiency was suspected, so exploratory arthroscopy was performed. Arthroscopy revealed partial rupture of the cranial cruciate ligament (CrCL) in both cases. Case 1 showed unstable partial CrCL rupture, while Case 2 had stable CrCL rupture. Tibial tuberosity advancement (TTA) was carried out as planned. Seroma occurred one week postoperatively in Case 2, and was removed surgically. The patients returned to satisfactory weight-bearing ambulation 5 months after initial surgery. Based on the results of these cases, TTA appears to be a useful procedure in the treatment of CrCL partial rupture.

Key words **:** arthroscopy, tibial tuberosity advancement, cranial cruciate ligament, partial rupture, dog.

Introduction

Rupture of the cranial cruciate ligament (CrCL) is one of the most common causes of progressive osteoarthritis of the stifle joint (6). Various surgical options for CrCL rupture have been reported which result in good limb function and clinical outcomes after surgery (16). Of these, extracapsular and intracapsular techniques have traditionally been used to treat rupture of the CrCL in orthopedic veterinary medicine. The extracapsular technique uses suture material and wire to stabilize stifle joints affected by periarticular fibrosis (5,16). The intracapsular technique entails CrCL reconstruction using autogenous tissues (1,16).

Although these surgical techniques demonstrate satisfactory outcomes, the concept of alternative surgical techniques has been recently suggested by establishing dynamic stability of the ruptured CrCL in the stifle joint by tibial osteotomy. Variety osteotomy techniques have been developed since Slocum first described cranial tibial wedge osteotomy (10). Tibial tuberosity advancement (TTA), which was developed recently, is widely used to repair rupture of the CrCL. TTA seeks to neutralize cranially tibiofemoral shear force by altering the relative alignment of the patellar tendon to the tibial plateau (11).

Rupture of the CrCL is generally diagnosed by physical and radiographic examination (16). However, in cases of partial rupture of the CrCL, diagnosis is difficult by general examination. These cases require arthroscopy and magnetic resonance imaging (MRI) to confirm partial tear of the CrCL and pathology of the stifle joint (12,16).

The aim of this case study was to report the results of tibial tuberosity advancement for partial cranial cruciate ligament rupture, as confirmed by arthroscopy in two dogs.

Case

A 7-year-old, 27 kg, female Siberian Husky (Case No. 1) and a 3-year-old, 42 kg, male Rottweiler (Case No. 2) presented for evaluation of weight-bearing lameness of the left and right hindlimbs, respectively. The lameness had been present for 2 months as the result of a falling trauma during training in Case 1. The lameness in Case 2 had occurred 3 months prior due to an unknown cause. Both dogs demonstrated temporary clinical improvement after administration of nonsteroidal anti-inflammatory drugs. However, the patients continued to have problems with hindlimb lameness. On physical examination, there was moderate pain at the stifle joint and mild cranial translation on cranial drawer test in Case 1. This translation was obvious when the patient was under general anesthesia. Case 2 showed discomfort during hyperextension of the stifle joint, but no significant cranial translation under general anesthesia. The results of laboratory blood tests were within normal limits. Radiographs revealed joint swelling (Case 1 and 2) and mild osteophyte formation (Case 2) (Fig 1A, B and 2A, B). Case 2 exhibited

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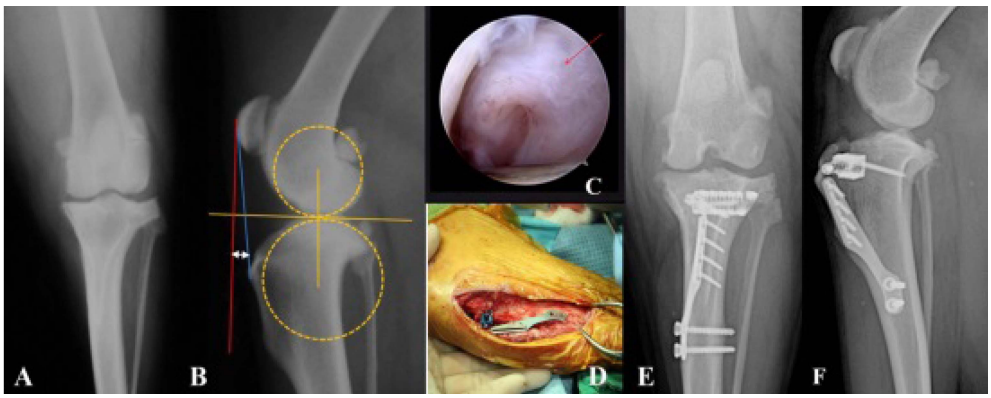

Fig 1. Radiographs (A, B, E, F), arthroscopy image (C), and intraoperative view (D) of Case 1. Preoperative radiograph (A, B) of the left stifle mild joint showing joint swelling; PTA is measured at 90° by using the common tangent method and the arrow indicates cage size (6 mm). Arthroscopy image revealing the stretched cranial cruciate ligament which led to partial rupture of the unstable cranial cruciate ligament (red arrow) (C). The cage and TTA plate is placed in the osteotomy site (D). Postoperative radiograph at 4 months (E, F).

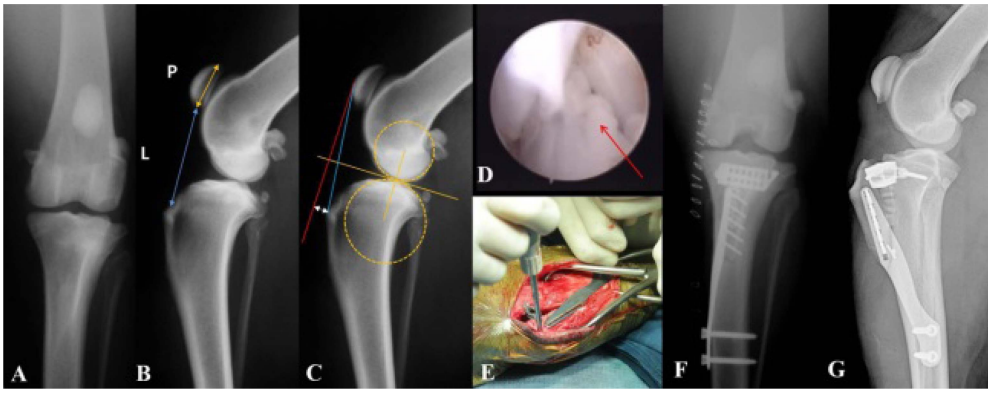

Fig 2. Radiographs (A, B, C, F, G), arthroscopy image (D), and intraoperative view (E) of Case 2. Preoperative radiograph (A, B) of the right stifle joint, showing mild joint swelling, osteophyte, and patella alta (P:L = 2.08). PTA is measured at 94° by using the common tangent method and the arrow indicates the cage size (9 mm) (C). Arthroscopy image revealing partial tearing of the cranial cruciate ligament (red arrow) (D). The tibial crest is transposed 5 mm distally for the correction of patella alta (E). Postoperative radiographs taken immediately (F) and at 4 months (G).

patella alta (P:L = 2.08) (Fig 2B) (7). Based on physiologic and radiographic examination, we tentatively diagnosed cranial cruciate ligament deficiency. Arthroscopy was performed to evaluate the cruciate ligament, articular surface, and menisci. Arthroscopy revealed partial rupture of the cranial cruciate ligament (CrCL) in both patients. Case 1 had an unstable partial CrCL rupture (Fig 1C), while Case 2 had a stable CrCL rupture (Fig 2D). All partial CrCL ruptures were removed by grasp forceps during arthroscopy.

The patients were premedicated with atropine (0.02 mg/kg SC, Atropine Sulfate Daewon®; Dae Won Pharm, Korea) and butorphanol (0.3 mg/kg IM, Butophan Inj®; Myung Moon Pharm, Korea). General anesthesia was induced using propofol (6 mg/kg IV, Anepol IN®; Ha Na Pharm, Seoul, Korea) and was maintained with isoflurane (Forane soln®, JW pharmaceutical, Korea) delivered in oxygen. Cephalexin (22 mg/kg IV q 2 hours, Methilexin Inj®, Union Korea Pharm, Korea) was also given at the time of induction. Lidocaine 2% (1 ml/4.5 kg, Lidocaine Hcl Dalhan Inj®, Dai Han Pharm, Korea) was administered in the lumbosacral space for epidural anesthesia.

The surgeries were performed with Kyon implants (Kyon Inc, Zurich, Switzerland) using standard surgical techniques (11). The common tangent method was used to determine the distance necessary to place the patella tendon at a 90-degree angle to the tibial plateau (4). The distance to advance in cage was 6 mm (Case 1) and 9 mm (Case 2). The limb was prepared for aseptic surgery. The patients were positioned dorsally on a table. After a medial proximal tibial approach, 7 drill holes were made on the tibial crest using an 8-hole guide for initialization of the fork. A TTA tension-band plate was seated after osteotomy at the tibial crest (Fig 1D and Fig 2E). The cages were secured with 2.4 mm screws in the osteotomy gap. In Case 2, the TTA plate was placed 5 mm distally for the patella alta. Furthermore, allogeneic cortical bone was placed within the osteotomy gap. The distal drill hole of plate was secured with 3.5-mm screws. The surgical incision was routinely closed in layers. Postoperative radiographs of both

patients documented the implant location and PTA angle (Case 1: 90º and Case 2: 94º) (Fig 1E, F and Fig 2F, G). The patients were placed in a cast and underwent physical therapy for 6 weeks. Seroma occurred at the surgical site one week postoperatively in Case 2, and was removed surgically. The patients returned to satisfactory weight-bearing ambulation 5 months after initial surgery.

Discussion

Tibial osteotomies for CrCL rupture have become more common in recent years. TTA is a recent development compared to other forms of tibial osteotomies (2,10). Montavon and Tepic introduced TTA in 2002 based on the human knee model and the theory that the patella tendon and the tibial plateau occur at a 90-degree angle to each other, and there is no cranial tibiofemoral shear force during weight bearing (11,14). Our cases were maintained at 90 ± 9 degrees after TTA procedures and showed improvement in clinical signs. In particular, TTA treatment is advantageous in stable partial rupture of the CrCL, such as in Case 2. Kim et al. evaluated tibial plateau-leveling osteotomy (TPLO) on femorotibial contact mechanics and stifle kinematics in the CrCL rupture of dogs. TPLO-treated stifles showed that the femorotibial contact area and peak contact pressures remained significantly smaller and were positioned more caudally on the tibial plateau compared to the normal stifle joint (8). In contrast, a study with TTA which was evaluated using the same method demonstrated that there were no significant differences in any contact mechanic and kinematic parameters between normal and TTA-treated stifles (9). TTA does not change the tibiofemoral articulation, whereas other tibial osteotomies do not. If stable partial rupture of the CrCL is confirmed, TTA is an optimal surgical procedure compared to other tibial osteotomies.

The patella alta in Case 2 was treated by fixed TTA plate distally and allogeneic cortical bone was placed in the bone defect. Cranial tibial closing wedge osteotomy (CTWO) in tibial osteotomies can be used to treat patella alta. However, CTWO has the disadvantages of patella baja, change in tibiofemoral articulation, and limb shortening (16). The standard surgical protocol recommends the application of bone graft into the gap after TTA (11). Autogenic bone is the gold standard for bone graft. However, autogenic bone is limited by insufficient supply, requiring a second surgery, and pain at the donor site. Allogeneic cortical bone has been used instead of autogenic bone. Although allogeneic cortical bone cannot provide the effect of osteogenesis and osteoinduction, it results in bone formation in the defect by providing mechanical strength and osteoconduction (3).

It may be difficult to diagnose CrCL rupture by physical examination. In a recent study which assessed the drawer test and tibial compression test for the diagnosis of CrCL rupture, these tests were not sensitive enough to detect rupture of the cranial cruciate, caudal cruciate or total cruciate ligament (13). Furthermore, with a partial rupture of the CrCL, if the drawer test is absent, it is more difficult to make an accurate diagnosis. These cases are easier to diagnose using alternative diagnostic methods such as arthroscopy and magnetic resonance imaging (MRI). Arthroscopy provides minimally invasive, low-morbidity magnification during the diagnostic and surgical process. Although there are insufficient studies regarding arthroscopy in veterinary medicine, a few have documented the advantage of arthroscopy compared to arthrotomy (16). A previous study comparing arthroscopy and arthrotomy suggested that arthroscopy may be more sensitive than arthrotomy for detection of meniscal pathology in cranial cruciate ligament rupture in dogs (15).

In our two cases, tibial tuberosity advancement was used to treat partial rupture of the cranial cruciate ligament in dogs. These ruptures were confirmed by arthroscopy. Our patients demonstrated satisfactory weight-bearing ambulation and no surgical complications after the surgery. Arthroscopy can be a sensitive tool to diagnose partial CrCL rupture in dogs. Based on the results of these cases, TTA appears to be a useful procedure in the treatment of partial CrCL rupture.

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경골조면 전이동술을 이용한 개에서의 부분 전십자인대 단열치료 2례

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요 약 : 두 마리 개가 (증례 1: 27 kg, 증례 2: 42 kg) 뒷다리 파행을 주증으로 내원하였다. 신체검사상, 증례 1은 무릎 검사 시 중증도 통증과 마취 상태에만 경골의 전위 증후을 보였고 증례 2는 과신전시 불편함을 호소하였으나 마취 전후 모두 전위 증후는 관찰되지 않았다. 방사선검사에서 두 증례 모두 관절 내 종창을 확인할 수 있었다. 위의 검사를 바탕으로 전십자인대 단열을 의심하고 관절경을 실시하였다. 관절상에서 증례 1은 불안정한 부분 전십자인대 단열을 증례 2는 안정화된 부분 전십자인대 단열로 진단하였다. 두증례 모두 경골조면 전이동술을 이용하여 치료 하였다. 증례 2에서 술 후 수술 부위에 장액종이 발생하여 수술적으로 제거하였다. 수술 5개월 후 두 증례 모두 임상증상이 개선되었다. 이 증례들을 바탕으로 경골조면 전이동술은 부분 전십자인대 단열에서 유용한 치료법으로 사료된다.

주요어 : 관절경, 경골조면 전이동술, 전십자인대, 부분단열, 개