

## Circular Tibial Tuberosity Advancement for Cranial Cruciate Ligament Rupture in a Dog

Cheol-Kyu Han, Jin-Su Kang, Dong-bin Lee, Hae-Beom Lee\*, Nam-Soo Kim and Su-Young Heo<sup>1</sup>

College of Veterinary Medicine, Chonbuk National University, Iksan 54596, Korea  
\*College of Veterinary Medicine, Chungnam National University, Dajeon 34134, Korea

(Received: August 13, 2019 / Accepted: October 13, 2019)

**Abstract :** A 8-year-old, intact female, 2.1 kg, yorkshire terrier dog was referred to Animal Medical Center, Chonbuk National University due to right hindlimb lameness. Orthopedic examinations revealed pain during extension and flexion on stifle joint, positive cranial drawer sign, positive tibial compression test and patella luxation. Radiography showed the cranial displacement of right tibia with mildly increasing the synovial volume. The surgical procedure involved radial osteotomy of the proximal tibia and fixation by 1.2 T-locking plate. At two weeks after surgery, the patient was able to weight-bearing and gait gradually improved. This case report describes circular Tibial Tuberosity Advancement (cTTA) surgical technique and the successful surgical repair of cranial cruciate ligament rupture a dog.

**Key words :** drawer sign, radial osteotomy, 1.2 T-locking plate, dog, tibial compression test.

### Introduction

Rupture of the cranial cruciate ligament is one of the most common causes of pelvic limb lameness in dogs (4,8). Cranial cruciate ligament injuries are commonly stabilized with extracapsular techniques or tibial osteotomy techniques. Among the tibial osteotomy techniques, the most common surgical procedures are Tibial Plateau Leveling Osteotomy (TPLO) and Tibial Tuberosity Advancement (TTA).

TPLO has been reported to functionally stabilize the stifle joint during weight bearing, neutralizing the cranial tibial thrust by reduction of tibial plateau angle. TTA has been reported to functionally stabilize the stifle joint during weight bearing by neutralizing the cranial tibial thrust by advancing the tibial tuberosity (1). The circular Tibial Tuberosity Advancement (cTTA) is a technique which integrates the principles of a TTA with the advantage of a radial osteotomy which has benefit of a continuous degree of tibial correction with compression improving stability and healing (6).

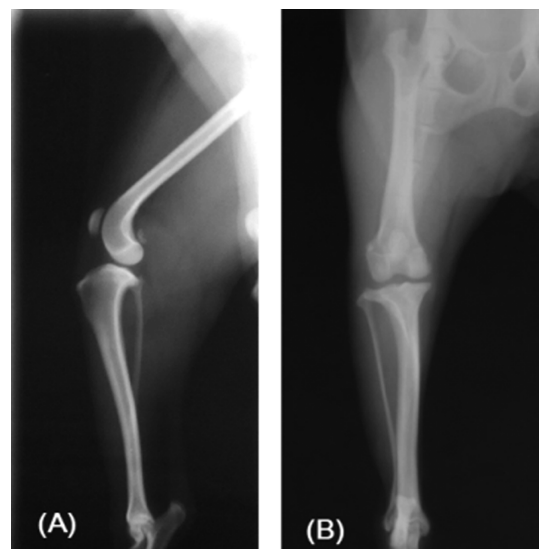
In the present case, we explained the cTTA technique, and, in this report, we describe the application of cTTA technique in acute cranial cruciate ligament rupture in a dog.

### Case

A 8-year-old, intact female, 2.1 kg, Yorkshire terrier dog was referred to the Animal Medical Center, Chonbuk National University due to right hindlimb lameness. The patient had right hindlimb lameness about one week before referred to Animal Medical Center. On orthopedic examinations, the patient revealed pain during extension and flexion on stifle

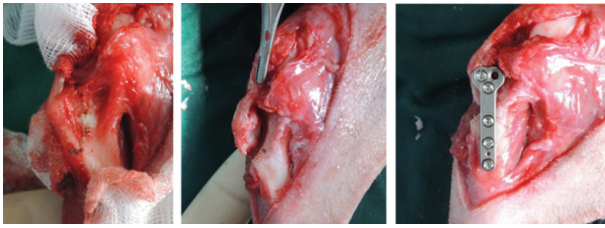
joint, positive cranial drawer sign, positive tibial compression test and patella luxation grade 2. No abnormalities were detected in blood test results. Radiography showed the cranial displacement of right tibia with mildly increasing the synovial volume (Fig 1). Based on the radiographic examination and orthopedic examinations, we considered that the patient had acute cranial cruciate ligament rupture.

For surgery, propofol (6 mg/kg) was used as the anesthetic induction agent and sevoflurane was used as the anesthetic maintenance agent. Cefoxitin (30 mg/kg) and tramadol (3 mg/kg) were used as premedication.



**Fig 1.** Preoperative radiographs. In mediolateral view (A), right tibia displaced cranially and the caudal fascial plane was displaced caudally, consistent with slightly increased the synovial volume of stifle joint. In mediolateral (A), and craniocaudal view (B), there were no enthesophyte and osteophyte.

<sup>1</sup>Corresponding author.  
E-mail : syheo@jbnu.ac.kr



**Fig 2.** Intraoperative surgical images. Craniomedial approach was performed to examine cranial cruciate ligament. The tibia radial osteotomy was performed as pre-planned surgery, and then fixed with 1.2 mm T-locking plate.

The patient was prepared and placed in dorsal recumbency. The incision arcs distally over the medial femoral epicondyle to the proximal medial tibia. A radial osteotomy was performed oriented parallel to the long axis of the tibia at the level of the tibial tuberosity. The tuberosity was rotated, cranially and proximally along the tibia, the amount of rotation based on pre-operative measurements. The osteotomy was reduced in compression and secured with a 1.2 T-locking plate (Fig 2).

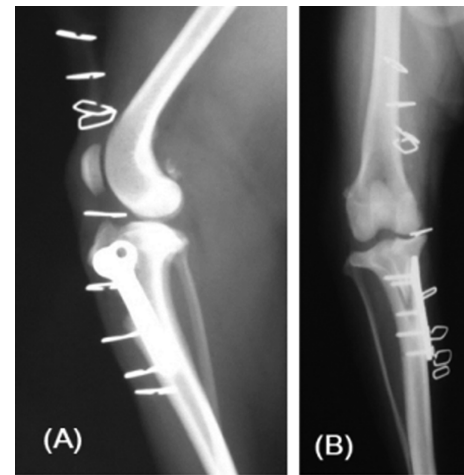
Postoperative medications were cefoxitin (30 mg/kg) and tramadol (3 mg/kg). The patient was also treated with carprofen (2.2 mg/kg), famotidine (0.5 mg/kg). After surgery, the patient was maintained Robert-johns bandage for 3 days. Two weeks after surgery, the patient visited the hospital for re-examination. The patient was able to weight-bearing and walk. Four weeks after surgery, the patient improved walking. On radiography, 1.2 T-locking plate was maintained in the same positions as those after surgery. Laboratory examination results were normal.

## Discussion

Cranial cruciate ligament injuries are the most common orthopedic injuries in dogs and are commonly dynamically stabilized with either a TPLO or TTA procedure (6). The biomechanical rationale of TTA is that a forward shift in the position of the tibial tuberosity counteracts the instability created within the stifle following a CCL tear. The tibial tuberosity is secured with specially designed implants so that the patellar ligament is perpendicular to the tibial plateau. TTA is considered by many to be a much simpler procedure than the TPLO. Also, the surgical dissection is confined to cranial portion of the bone so there is very limited possibility for iatrogenic surgical injury with TTA (1).

Despite the advantages of the TTA surgical procedure, complications also exist. In previous studies, major and minor complications were explained (1,9). In that study, The 2 studies (179 cases) reporting complications in CrCL-deficient stifle joints repaired using TTA, report an overall complication rate of 31.6-59% (3,5). The major complications accounted for 12.3-38%. Combining the data, these complications, in order of frequency, were as follows: meniscal tears (7.2%), infection (3.9%), medial patellar luxation (1.1%), tibial fractures (1.1%), and implant failure (1.1%).

The cTTA is an alternative to the traditional TTA procedure for reducing the complications. cTTA provides dynamic

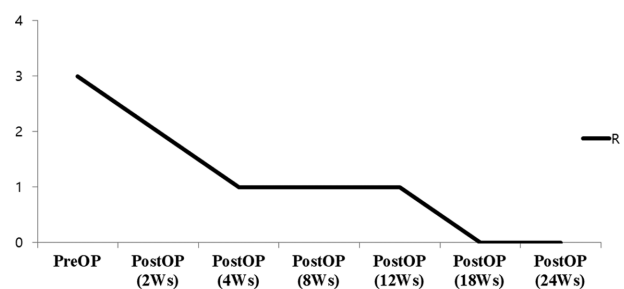


**Fig 3.** Immediate postoperative. In mediolateral view (A), the right tibia displaced cranially was corrected to its position after surgery.

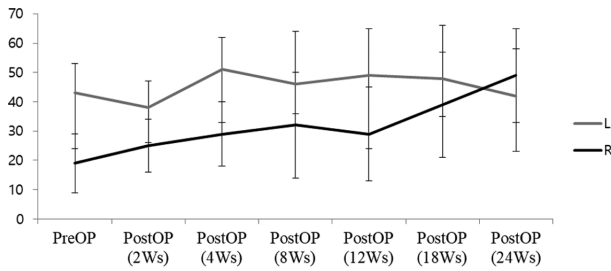
stabilization of CCL deficient stifles and is performed by a circular osteotomy of the tibial tuberosity followed by a cranial rotation (6). The advantage of the technique is that it allows a continuous degree of correction, with no need for standard cage sizes (2,6,7). Unlike TTA, cTTA does not form a gap in the osteotomy site but maintains a continuous contact between the tibia tuberosity and the tibial metaphysis. The displaced tibial tuberosity segment is secured with a custom T-shaped locking plate (7), so it can be applied to patient's bone size. In this case, the plate size was chosen as the diameter of the patient's tibia bone diameter and fixed with a 1.2 mm T-locking plate. To our knowledge, the present case is the first reported case of applying cTTA technique in cranial cruciate ligament rupture a dog in Korea.

One study revealed the influence of the angulation of osteotomy in the frontal plane (FPA) of the tibial tuberosity osteotomy and the effect of the angle of rotation of the tibial tuberosity in the sagittal plane on the final displacement of the patellar tendon insertion in relation to the frontal, sagittal, and axial planes (7). As a result of this study, when FPA is positive, rotation of the tibial tuberosity produced a variable lateral shift of the tibial tuberosity about 2.5 mm.

Based on the results of previous studies, the limitation of cTTA is that it can be applied only when the tibial plateau angle (TPA) angle is less than 28 degrees (6). The reason for



**Fig 4.** Postoperative five-point lameness scoring system. Lameness scores were recorded 2, 4, 8, 12, 18, 24 weeks postoperatively.



**Fig 5.** Postoperative hindlimb pressure mapping. The weight-bearing degree of the patient's hindlimb was measured using Kitronyx Sensor mat (MC1509, MS9705).

this is that if the TPA angle is greater than 28 degrees, the risk of tibial crest and tibial fractures is high because of inadequate bony contact at the osteotomy site. Also, positive FPA can allow the patellar tendon insertion to be displaced laterally by a median of 2.5 mm, but there is no clinical application in medial patella luxation with cranial cruciate ligament rupture yet and further research is needed. The postoperative lameness score was improved for each patient recheck (Fig 4). As the postoperative time progresses, the pressure mapping of the normal left hindlimb and the operated right hindlimb became similar (Fig 5).

### Conclusion

This case report describes cTTA surgical technique and the successful surgical repair of cranial cruciate ligament rupture a dog. To the authors' knowledge, this is the first case report, in Korea. Although further research and clinical applications are needed, it may be one of the surgical options that can be

applied in patients with cranial cruciate ligament rupture.

### References

1. Boudrieau RJ. Tibial plateau leveling osteotomy or tibial tuberosity advancement? *Vet Surg* 2009; 38: 1-22.
2. Hinds J. cTTA-A new method for treating cranial cruciate ligament rupture in dogs: early results 2016.
3. Hoffmann D, Miller J, Ober C, Lanz O, Martin R, Shires P. Tibial tuberosity advancement in 65 canine stifles. *Vet Comp Orthop Traumatol* 2006; 19: 219-227.
4. Johnson JA, Austin C, Breur GJ. Incidence of canine appendicular musculoskeletal disorders in 16 veterinary teaching hospitals from 1980 through 1989. *Vet Comp Orthop Traumatol* 1994; 7: 56-69.
5. Lafaver S, Miller NA, Stubbs WP, Taylor RA, Boudrieau RJ. Tibial tuberosity advancement for stabilization of the canine cranial cruciate ligament?deficient stifle joint: surgical technique, early results, and complications in 101 dogs. *Vet Surg* 2007; 36: 573-586.
6. Petazzoni M. cTTA (circular Tibial Tuberosity Advancement). *ESVOTVOS proceedings* 2010: 295-296.
7. Rovesti GL, Katic N, Dalpozzo B, Dondi F, Dupré G. Effects of rotation and osteotomy angulation on patellar tendon insertion position during circular tibial tuberosity osteotomy. *Vet Surg* 2013; 42: 51-59.
8. Wilke VL, Robinson DA, Evans RB, Rothschild MF, Conzemius MG. Estimate of the annual economic impact of treatment of cranial cruciate ligament injury in dogs in the United States. *J Am Vet Med Assoc* 2005; 227: 1604-1607.
9. Wolf RE, Scavelli TD, Hoelzler MG, Fulcher RP, Bastian RP. Surgical and postoperative complications associated with tibial tuberosity advancement for cranial cruciate ligament rupture in dogs: 458 cases (2007-2009). *J Am Vet Med Assoc* 2012; 240: 1481-1487.