

## Case Report

# Importance of meniscal injury diagnosis and surgical management in dogs during reconstruction of cranial cruciate ligament rupture: A retrospective study

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### ABSTRACT

**Objective:** The objective of this study was to evaluate the benefits of the clinical outcome of meniscal injury diagnosis and surgical management during the reconstruction of cranial cruciate ligament rupture (RCCL) in dogs.

**Materials and methods:** For these purpose two groups with 2 different surgery regimens; group 1 (G1), RCCL was corrected with partial meniscectomy and tibial tuberosity advancement (TTA), and another one (group-2, G2) only with TTA. Long-term follow-up about postoperative complications and any recurrence of signs were recorded by referring veterinarians by medical questionnaire over telephone contact and radiographic postoperative follow-up of bone healing was evaluated.

**Results:** Meniscal injuries were diagnosed arthroscopically in five dogs out of six dogs, and corrected by partial meniscectomy arthroscopically. The percentage of presence of meniscal injury was 83%. It was found that clinical outcomes were superior in G1 than G2 group both walking starting time ( $4.6 \pm 2.5$  and  $6.4 \pm 2.9$  days, respectively) or full recovery time ( $39.2 \pm 26.9$  and  $58.1 \pm 24.5$  days, respectively) was significantly shortage ( $P < 0.05$ ) along with less postoperative complication at two years postoperative observation. Out of the five dogs, lameness, arthritis was developed in four dogs in G2 group while the number of dogs was two in G1 group within two years.

**Conclusion:** Finally based on the clinical superiority, it is recommended that meniscal injury should be checked and corrected during RCCL reconstruction for getting better clinical outcomes.

### KEYWORDS

RCCL; Meniscal injury; Partial meniscectomy; Tibial tuberosity

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## INTRODUCTION

Cranial cruciate ligament (CCL) is one of the important load-bearing ligaments in dogs which always has tension and very prone to torsion, injury or rupture. The meniscus is two C-shaped structures composed of fibrous cartilage connected by ligaments attached to the tibia and femur. It provides stability to the direction of movement of the knee joint, front-back, adduction-abduction, and rotation ([Franklin et al., 2010](#)). Rupture of cranial cruciate ligament (RCCL) is the most common orthopedic problem requiring treatment in dogs and is frequently comorbid with meniscal injury until 70% ([Thieman et al., 2006](#)). It is believed that secondary meniscal injury occurs because most of the owner delayed to come to the hospital due to ignorance about this condition and think it will be recovered automatically after some times. RCCL combined with the loss of meniscal function create a complex pathological condition in joints which exacerbates the pain, inflammation, and dysfunction ([Hayes et al., 2010](#)).

Indeed, meniscal pathology at the time of cruciate reconstruction plays a major prognostic factor in the improvement of osteoarthritis within the knee joint ([Hayes et al., 2010](#)). There are many surgical procedures have been using for surgical management of the joint instability associated with RCCL such as extracapsular lateral suture technique (LST), tibial tuberosity advancement (TTA), tibial plateau leveling osteotomy (TPLO) etc ([Bergh et al., 2014](#)). However, even after surgical correction of RCCL, postoperative complication with meniscal injury still occurs in a large number of dogs that is challenging in veterinary practice ([Thieman et al., 2006](#)).

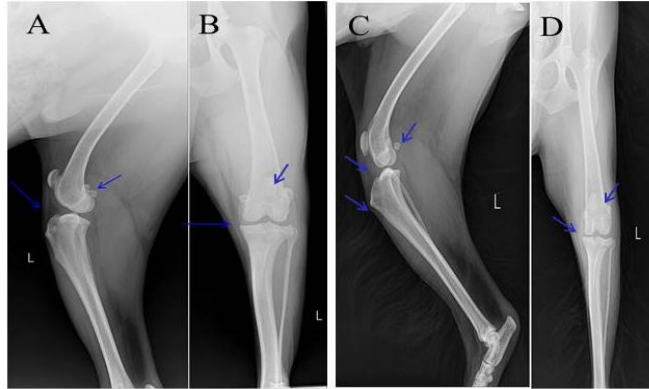
Meniscal injury ignoring might be one of the important factors for recurrence of postoperative complications in the dogs with RCCL. So, correction meniscal injury during the reconstruction of CCL could be an important regulatory factor for good clinical outcome. However, it still remains controversy that described in veterinary practice ([Thieman et al., 2006](#)) as well as human knees is that meniscectomy is beneficial ([Stein et al., 2010](#); [El Ghazaly et al., 2015](#); [Demange et al., 2016](#)) or have negative effect ([Petty and Lubowitz, 2011](#); [Lee et al., 2013](#)) or have no beneficial effect ([Sihvonen et al., 2016](#)). Therefore, the aim of this study was to evaluate clinical outcomes of tibial tuberosity advancement with arthroscopic partial meniscectomy for the treatment of dogs with cranial cruciate ligament rupture and resulting meniscal lesions and to compare these treated joints with those of dogs treated without partial meniscectomy.

## MATERIALS AND METHODS

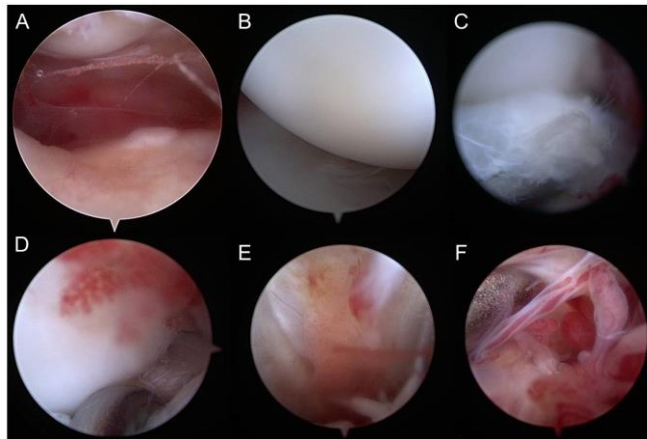
Dogs were admitted to the Royal Animal Medical Center with acute or chronic lameness. The dogs were primarily diagnosed for RCCL by physical examination by expert veterinary surgeons and subsequently confirmed by radiographic examination (Titan 2,000, COMED Medical Systems Co. Ltd., Korea) (**Figure 1**). The meniscal injury was confirmed by the invasive arthroscopic procedure by Arthrex arthroscopic instrument (Arthrex, Naples, Florida, USA). Total five dogs which were diagnosed RCCL with meniscal injury and surgically corrected by combined procedures of TTA and arthroscopic partial meniscectomy were carefully included in this retrospective study from the historical record of this hospital. Indeed, there are many affecting factors that are involved in the healing rate in many orthopedic surgeries such as age, sex, health status, fracture type, soft tissue trauma severity, and surgeon skill, fixation of the fracture edges, fracture fixation technique, and postoperative care ([Rahman et al., 2017](#)).

By considering this matter some of those factors an additional five breed- age- and weight-matched dogs those were clinically diagnosed for RCCL and underwent CCL reconstruction by TTA were selected in this study while the meniscal injury was completely ignored to compare with the previous group. The surgery of all dogs was performed by the same surgeon (Dr. In-Seong Jeong) and assisted by other authors. The clinical history and clinical outcomes were shown in **Table 1**. These clinical cases were diagnosed and surgical treatment were decided by the expert veterinary surgeon by the team meeting at Royal Animal Medical Center and committee on the care of animal resources was approved all protocols employed herein (Approval number: RAMC IACUC 15-KE-031).

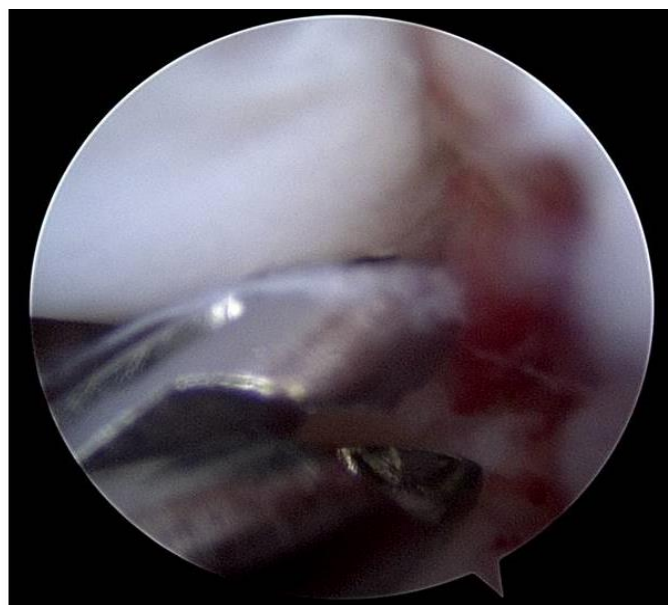
The six dogs were anesthetized in accordance with the standard protocol of this hospital. Briefly, general anesthesia was induced by propofol, 8 mg/kg bwt, sig., IV and volatile anesthetic sevoflurane inhalant (1-5%; Korean Abbot) was used to maintain anesthesia. After shaving aseptic preparation, clipping and draping on the stifle joint area a medial parapatellar mini-arthrotomy was done on affected stifle joint and arthroscopic surgeries were performed using a 2.7 or 2.9 mm 30° rigid optic arthroscope (Arthrex, Naples, Florida, USA) placed in the mini-arthrotomy incision angle without a special leg positioner. Stifle joint areas (lateral and medial pouches, lateral and medial femoro-tibial joint compartments, the intercondylar notch, and the femoro-patellar joint) were evaluated arthroscopically, photographs and digital video were collected (**Figure 2**).



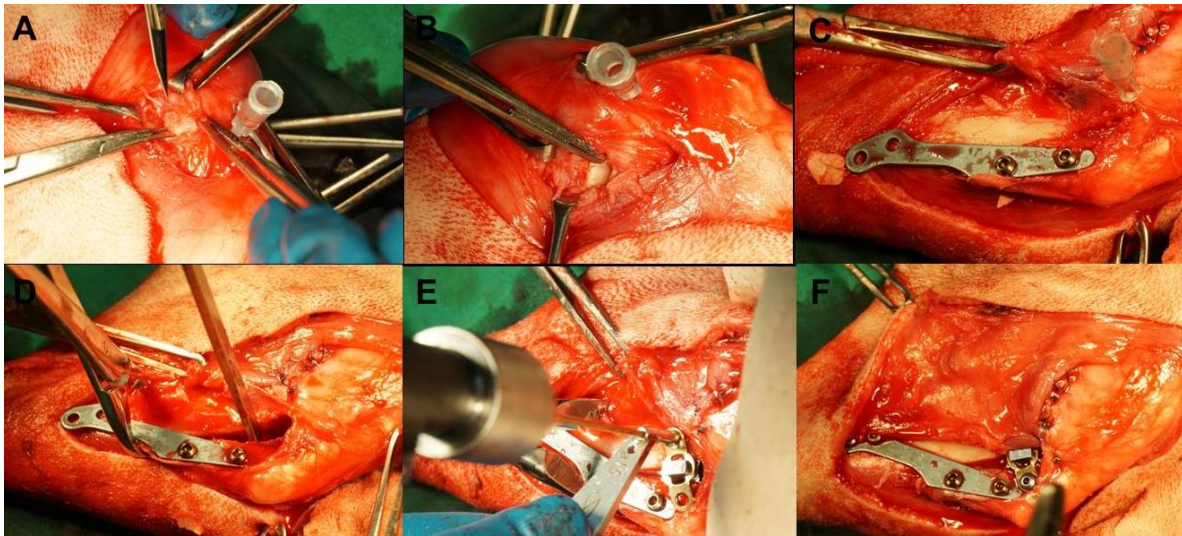
**Figure 1.** Diagnosis of cranial cruciate ligament rupture by radiographic images (case-1). (A-B), case 1; (B-C) case-2; (A,C), reduced fat pad, muscle in the femur area; (B, D), posterior displacement of the femur, and upward displacement of the patella were observed. But meniscal injury was not diagnosed by radiographic image.



**Figure 2.** Diagnosis of pathological condition of stifle joint, meniscal injury and cranial cruciate ligament rupture by arthroscopic approach (case-1). (A) Patellar groove inflammation, osteoporosis; (B-C) presence of meniscal injury; (D-F) presence of cranial cruciate ligament rupture.



**Figure 3.** Image of arthroscopy, meniscectomy, and simultaneous releasing with prove (case-1)



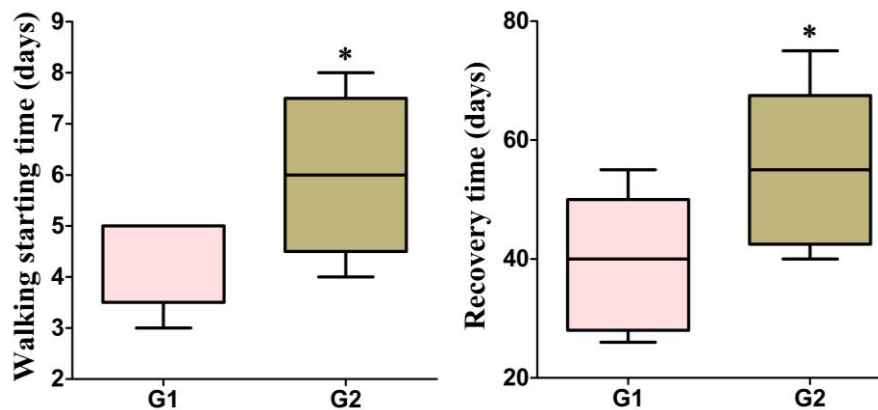
**Figure 4.** Intraoperative images of tibial tuberosity advancement (TTA), TTA blade fixation (case-1).



**Figure 5.** Post operative radiographic evaluation of meniscectomy and TTA (case-1).



**Figure 6.** Long-term postoperative evaluation of clinical outcomes by physical examination (case-1). Dog stood up at day 2; Dog could walking comfortably at day 5 and the r-j bandage was removed after 5 days. Long-term evaluation of walking at day 10 and 26.



**Figure 7.** Surgical management of meniscal injury by partial meniscectomy and reconstruction of cranial cruciate ligament rupture (RCCL) by tibial tuberosity advancement (TTA) (G1) had time of walking with four legs and clinical healing time superiority over blind surgical management of RCCL by TTA (G2). Data presented as mean  $\pm$  SD values (n = 5 per group). Analyzed by Bonferroni post hoc test following one-way ANOVA of G1 versus G2 results (n = 5 \*:  $P < 0.05$ ).

**Table 1.** Comparison of clinical characteristics and results of dogs treated by combination of TTA and arthroscopic partial meniscectomy (group-1, G1) or by only TTA (group-2, G2) in dogs with cranial cruciate ligament rupture-

SL	Breeds		Age (year)/sex		Weight (kg)		BCS (out of 9)		Walking starting(days)		Full Recovery (days)		Long-term clinical outcomes	
	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2	G1	G2
1	AB	B	8 / M	7 / M	32	22	5	5	5	8	26	60	Lameness, arthritis developed at 21 months postoperatively	Lameness, arthritis developed at 11 months postoperatively
2	CS	CS	8.4 / M	10 / M	8.4	10.1	4	4	5	4	39	40	No complication recorded within 24 months	No complication recorded within 24 months
3	Mt	Mt	8.6 / F	9.5 / F	8.6	10.2	4	4	3	6	55	75	Lameness, arthritis developed at 18 months postoperatively	Lameness, arthritis developed at 23 months
4	Mx	Mx	11.1 / F	9.7 / F	11.2	9.7	4	4	4	7	30	45	No complication recorded within 24 months	Lameness, arthritis developed at 7 months postoperatively
5	ST	ST	10.5 / M	8.4 / M	10.5	8.4	5	4	5	5	45	55	No complication recorded within 24 months	Lameness, arthritis developed at 15 months postoperatively

BCS, body condition score; AB, American Bulldog; B, Beagle; CS, Cocker Spaniel; Mt, maltase; Mx, mixed; ST, Shib Tzu; M, male; F, female.

Meniscal injuries were diagnosed arthroscopically in five dogs out of six dogs. These five dogs were surgically corrected by arthroscopic partial meniscectomy and RCCL reconstructed with TTA which were served as group-1 (G1) and the remaining dog was included in the second group (G2) with other 4 dogs which were treated by TTA for RCCL without approaching arthroscopically. We were blind about the four dogs in G2 group whether meniscal injury present or not. For the partial

meniscectomy, the different angulate punch instruments were used (Arthrex), and the rupture zone was resected carefully by taking into account the semilunar meniscal shape (Figure 3).

After that TTA were performed as described previously (Wolf et al., 2012). Briefly, an incision was made and extended distally to allow exposure of the proximal aspect of the tibia by a standard medial parapatellar

approach of the stifle joint. The joint was detected via a craniomedial mini-arthrotomy without luxation of the patella. The autogenous bone graft of proximal aspect of the tibia was harvested via the osteotomy and was used alone or in conjunction with demineralized bone matrix in the osteotomy site. Appropriate implants were used in all dogs according to individual anatomic differences (**Figure 4**). Postoperative radiographs were obtained before recovering from anesthesia, and a modified Robert-Jones bandage was applied at the operating site up to 5 days postoperatively (**Figure 5**). Dogs were discharged from the hospital the 7-10 days on the basis of the improvement of patients walking ability at a satisfied level of surgeons (**Figure 6**).

The postoperative medications were systemic antibiotics (cephradine, 30 mg/Kg bwt, IV twice daily for 7 days and orally 7 days more; enrofloxacin, 10 mg/Kg sig. IM for 3 days); a pain killer (tramadol, 3 mg/Kg bwt, IV 2-4 times for 5 days); anti-inflammatory (meloxicam 0.1 mg/Kg bwt orally for 2 weeks) and cimetidine 10 mg/Kg bwt IV bid for 7 days orally for 7 days were administered. Skin staples were removed 10 to 12 days and follow-up radiographs of the stifle joint were obtained at 6 to 7 weeks after surgery. Prohibition on running and jumping and short leash walks was strictly recommended until 6 to 8 weeks after surgery. Long-term follow-up about postoperative complications and any recurrence of signs were recorded by referring veterinarians by medical questionnaire over telephone contact and radiographic postoperative follow-up of bone healing was evaluated and confirmed.

## RESULTS AND DISCUSSION

RCCL occurs either acute lameness form with the “toe-touching” gait characteristic or chronic lameness that is severe at initially, however, improved gradually with rest, but never fully recovered ([Harasen, 2000](#)). So abnormal compressive and shearing forces present in the CCL deficient stifle may result in various medial meniscal lesions: folded caudal horn, bucket handle and longitudinal tears, fibrillation, axial fringe and transverse tears of the meniscus ([Ertelt et al., 2009](#)).

In this study, we arthroscopically diagnosed meniscal injuries in five dogs out of six dogs. The percentage of presence of meniscal injury was 83%. Our findings are consistent with the other reports ([Thieman et al., 2006](#)). They reported that meniscal injury may present up to 70% in RCCL patients. However, our reportage is a little bit high it might be for few numbers of the animal only 6 dogs. This results of this study also indicating the importance of meniscal injury diagnosis in RCCL dogs.

To best of our knowledge, there are no reports of the effects of partial meniscectomy and TTA on correction of subsequent meniscal injury or long-term patient outcome in terms of clinical function. This scarcity of published data on partial meniscectomy and TTA limits a surgeon’s ability to make decisions on whether to perform this procedure or not. Therefore, our purpose was to compare the clinical outcome of partial meniscectomy and TTA outcomes between 2 different surgery regimens. It was found that clinical outcomes were superior in combined partial meniscectomy and RCCL reconstructed group (G1) than alone RCCL reconstructed by TTA in G2 group both in walking starting time ( $4.6 \pm 2.5$  and  $6.4 \pm 2.9$  days, respectively) or full recovery time ( $39.2 \pm 26.9$  and  $58.1 \pm 24.5$  days, respectively) was shortage (**Figure 7**) along with less postoperative complication at two years postoperative observation. Out of the five dogs, lameness, arthritis was developed in four dogs in G2 group while the number of dogs was two in G1 group within two years (Table 1). Based on the clinical outcomes, combined partial meniscectomy and RCCL reconstructed group was clinically superior to only TTA treated group. The limitation of our study is that we couldn’t diagnose meniscal injury in four dogs in the G2 by considering the owner request. Most of the time meniscal injury is ignored in correcting the RCCL as it is more than 90% performed by general practitioners ([Wilke et al., 2005](#)).

Furthermore, it is happened due to noninvasive diagnostic difficulties and economic concern. Magnetic resonance imaging (MRI) is used to diagnosis of meniscal injury but it is expensive ([Crawford et al., 2007](#)). Moreover, confirmatory diagnosis can be done by exploratory arthrotomy and arthroscopy. However, arthrotomy has a high risk for inducing arthritis and persistent lameness. On the other hand, till now arthroscopy considered as a gold standard for diagnosis of meniscal injury as confirmatory diagnosis and meniscectomy can be done at the same approach. Nevertheless, delaying starting of walking time and full recovery time indicates that meniscal injury may be present in those dogs. This thinking can be insisted by the clinical outcomes of dogs (No 2 at G2 group in **Table 1**) while walking starting time was lowest (4 days) and full recovery time was 40 days as the dog was arthroscopically examined but meniscal injury was not observed. The Meniscal injury should be checked and corrected if present in the dogs with RCCL. It could be an important regulatory factor for good clinical outcome.

The results of our study suggest that treatment of meniscal injury in dogs by applying the arthroscopic meniscectomy can result in good radiologic and clinical

outcomes might be for allowing the medial meniscus to shift its anatomic position which is helpful to avoid further injury during weight bearing in the CrCL deficient stifle (Thieman et al., 2006). So it is important to diagnose meniscal injury and surgical management in dogs during the reconstruction of cranial cruciate ligament rupture. Our results are consistent with those reported by others (Demange et al., 2016). However, there are also contrasting reports (Lee et al., 2014; Sihvonen et al., 2016; Beaufilet et al., 2017).

Direct comparison of our findings with those in other reports is unwise because fracture healing in orthopedic surgery is influenced by many factors including age, sex, health status, fracture type, soft tissue trauma severity, and surgeon skills, fracture fixation technique, and postoperative care (Rahman et al., 2017). To take into account some of those factors we tried to minimize during the selection of dogs with cautiously from historical records of this hospital and compared breed-age- and weight-matched two groups and with the surgery performed by the same surgeon Dr. In-Seong Jeong and assisted by other authors. The results were compared to determine if dogs diagnosed with meniscal injury should be managed with arthroscopic meniscectomy and TTA to get different beneficial outcomes from those in dogs managed with alone TTA.

## CONCLUSION

Finally based on the clinical superiority such as early starting of walking, early recovery and less recurrence of postoperative complication, it is recommended that meniscal injury should be checked and corrected during RCCL reconstruction for getting better clinical outcomes.

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## CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## AUTHORS' CONTRIBUTION

All authors contributed equally.

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