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Clinical Evaluation of TightRope Cranial Cruciate Ligament Technique for Treatment of Cranial Cruciate Ligament Deficiency in Dogs

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Abstract : Nine dogs presented to the Veterinary Medical Teaching Hospital of Konkuk University and Woosung Animal Hospital with a history of pelvic limb lameness. On physical examination, 9 dogs all showed a consistent weight bearing lameness and mild muscle atrophy. There was cranial drawer sign with pain in 9 dogs. Mediolateral radiographic projection revealed cranial subluxation of the tibial tuberosity in a tibial compression view. The right and left stifle joints were affected in 7 dogs and 2 dogs respectively. TightRope cranial cruciate ligament (CCL) technique for treatment of CCL deficiency was performed. Polyester and nylon were used to stabilize the stifle in 3 dogs and 6 dogs respectively. Suture sizes were 0.8 mm (n = 2), 0.9 mm (n = 4), 1.1 mm (n = 2), and 1.1 mm × 2 strands (n = 1) in diameter. Mean (± SD) surgical duration was 48.3 ± 8.5 minutes (range 35 to 60 minutes). Preoperative and postoperative mean (± SD) cranial drawer signs were 8.6 ± 1.6 mm (rage 7 to 12 mm) and 1.2 ± 1.0 mm (rage 0 to 3 mm) respectively. Immediate postoperative radiographs of the affected limb revealed no evidence of cranial subluxation of the tibial tuberosity in a tibial compression view of 9 dogs. Normal limb function was regained in 8 dogs within 8 weeks postoperatively. A consistent weight bearing lameness resolved in all dogs after TightRope CCL technique, but reoccurred in one dog (case No. 6) 2 weeks after surgery. Cranial subluxation of the tibial tuberosity was identified in a tibial compression test. During the second surgery, breakage of surgical button was identified and a tibial wedge osteotomy was performed. Based on surgical time, complication, stifle stability, and functional recovery, the present study indicated that TightRope CCL technique is effective treatment for the dogs with CCL deficiency.

Key words **:** cranial cruciate ligament deficiency, TightRope technique, cranial drawer sign, dog.

Introduction

Injury of the cranial cruciate ligament (CCL) is one of the most common causes of lameness in dogs, resulting in stifle instability and degenerative joint disease (4,6). Early surgical stabilization is recommended for most affected dogs, because poor results are described for most affected dogs with non-operative treatment (8,13). Whereas many surgical techniques has been described to stabilize the CCL deficient stifle, none have proven to provide a superior outcome in the aspect of complete stabilization, complication rate, technical ease, and costs (3). Numerous reports of complications associated with surgical techniques including tibial plateau leveling osteotomy (TPLO), tibial tuberosity advancement (TTA), tibial wedge osteotomy (TWO), and extracapsular suture stabilization (ESS) technique have been reported with complication rates ranging from 17% to 59% (2,3,5). TightRope CCL technique has been recently investigated to provide successful functional outcomes with low overall and major complication rates in a cost effective manner; however, the results of such a technique have been described in only two reports (3,12). The purpose of our study is to evaluate the clinical outcome of TightRope CCL technique for treatment of cranial cruciate ligament deficiency in nine dogs.

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Materials and Methods

Criteria for selection of cases

Medical records of all dogs that were admitted to the Veterinary Medical Teaching Hospital of Konkuk University and Woosung Animal Hospital during the period from 2011 to 2012 and underwent TightRope CCL technique for treatment of CCL deficiency were reviewed.

Preoperative preparation

The same surgeon (HY) performed all surgical procedures. Dogs were premedicated for surgery with atropine sulfate (0.02 mg/kg SC; Atropine sulfate inj®, Je Il Pharm. Co., Ltd, Korea), followed by anesthetic induction with propofol (6 mg/kg IV; Provive 1%®, Myungmoon Pharm. Co., Ltd, Korea).

Dogs were intubated and anesthesia was maintained with isoflurane (Isoflurane®; Choongwae. Co., Ltd, Korea) and oxygen. Normal saline was administered intravenously at a rate of 5 mL/kg/h until completion of the surgical procedure. Dogs received cefazolin (20 mg/kg IV; Cefazolin inj, Daehan Newpharm. Co., Ltd, Korea) at the time of anesthetic induction.

TightRope CCL procedure

Each dog was positioned in dorsal recumbence. Surgical exploration of the stifle joint was performed through an arthrotomy lateral to the patellar ligament. For all dogs, the stifle of each dog was evaluated and the torn cranial cruciate ligament was completely debrided. Damaged meniscus, when present, was treated by partial meniscectomy. The stifle joint was then lavaged with warmed sterile saline. TightRope CCL technique was performed for cranial cruciate ligament injury. To prevent cranial drawer motion, two tunnels were drilled; one tunnel was created from the caudal portion of the lateral femoral condyle to the distal diaphysis of the medial femur and the other tunnel was formed from the cranioproximal edge of the extensor groove of the lateral tibia to the cranioproximal portion of the medial tibia. The stifle was held at caudal translation of the tibia with lateral rotation. The stifle was then stabilized using polyester (Ethibond Excel; Johnson & Johnson, USA) or nylon (Spectra®; Magibraid™, USA) placed through the tunnels and two surgical buttons (Polypropylene Suture Button; IMEX™, USA) or toggle pin (Toggle Pin; IMEX™, USA) to secure the suture, with stifle at a weight bearing angle (135°). The fascia of the vastus medialis and sartorius was apposed over the button, and subcutaneous tissue and skin closure was routine.

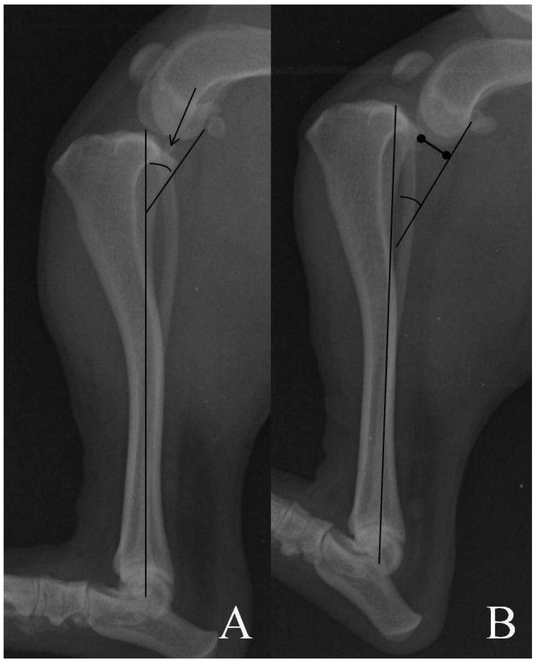

Fig 1. Lateral radiographs of the contralateral limb (A) and the affected limb (B). A. the center of the trochlea of the talus and the center of the intercondylar eminence of the tibial plateau are marked with the contralateral stifle joint flexed to 90 degrees. These two points are connected with a line (line a). Caudal parts of the femoral condyle and the tibial condyle are marked respectively. These points are connected with a line (line b). The angle (arrow) between the lines a and b is measured. B. the angle between the lines a and b is applied to the affected limb. The distance (dumbbell-shaped line) between the line b and a caudal part of the tibial condyle is estimated as cranial drawer.

Outcome measures

Recheck examinations were performed until 6 months postoperatively. Assessment of cranial drawer of the affected limb was based on the contralateral limb. On lateral radiographs, the center of the trochlea of the talus and the center of the intercondylar eminence of the tibial plateau were marked with the contralateral stifle joint flexed to 90 degrees (Fig 1a). These two points were connected with a line (line a). Caudal parts of the femoral condyle and the tibial condyle were marked respectively. These points were connected with a line (line b). The angle between the lines a and b was measured and applied to the affected limb (Fig 1b). The distance between the line b and a caudal part of the tibial condyle was estimated as cranial drawer. Function was evaluated 6 months postoperatively, based on physical examination by a veterinarian (HY) and telephone interview with owners. The owners were asked if there was lameness and pain when walking.

Results

Five male and 4 female dogs underwent TightRope CCL technique for treatment of cranial cruciate ligament deficiency. Breeds were Cocker Spaniel (n = 3), Jin-do dog (n = 2), Poodle (n = 2), Beagle (n = 1), and Alaskan Malamute (n = 1). Mean (± SD) body weight for dogs was 18.9 ± 12.8 kg (range 7.5 to 52.0 kg). The age range of dogs was 3 to 10 years, with mean (± SD) of 7.3 ± 2.3 years. On physical examination, 9 dogs all showed a consistent weight bearing lameness and mild muscle atrophy. There was cranial drawer sign with pain that was elicited on the affected stifle joint manipulation in 9 dogs. No evidence of caudal drawer sign was identified and the varus and valgus stress tests were unremarkable in 9 dogs. Mediolateral radiographic projection revealed cranial subluxation of the tibial tuberosity in a tibial compression view in 9 dogs. The right and left stifle joints were affected in 7 dogs and 2 dogs respectively. Polyester and nylon were used to stabilize the stifle in 3 dogs and 6 dogs respectively. Suture sizes were 0.8 mm (n = 2), 0.9 mm (n = 4), 1.1 mm (n = 2), and 1.1 mm × 2 strands (n = 1) in diameter. Mean (± SD) surgical duration was 48.3 ± 8.5 minutes (range 35 to 60 minutes). Preoperative and postoperative mean (± SD) cranial drawer signs were 8.6 ± 1.6 mm (rage 7 to 12 mm) and 1.2 ± 1.0 mm (rage 0 to 3 mm) respectively. No evidence of internal rotation of the tibia was identified on postoperative physical examination in 9 dogs. Signalment, suture materials, suture

Table 1. Signalment, suture materials, suture size, surgical duration, and cranial drawer in eight dogs with TightRope cranial cruciate ligament technique for treatment of cranial cruciate ligament deficiency

Case No.	Breed	Age (year)	Sex	Weight (kg)	Affected limb	Suture materials	Suture diameter (mm)	Surgical duration (min)	Cranial drawer (mm)	
									Before surgery	After surgery
1	Jindo dog	5	F	27.0	Left	Nylon	1.1	55	11	1
2	Poodle	10	M	7.5	Right	Polyester	0.8	35	7	0
3	Beagle	3	M	14.5	Left	Polyester	0.9	40	8	2
4	Jindo dog	9	F	16.0	Right	Nylon	1.1	50	8	2
5	Cocker Spaniel	8	M	16.8	Right	Nylon	0.9	45	8	0
6	Alaskan Malamute	6	F	52.0	Right	Nylon	1.1 × 2*	60	12	3
7	Cocker Spaniel	10	M	13.1	Right	Polyester	0.9	50	7	2
8	Cocker Spaniel	6	F	13.0	Right	Nylon	0.9	40	8	1
9	Poodle	9	M	9.8	Right	Nylon	0.8	60	8	0

F, Female; M, Male; *Two strands of 1.1 mm diameter suture.

Fig 2. Radiographs right after surgery (A) and 6 weeks after surgery (B). The affected limb reveals no evidence of cranial subluxation of the tibial tuberosity.

size, surgical duration, and cranial drawer are summarized in the Table 1. Damaged meniscus was treated by partial meniscectomy in 2 dogs.

On radiographs right after surgery and 6 weeks after surgery, the affected limb revealed no evidence of cranial subluxation of the tibial tuberosity in a tibial compression view (Fig 2). A full-limb soft-padded bandage was applied for 4 weeks and then removed. The dogs were discharged 3-7 days after surgery. Owners were instructed to administer firocoxib (5 mg/kg orally once daily; Previcox®; Merial, Frence) for 14 days and tramadol (3 mg/kg orally twice daily; Tridol®; Yuhan. Co., Ltd, Korea) for 3 days postoperatively. Instruction for postoperative care included strict activity restriction limited to short-leash walking for 8 weeks postoperatively. Normal limb function was regained in 8 dogs within 8 weeks postoperatively. A consistent weight bearing lameness resolved in all dogs after TightRope CCL technique, but reoccurred in one dog (case No. 6) 2 weeks after surgery. Cranial subluxation of the tibial tuberosity was revealed in a tibial compression test. During the second surgery, breakage of surgical button was identified and a tibial wedge osteotomy was performed. Seroma formation was caused by suture reaction in one dog (case No. 4). The seroma disappeared spontaneously within 14 days postoperatively.

Discussion

Presently available surgical options for treatment of CCL deficiency are intracapsular reconstruction technique, extracapsular suture stabilization technique, or corrective osteotomy including TPLO, TTA, TWO, chevron wedge osteotomy (CWO), hinged hybrid circular external fixation, (HHCEF), and wedge osteotomy linear fixation (WOLF) (7,9,11). These techniques both have advantages and disadvantages. The corrective osteotomy including TPLO, TWO, CWO, and HHCEF require high cost and tibial osteotomy performed to normal bone that is more invasive technique than intracapsular and extracapsular reconstruction technique. However, the corrective osteotomy techniques can provide a permanent decrease of tibial plateau slope (TPS), resulting in decrease of cranial tibial thrust. Compared to the corrective osteotomy, extracapsular suture stabilization technique is more likely to cause implant failure including suture breakage. However, the extracapsular suture stabilization technique provides low cost and is less invasive than corrective osteotomy technique. Decision-making regarding choice of technique can be appropriately made based on factors including technical aspects of the procedure, client perception, cost, and safety. In this study, mean surgical duration was 48.3 minutes that was shorter than surgical duration (65 minutes) for lateral fabellotibial suture surgery reported in the previous study (2). No complication was associated with surgical procedures and TightRope CCL technique cost only two surgical buttons and suture. In addition, the owners were reluctant to choose corrective osteotomy techniques because of invasiveness.

The CCL contributes to passive restraint of the stifle by limiting cranial translation of the tibia relative to the femur, excessive internal rotation of the tibia, and hyperextension of the stifle (9). Resolution of craniocaudal and internal rotational instability in stifle joint is critical to successful treatment of CCL deficiency. In the present study, postoperative cranial drawer signs considerably decreased and no evidence of internal rotation of the tibia was identified on postoperative physical examination.

Many research has been performed evaluating the various suture materials, including polyester, polybutester, Kevlar, fiberwire, fiber tape, fishing line, leader line, polypropylene, and nylon, used for extracapsular suture stabilization technique (1,3,9). The major factors considered include strength, stiffness, creep, knot/fastener security, and biocompatibility of the materials. In general, multifilament braided materials have superior load-to-failure, stiffness, creep, and knot security, while monofilament materials provide crimp fastening and are associated with less susceptibility for infection, tissue reaction, and sinus formation. Two suture materials (nylon, polyester) used in the present study did not cause suture-related major complication such as suture breakage; however, there was seroma formation around nylon knot in a skinny dog. Suture knot should be buried in the soft tissue envelope or suture can be crimped to avoid tissue reaction caused by skin irritation.

In the previous report, major and minor complications related with TightRope CCL technique have been described in 12.5% and 29.2% of cases respectively and included implant failure/instability, infection, meniscal tear, and seroma (3). Complications associated with lateral fabellotibial suture surgery have been expected 17.4% of cases and included neurologic deficits, surgical site infection, incisional complications, mesniscal complication, and implant-related complications (2). In the present study, implant-related complications were identified in two dogs; one was seroma resulted from skin irritation by nylon and the other was surgical button breakage that required the second surgery.

In the previous report, TightRope technique was performed after arthroscopic assessment and treatment of joint pathology (3). In the present study, TightRope technique was performed after arthrotomy. Arthroscopic assessment and treatment before performing TightRope technique is less invasive than arthrotomy; however, arthrotomy could be primary option in cases where arthroscopic equipment is not available or joints are too small to allow arthroscopic access.

Some technical consideration in surgery might increase the likelihood of a successful surgery. The stifle can be held at caudal translation of the tibia with lateral rotation to completely restore stability of the stifle. Surgical button placed on medial portion of the femur should be placed on the distal diaphysis. Surgical button might be migrated into the bone marrow that can cause suture loosening if the button is placed on the epiphysis.

Conclusion

This study described the surgical treatment using TightRope CCL technique in 9 dogs with CCL deficiency. Based on surgical time, complication, stifle stability, and functional recovery, the present study indicated that TightRope CCL technique is effective treatment for the dogs with CCL deficiency.

A study of large case series with long-term follow-up is warranted to better determine the overall success and complication rate and severity of TightRope CCL technique.

Acknowledgements

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전방 십자인대 결손을 보이는 개에서 TightRope을 이용한 치료방법 평가

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요 약 : 뒷다리 파행 병력을 보이는 아홉 마리 개가 건국대학교 부속 동물병원과 우성 동물병원에 내원하였다. 신체 검사에서 아홉 마리 모두 지속적 디딤 파행, 근위축, 통증을 동반한 전방 밀림 증상을 보였다. 경골 압박 자세를 취한 측면 방사선 사진에서 경골 결절의 전방 밀림 증상을 확인하였다. 손상 된 무릎 관절은 각각 오른쪽 7마리, 왼쪽 2 마리에서 확인 되었으며 전방 십자인대 결손 치료를 위해 TightRope 방법이 실시 되었다. 인대 복원을 위한 봉합사로 polyester와 nylon이 각각 3마리와 6마리에서 사용 되었으며 봉합사 두께는 0.8 mm (n = 2), 0.9 mm (n = 4), 1.1 mm (n = 2), and 1.1 mm × 2 가닥 (n = 1)이 사용 되었다. 평균 (± SD) 수술 시간, 수술 전 후 전방 밀림 현상은 각각 48.3 ± 8.5 분 (35-60 분), 8.6 ± 1.6 mm (7-12 mm), 1.2 ± 1.0 mm (0-3 mm)로 확인 되었다. 수술 직후 방사선 촬영에서 아홉 마리 모두 경골 결절 전방 밀림 현상은 확인 되지 않았다. 여덟 마리에서 수술 후 8주 내 정상 보행을 확인할 수 있었으며 1 마리에서 수술 후 2 주 경골 결절 전방 밀림 현상과 디딤 파행 재발을 확인하였다. 재 수술 과정에서 외과용 단추가 부러진 것을 확인 하였고 tibial wedge osteotomy를 실시 하였다. 수술 시간, 부작용, 관절 안정성, 기능 회복 면에서 전방 십자인대 결손 치료를 위한 TightRope 방법이 효과적임을 확인 하였다.

주요어 : 전방 십자인대 결손, TightRope 방법, 전방 밀림 증상, 개