RESEARCH ARTICLE

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Treatment of Experimentally Induced Cranial Cruciate Ligament Ruptures with Autografts in Goats: Physical, Radiographic, Arthroscopic and Histopathological Evaluations *,**

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Cranial cruciate ligament rupture, a significant cause of posterior extremity lameness, is an important concern in veterinary orthopedics. Three primary methods have been described for treating CCL ruptures: intra-articular, extra-articular, and osteotomy techniques. Both autogenous and synthetic materials are preferred for the intra-articular technique. For intra-articular stabilization, autografts such as skin, fascia lata, ligament, bone-patellar ligament, and tendons are used. In this study, two different autografts, the Musculus Peroneus Longus (MPL) and the Musculus Tibialis Cranialis (MTC) were employed using the intra-articular stabilization method to treat CCL ruptures. The study involved 12 female Anatolian Black Goats, averaging 38 kg in weight and aged between 3-4 years. The goats were randomly divided into two groups. MPL and MTC autografts were utilized for treating CCL ruptures through the intra-articular stabilization method. General anesthesia was induced with intramusculer injections of 11 mg/kg ketamine hydrochloride following 0.1 mg/kg xylazine hydrochloride as premedication. After inducing general anesthesia, the animals underwent surgery according to the intra-articular stabilization method. Physical, radiographic, and arthroscopic examinations were performed up to six months post-operation. At the six-month mark, all subjects were euthanized for macroscopic and microscopic examination of the knee joints. Intra-articular stabilization with MPL and MTC tendon autografts for treating CCL rupture was evaluated through physical, radiographic, arthroscopic, macroscopic, and histopathological assessments. The results indicated no complications during the six months following the CCL ruptures, confirming the autografts' effectiveness. Consequently, the findings suggest that the autografts utilized can effectively repair ruptured CCL and provide a viable treatment option.

Key Words: *Goat, cranial cruciate ligament, intraarticular stabilization, autograft, arthroscopy*

Keçilerde Deneysel Olarak Oluşturulan Ön Çapraz Bağ Rupturlarının Otogreftlerle Tedavisi: Fiziksel, Radyografik, Artroskopik ve Histopatolojik Değerlendirmeler

Ön çapraz bağ rupturları, veteriner ortopedi alanında önemli bir arka ekstremite topallık nedenidir. Ön çapraz bağ rupturlarının tedavisi için intra-artiküler, ekstra-artiküler ve osteotomi teknikleri olmak üzere üç temel yöntem tanımlanmıştır. İntra-artiküler stabilizasyon için otojen ve sentetik materyaller tercih edilmektedir. İntra-artiküler stabilizasyon için deri, fascia lata, ligament, kemik-patel ligamenti ve tendonlar gibi otogreftler kullanılmaktadır. Bu çalışmada, Musculus Peroneus Longus (MPL) ve Musculus Tibialis Cranialis (MTC) gibi iki farklı otogreft, intra-artiküler stabilizasyon yöntemi kullanılarak ön çapraz bağ rupturlarının tedavisinde uygulanmıştır. Çalışmada, ortalama 38 kg ağırlığında, yaşları 3-4 arasında değişen 12 dişi Anadolu Kıl Keçisi kullanılmıştır. Keçiler rastgele iki gruba ayrılmıştır. Gruplarda MPL ve MTC otogreftleri, intra-artiküler stabilizasyon yöntemiyle ön çapraz bağ (ÖÇB) rupturları tedavisinde kullanılmıştır. Genel anestezi, premadikasyon olarak 0,1 mg/kg ksilazin hidroklorürün intramusküler enjeksiyonu ardından 11 mg/kg ketamin hidroklorürün inrtamusküler enjeksiyonu ile sağlanmıştır. Genel anestezi uygulandıktan sonra hayvanlar intra-artiküler stabilizasyon yöntemine göre ameliyat edilmiştir. Fiziksel, radyografik ve artroskopik muayeneler operasyondan sonraki altı ay boyunca yapılmıştır. Altı aylık süre sonunda tüm hayvanlar diz ekleminin makroskopik ve mikroskopik incelemesinin yapılabilmesi için ötenazi edilmiştir. MPL ve MTC tendon otogreftleri ile intra-artiküler stabilizasyonun ön çapraz bağ rupturlarının tedavisindeki etkinliği fiziksel, radyografik, artroskopik, makroskopik ve histopatolojik değerlendirmelerle değerlendirilmiştir. Sonuçlar, ön çapraz bağ rupturu oluşturulan deneklerin altı ay boyunca takibi sonucunda herhangi bir komplikasyon gerçekleşmediğini ve kullanılan otogreftlerin etkinliğini doğrulamaktadır. Dolayısıyla, kullanılan otogreftlerin, ön çapraz bağ rupturlarını etkili bir şekilde onarabileceği ve geçerli bir tedavi seçeneği sağlayabileceği sonucuna varılmıştır.

Anahtar Kelimeler: *Keçi, ön çapraz bağ, intraartiküler stabilizasyon, otogreft, artroskopi*

Introduction

A cranial cruciate ligament (CCL) rupture which constitutes a large part of the posterior extremity lameness is an important disease in veterinary orthopaedic. CCL ruptures are one of the most common injuries in dogs and are the main cause of degenerative joint disease in the knee joint (1, 2). The CCL rupture is the condition

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affecting the knee joint of patients and inevitably leads to the development of osteoarthritis (1, 3 -5). The ruptures of the CCL can be occur as avulsion, partial or complete (6). Three main methods have been described for the treatment of CCL ruptures; intraarticular, extra-articular and osteotomy techniques. For intra-articular technique, autogenous or synthetic materials can be prefered. Various autografts such as skin, fascia, connective tissue, and bone-patellar ligament can be utilized for intraarticular stabilization. These materials serve as autograft options in surgical interventions, aiming to provide joint stabilization and support the healing of damaged tissues. Autografts, being harvested from the patient's own body, offer compatibility and biocompatibility, contributing to the achievement of more successful outcomes following surgical procedures. These approaches are particularly employed in surgical treatments related to joint damage and instability (7).

The diagnosis of a ruptured CCL involves the use of clinical, radiographic, ultrasonographic, computed tomography (CT), magnetic resonance imaging (MRI), and arthroscopic examinations (6, 8-10). Clinical findings typically manifest as sudden lameness and an abnormal leg posture, with identification facilitated by the cranial drawer movement test (4,8). Radiographic examination of the knee joint may reveal osteoarthritic changes, and the caudal positioning of the tibia relative to the femur in both mediolateral and craniocaudal views can indicate a diagnosis of CCL rupture (6,11,12). Arthroscopic assessment provides a comprehensive evaluation of the knee joint components, including the patella, trochlear groove, femoral condyle, tibial plateau, CCL, caudal cruciate ligament, and menisci. Confirmation of CCL rupture is achieved through arthroscopic diagnosis (2, 6, 8, 13).

The objective of this study is to optimize patient outcomes by determining the most effective materials for treating CCL ruptures, which compromise knee stability. The study aims to achieve optimal stabilization and identify the ideal graft for this purpose. In pursuit of this goal, Musculus Peroneus Longus (MPL) and Musculus Tibialis Cranialis (MTC) tendons were employed in the intra-articular stabilization method for the treatment of CCL ruptures.

Materials and Methods

Research and Publication Ethics: This research received approval from the Fırat University Ethics Committee of Animal Experiments under the reference number 2014/2. The study involved a sample of 12 female Anatolian Black Goats, with an average weight of 38 kg, and ages ranging between 3 to 4 years. The study subjects were housed at the Animal Hospitalization Unit of Fırat University Animal Hospital throughout the research period. Approximately one month prior to the commencement of the experimental phase, the goats were randomly allocated into two groups. Internal and external parasitic treatments were administered using Okzan oral tablets (Ceva, Turkey) and Dektomax (Pfizer, Brazil). General health examinations and observations were conducted during the adaptation period. At times, the goats were allowed to graze in designated areas on the university campus. Prior to and following the surgical intervention, assessments encompassing physical, radiographic (Canon CXDI-50G, Japan), and arthroscopic (Karl- Storz as a set of arthroscopy; 2.7 mm diameter, 175 mm long 30 ° arthroscope, Tutlingen, Germany) examinations were conducted. Facilities such as Fırat University Large Animal Hospitalization Unit, Large Animal Clinic, Arthroscopy Unit, X-ray, and Imaging Center were utilized for the duration of the study.

In this investigation, specially crafted acrylic (Polymethyl Methacrylate) buttons were employed for the fixation of tendons in lieu of the CCL, and subsequent results were assessed. The acrylic button patterns, measuring 2 mm in thickness with an outer diameter of 16 mm and an inner diameter of 12 mm, were lubricated with light machine oil and positioned on a slide for experimentation. These acrylic buttons were positioned on a single slide, covering patterns filled with cold acrylic. Once the acrylic had solidified, the buttons were carefully removed from their patterns. Subsequently, two holes, each measuring 2 mm in diameter and spaced 4 mm apart, were drilled at the center of the buttons. The acrylic (Polymethyl Methacrylate) buttons, once obtained, underwent a meticulous cleaning process followed by sterilization.

Anesthesia: General anesthesia was induced through intramuscular (IM) injections, commencing with 0.1 mg/kg xylazine hydrochloride (Rompun®; 23.32 mg/ml, Bayer, Istanbul, Turkey) premedication, followed by 11 mg/kg ketamine hydrochloride (Ketasol; 10%, 100 mg/ml, Richterpharma, Austria). Postoperatively, all subjects received intramuscular administration of flunixin meglumine (Vet-Fulin®, 82.95 mg/ml, Turkey) at a dosage of 2 mg/kg for three days. Additionally, ceftiofur (Sefakim®, 50 mg/ml, Topkim, Turkey) was administered intramuscularly at a dose of 1 mg/kg for a duration of seven days during the postoperative period. Subsequent to the induction of general anesthesia, the right knee joint and the associated graft area underwent a shaving procedure. Following the shaving process, the subjects were positioned on the operating table. The surgical site was then thoroughly disinfected using 10% povidone iodine (Batticon; Adeka, Turkey).

Preparation of Graft: MTC tendon graft access and preparation involved making an incision through the parapatellar approach, distally from the medial side of the tibia. Once the skin incision was performed, the tendon was accessed in the region guided by an elevator. The identified MTC tendon was excised at a distal location near the tarsi joint using scissors (Figure 1). Subsequently, the graft was reshaped proximally, and the distal portion of the graft was intricately knitted using a special technique with Polyglactin 910 USP: 0 (Vicryl, No: 0, Ethicon, Johnson & Johnson, USA) (Figure 1). Saline solution (0.9%) was added during the knitting process. Upon completion of the knitting operation, the graft was maintained under a moist gas hydrophilic environment.

MPL tendon graft access and preparation followed a similar procedure, where an incision was made laterally through the skin to reach the MPL tendon The MPL tendon graft was excised both proximally and distally, followed by thorough washing with saline. Subsequently, the entirely free distal and proximal parts of the MPL tendon graft were intricately knitted using the same technique with Polyglactin 910 USP: 0 (Vicryl, No: 0, Ethicon, Johnson & Johnson, USA) (Figure 1).

Surgical Protocol: The excision of CCL was performed through a lateral parapatellar approach, with the incision extended down to the distal aspect of the tibia. Prior to initiating the experimental study, it was observed, based on experience gained from preliminary arthroscopic studies on cadavers, that the corpus adiposum infrapatellare (fat pad) tissue in the region posed challenges to the arthroscopic procedure. Consequently, a portion of the fat pad tissue was excised during the operation (Figure 2). Post-removal, there was notable bleeding in the area, and to mitigate this risk, 1 mL of adrenaline was injected before cutting the tissue.

The joint was brought into a flexion position, and the CCL was identified and subsequently cut. Great care was taken to ensure the complete removal of the CCL without any residual tissue (Figure 2). The Paatsama technique was used in the study. The Paatsama technique is one of the first developed and still applied intracapsular operation techniques. Holes were drilled into the anatomical connection points of the CCL in the femur and tibia without damaging the CaCL and the grafts were placed. To facilitate the passage of the prepared graft, a 4-millimeter diameter tunnel was drilled into the tibia (Figure 3). Subsequently, the tunnel was opened from the femoral condyle using the same drill, delineating the path for the graft passage (Figure 3). An intraarticular tunnel, opening towards the right medial aspect of the proximal articular face of the tibia (i.e., towards the insertion point of the CCL on the tibia), was established with a drill. Additionally, a second tunnel in the lateral femoral condyles, directed towards the insertion point of the CCL, was created.

The MPL and MCT tendons from the right hind legs of the subjects were utilized as substitutes for the excised cruciate ligaments. The grafts underwent reinforcement through a knitting process and were threaded through tunnels in both the tibia and femur. The knitted graft, whether MTC or MPL, was extracted from the tibial tunnel using a 4 mm diameter hook. Simultaneously, the graft, having passed through the tibial tunnel, was further advanced into the distal femoral tunnel within the same procedure. The grafts retrieved from the tunnels were meticulously stretched to prevent any potential slack (Figure 4 and 5) Subsequently, prior to the fixation procedure, the knee joint underwent flexion and extension maneuvers.

In six goats, the MTC graft (secured with a single button on the femur), and in another six goats, the MPL graft (secured with two acrylic (polymethyl methacrylate) buttons, one on the tibia and one on the femur) were affixed utilizing acrylic buttons in lieu of the CCL (Figure 6). Specially crafted buttons, modeled after the Endobutton used in human medicine, were employed in the study for graft fixation. The findings suggested that acrylic buttons can be a viable option in the treatment of CCL rupture.

Postoperative Care: After the fixation, joint movements, including flexion-extension, were applied to assess the strength of the graft. The joint was closed once deemed sufficiently durable, and the operative site was closed following standard procedural methods. Locally, Penicillin G vial (1,000,000 IU) was applied to the region, and a 10% povidone iodine dressing was applied to the incision site. Postoperatively, PVC-supported bandages were applied to the subjects for a duration of 20 days. In the postoperative period, intramuscular administration of ceftiofur at 1 mg/kg and flunixin meglumine at a dose of 2 mg/kg was carried out. Antibiotic applications continued for seven days, and analgesic applications were administered for three days.

Six months postoperatively, the goats underwent euthanasia. The findings from physical examination, radiographic analysis, arthroscopic evaluation, and histopathological examinations of the goats observed over the six-month period were documented and subsequently analyzed in this study.

The tissue graft section outside the tunnel and the tissue surrounding the button were immersed in a 10% neutral formalin solution alongside the graft bone tissue within the tunnel. Subsequently, the graft tissue affiliated with the bone tissue underwent decalcification post formalin fixation. All tissues underwent standard processing procedures, leading to the preparation of paraffin blocks. Microphotographs (DP 72) were captured through staining techniques utilizing Hematoxylin Eosin (H.E), Masson's Trichrome, and Safranin O methods under a light microscope (Olympus BX43).

Results

Physical Examination Findings: In both experimental groups, goats exhibited facile use of their bandaged feet post-operation. Mild muscular atrophy and limping were uniformly noted in both the MTC and MPL tendon groups after the replacement of bandages. Over the six-month observation period, a notable reduction in lameness was observed. Throughout the physical examinations, negative drawer eye movement was consistently noted. Following the operation, subjects displayed mild lameness during the initial month, which gradually diminished. No local or systemic signs of infection were evident in any subject. Sutures remained intact in all goats, with complete recovery observed in the wound line. Throughout the twenty-day period, no complications impeding subjects' mobility with bandages were detected. Muscle atrophy exhibited a decline upon the removal of bandages. Goats acclimated to walking, jumping, and consuming leaves from trees when taken outdoors after the second month.

Radiographic Examination Findings: Radiographs of the right knee joint, captured in both craniocaudal and 90-degree lateral positions, were obtained both pre and post-operation. Examination of these radiographs revealed smooth joint surfaces and an absence of degenerative disorders. Neither osteophytic proliferation nor patella luxation was evident. Specifically, in the 90-degree lateral position, scrutiny was directed towards the cranial displacement of the tibia, characteristic of CCL rupture; however, no such displacement was observed in the radiographs. The radiographic assessments affirmed successful graft integration with the surrounding tissue, indicating sustained functionality throughout the duration of the experimental period (Figure 7, 8)

Arthroscopic Examination Findings: During the arthroscopy of the knee joint, a central approach was employed. The arthroscopic examination involved entering the joint through a point situated between the middle of the femoral condyle, distal patella, and crista tibia. This approach facilitated the visualization of the joint faces of the tibia and femur, as well as the meniscus and CCL. Arthroscopic examinations were conducted both before the surgical procedures and on postoperative days 30, 60, and 120, all under general anesthesia. These examinations were undertaken specifically to scrutinize the condition of the CCL and the overall integrity of the knee joint (Figure 9).

The arthroscopic examination revealed a sufficient amount of synovial fluid, and it was observed to be appropriately positioned over the graft. Any swelling resulting from joint irrigation fluid was completely resolved the following day following arthroscopic imaging. After the arthroscopy, a single dose of intramuscular flunixin meglumine and local administration of Penicillin-G were administered. Continuity of the grafts in their designated CCL positions was confirmed through imaging, demonstrating similarity to CCL images. The final arthroscopic examination detected joint contraction in some goats. Notably, in a subject from the MPL tendon group, an acrylic (Polymethyl methacrylate) button applied to the femur was observed during arthroscopy. This appearance is attributed to the substantial volume of fluid introduced into the joint. In arthroscopic imaging, the other structures comprising the knee joint along with the CCL (patella, trochlear groove, femoral condyle, tibial plateau, and menisci) were evaluated, and they were found to be in normal condition.

Macroscopic findings: At the conclusion of the six-month period, euthanasia was performed on the goats, and their knee joints were subsequently dissected. The morphological structures of the knee joint, along with the integrity and positioning of the autograft, as well as the endurance and alignment of the buttons, were observed to be satisfactory (Figure 10). Macroscopic examination indicated that the tendons utilized as grafts functioned effectively as CCL substitutes and maintained their intended positions. Furthermore, the assessment of the synovial fluid's physical properties revealed a normal color and viscosity in the majority of cases. However, in one subject from the MTC group, an increase in the quantity of synovial fluid and discoloration towards yellow were observed.

Upon evaluating the joints of the subjects, it was noted that two subjects in the MTC group exhibited mild tissue loss in the femoral medial and lateral condyles. Additionally, another subject within the same group presented a small lesion on the inner side of the femoral lateral condyle. Conversely, the joint faces of the remaining subjects in the MTC group were observed to be in a healthy condition. In the assessment of the joint faces of subjects in the MPL group, tissue loss was identified in a small area on the inner side of the femur medial condyle, observed in only one subject.

The macroscopic examination revealed that the appearance of the grafts utilized closely resembled that of the CCL (Figure 11). The acrylic (polymethyl methacrylate) buttons employed for graft fixation were observed to be intact. Surrounding the graft, integration with granulation tissue into the adjacent tissues was evident, with no observable suture material in the graft fixation area. In 2 animals, mild subcutaneous gelatinous edema was detected around the button. The acrylic buttons demonstrated biocompatibility, ensuring a secure junction with the surrounding region, and no signs of infection were present (Figure 10).

Upon examination of the opening and course of the tunnels, no lesions were observed in the entrance and exit areas of the femur and tibia. The locations of the grafts were found to be appropriate in both groups, with the autografts still present within the tunnels. To assess the grafts' positioning, longitudinal and sagittal cuts of the femur and tibia were executed (Figure 12). The evaluation of the grafts, both longitudinally and sagittally, revealed no instances of impingement in any subject.

Microscopic Findings: Initially, the microscopic appearance of the CCL and its associated tendons (MTC and MPL) obtained from the healthy leg was evaluated. Subsequently, in the euthanized animals, both the grafts inside and outside the tunnel were subjected to microscopic examination. The ligamentization process of the grafts, the arrangement of collagen fibers, the presence of nuclei (fibroblast-like), and the crimp structure were found to be comparable to those observed in the normal CCL at the conclusion of the experimental period (Figure 13).

In the Masson's Trichrome staining, used for the comparative analysis of cartilage and collagen within the grafts and tendons between the experimental and control groups, a similar amount of collagen tissue was noted in the control group. However, in Safranin O staining, collagen positivity was observed (Figure 14).

Microscopic Changes in Intracellular Grafts: Observations in the graft tissue included hemorrhage, revascularization, heightened osteoclast activity, distinct localization of Sharpey fibers within the graft tissue, the presence of spaces between the graft and bone tissue, development of expansive spaces, and the existence of compact tissue enriched with collagen.

Microscopic Changes in Non-Tunnel Grafts: In two distinct muscle applications, revascularization was observed. In a subject from the MTC group, perivascular mononuclear cell infiltrations were noted. Additionally, in two subjects from the MPL group, macrophages, lymphocytes, and plasma cells were attracted, evidenced by interstitial mononuclear cell infiltrations (Figure 15).

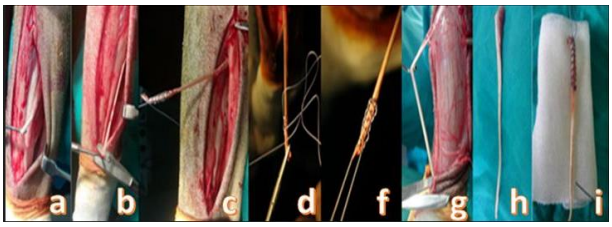

Figure 1.a. Detection Process of MTC Tendon. b. One-Sided Cutting of the MTC Tendon. c, d, f. Unilateral Knitting Process of MTC Tendon. g. Detecting and cutting the MPL Tendon. h. Image of Two-Sided Cut-Out MPL Tendon. i. Knitting Process of MPL Tendon, which is cut out on both sides, and moistened with serum physiological.

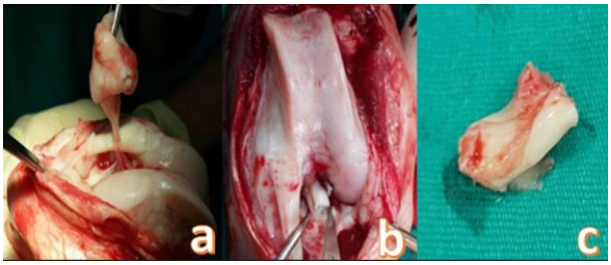

Figure 2. a. Removal of Fat Pad Tissue During Operation b.Discontinuation of the CCL. c. Image of CCL cut away.

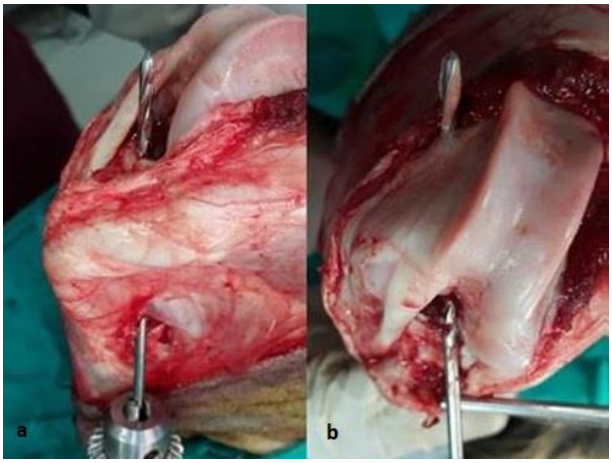

Figure 3. Tunneling to a. Tibia and b. Femur Conduit with drill

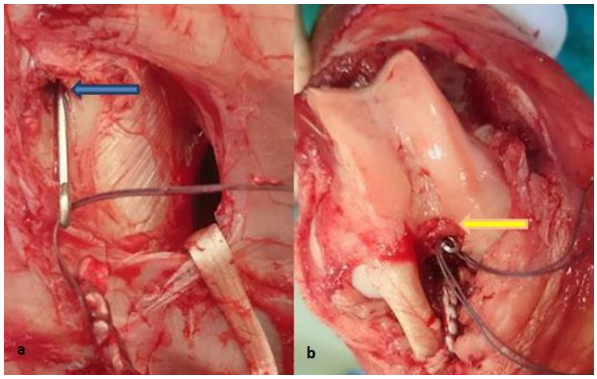

Figure 4. The Transition of the MTC Tendon Knitted with Polyglactin 910 Through the **a.** Tibia Tunnel and **b.** Femur Tunnel

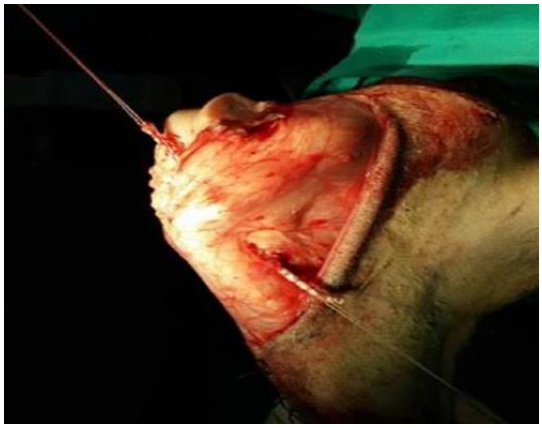

Figure 5. Double Sided Knitting of MPL Tendon and Transition Through the Tibial Tunnel

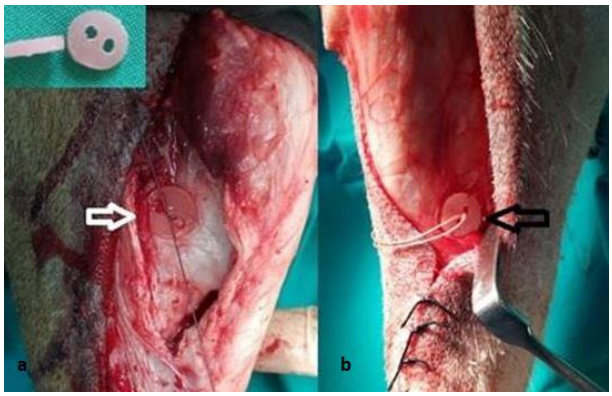

Figure 6. Placement of Acrylic (Polymethyl Methacrylate) Buttons: a. The appearance of a sterilized operation ready acrylic button, b. Placement of the acrylic button on the tibia

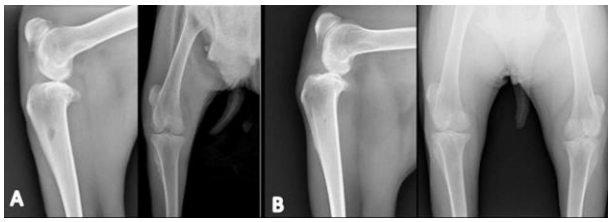

Figure 7. Radiographic Images; MTC Tendon Group in tibia L/L and V/L position; a. 1st month, b. 6th month

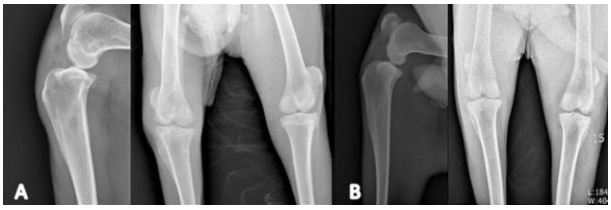

Figure 8. Radiographic Images; MPL Tendon Group in tibia L/L and V/L position; a. 1st month, b. 6th month

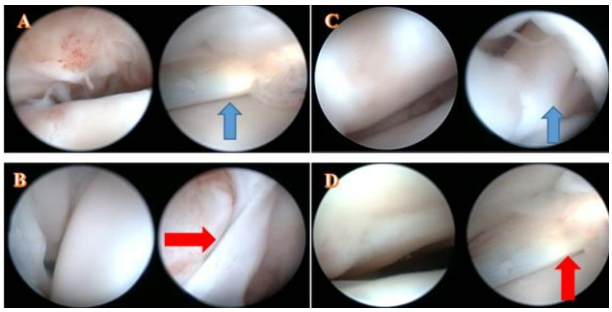

Figure 9. A. a. Arthroscopy Images of the MTC Group (1st month) b. Arthroscopy Images of the MPL Group (1st month) c. Arthroscopy Images of the MTC Group (4th month) d. Arthroscopy Images of the MPL Group (4th month)

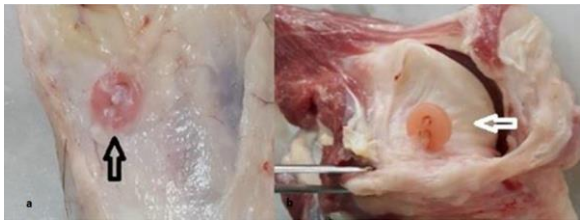

Figure 10. a. Macroscopic View of the Placement of the Acrylic (Polymethyl Methacrylate) Button in Tibia in a subject belonging to the MPL group (black arrow), b. Macroscopic View of the Placement of the Acrylic Button in the Femur in a subject belonging to the MPL group (white arrow)

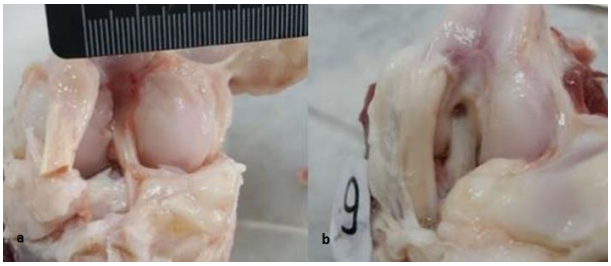

Figure 11. a. Postoperative 6th month: Macroscopic Knee Joint Image in a Subject belonging to the MTC Tendon Group (left figure), b. Macroscopic Knee Joint Image in a Subject belonging to the MPL Tendon Group (right figure)

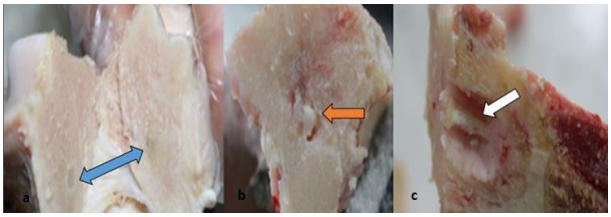

Figure 12. a. View of the Graft (MTC Group) Used in the Transversal Section of the Femur Condul (blue arrow), b. View of the Graft (MPL Group) Used in the Transversal Section of the Tibia Proximal (orange arrow), c. Position of the Graft in Tibia in a subject from the MTC tendon group (white arrow)

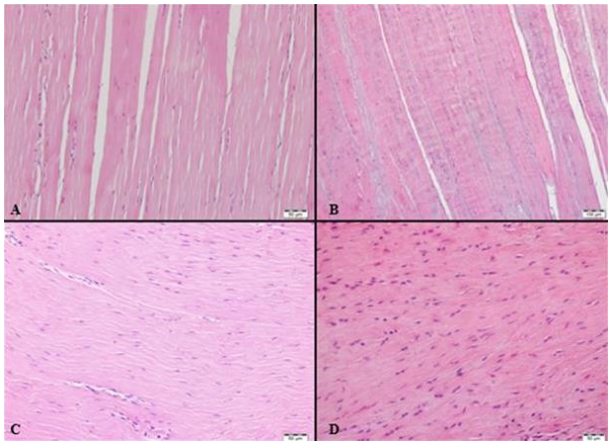

Figure 13. a. Microscopic View of Intact Tendon b. Microscopic View of CCL, c. Microscopic View of a Graft of the MTC Tendon Group, d. Microscopic View of a Graft of the MPL Tendon Group, HxE

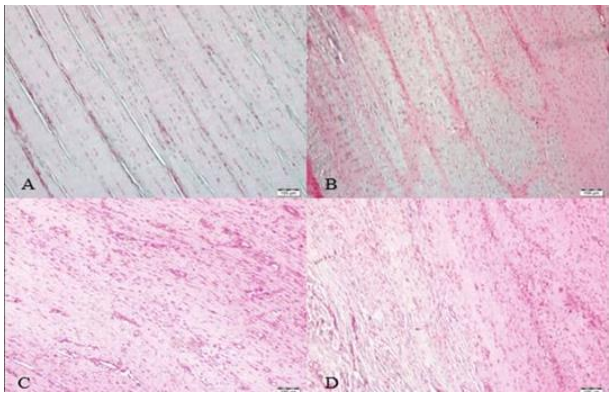

Figure 14. a. Microscopic view of normal tendon, b. Microscopic view of CCL, c. Microscopic view of the graft belonging to the MTC group, d. Staining of the graft belonging to the MPL group with the Safranin O staining technique

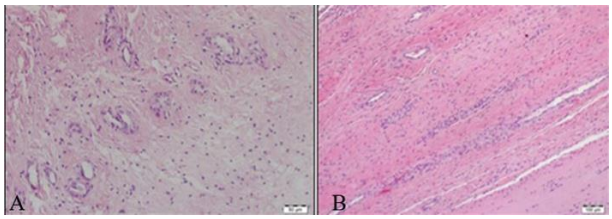

Figure 15. a. Graft of the MPL Tendon group, Revascularization, Newly Forming Multiple Capillaries in Interstitial Areas, HxE. b. Revascularization and Interstitial Mononuclear Cell Infiltration, HxE

Discussion

We opted for the intra-articular graft stabilization technique for CCL rupture, a method popular in human medicine (14). Numerous in vitro examinations have demonstrated that intra-articular treatment methods offer more normal joint movement compared to extra-articular methods (1). In this study, we selected the MTC and MPL tendons as autografts for intra-articular stabilization.

The follow-up of the disease can be conducted through clinical findings, radiography, ultrasonography, MRI, CT, and arthroscopic imaging (2, 15- 18). Radiographic examination is effective for visualizing the knee joint but often yields more prominent images in chronic cases (7, 15). Our study was assessed based on clinical findings, radiography, and arthroscopy results. Particularly in the diagnostic arthroscopy of the knee joint, the use of only two skin incisions with a central approach minimizes tissue trauma, reduces operation time, and contributes to a quicker healing process (2, 19). In our study, the central approach was employed for knee joint arthroscopy, and we concur that this technique offers practicality in approaching and examining joint sections.

Intra-articular methods employing autogenous or synthetic materials serve to replace the ruptured cruciate ligament, facilitating the functional restoration of the newly formed ligament in an anatomically accurate manner (or nearly anatomically) (1). In the context of treating CCL rupture in dogs, a clinical study comparing intra-articular stabilization with extra-articular stabilization and tibial osteotomy techniques revealed superior outcomes with the intra-articular technique, particularly between the 2nd and 6th months post-surgery (20). Similarly, in our study is reveale that goats began walking, jumping, and consuming leaves from trees after being taken outdoors starting from the second month onwards.

Allografts, autografts, and synthetic materials are employed intraarticularly to stabilize the stifle joint (21). Autografts are preferred for their easy intraarticular adaptation and successful results in graft ligamentization (22). In this study, MTC and MPL tendon autografts were used intraarticularly, and the grafts were secured with acrylic (Polymethyl Methacrylate) buttons. In the study conducted by Biskup et al. (23) using intra-articular allograft in 10 dogs, successful results were achieved based on postoperative subjective and objective measurements after 12 months. However, they reported that they could not achieve complete elimination of CCL instability. In parallel with this study, the general vitality of the goats in our research was considered high, walking ability high, climbing ability high, and lameness was assessed as moderate. Drawer movement was observed negative in the examination.

In a study where the musculus tibialis caudalis tendon was used as an intra-articular graft in dogs, synovial fluid, menisci, and joint surfaces were observed to be normal. It has been reported that the graft, used in place of the cruciate ligament, gradually assumed the appearance of a cruciate ligament, both macroscopically and microscopically. The graft was noted to firmly adhere to the tunnel and exhibit good vascularization (22). Likewise, in our study, both the MTC and MPL grafts were found to be well-adapted within the tunnels, not exhibiting loosening, showing good vascularization, and transforming into the appearance of a cruciate ligament, as determined through macroscopic and histological assessments. This transformation was also observed arthroscopically starting from the 4th month.

The success of CCL reconstruction relies on accurate tunnel angulation, lesion management, fixation method, graft quality, and ideal rehabilitation (21). Recent studies highlight the significant impact of tunnel positioning in intraarticular reconstruction on graft isometry success in both humans and dogs (14, 24, 25). Lio et al. (26) reported that different tunnel positions, as observed in postoperative examinations, may lead to thinning and elongation of the graft. In our study, the insertion points of the cross-link served as the starting points for the tunnels. Tunnel length was intentionally kept short, while the grafts were placed sufficiently long, resulting in successful outcomes.

In a study conducted by Unsaldi et al. (22), researchers reported favorable vascularization of the unilaterally used M. tibialis caudalis tendon graft. In our study, the MTC tendon was unilaterally fixed, while the MPL tendon was bilaterally fixed. No difference was observed between the two groups regarding the similarity of the CCL. We posit that synovial fluid contributes to the nourishment of the grafts transforming them into CCL-like structures.

As a result, this study concludes that MPL and MTC tendon grafts can be effectively utilized in the treatment of CCL rupture, which holds a significant position in the field of veterinary orthopedics. Both tendon groups demonstrate practical applicability. Moreover, the study introduces the use of arthroscopy, a routinely employed non-invasive method in the treatment of CCL in human medicine, to veterinary medicine, resulting in positive outcomes. The increasing adoption of the arthroscopic approach in veterinary medicine will ensure physician-technology compatibility and enhance patient welfare. This study underscores the potential of incorporating technological methods alongside classical approaches in the veterinary field, paving the way for the development of innovative techniques in the future.

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