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Short Communication

ACL Reconstruction Using a Plug-In Fascia Lata Graft for Anatomic Femoral Direct Fiber Coverage

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Abstract

This article describes a novel technique for ACL reconstruction using a fascia lata graft and Fibertags (Arthrex) for anatomic femoral direct fiber restoration. The folded fascia lata graft mimics the ribbonlike appearance of the ACL with an anteromedial and posterolateral portion. These portions are secured into separate femoral tunnels, which are connected by a ridge. Through this technique, the femoral direct fiber insertional morphology of the ACL is addressed. Further research is needed to show potential biomechanical and clinical advantages compared to contemporary single bundle ACLR.

Keywords: Cruciate Ligament; Fascia Lata; Anatomic Femoral

Abbreviations

AM: Anteromedial; ACL: Anterior Cruciate Ligament; ACLR: Anterior Cruciate Ligament Reconstruction; FL: Fascia Lata; ITB: Iliotibial Band; PL: Posterolateral

Introduction

ACL reconstruction techniques have constantly been refined to optimize clinical outcomes. A substantial body of research has focused on different factors affecting ACLR outcomes including graft options as well as technical aspects such as tunnel placement and ACL footprint coverage. However, modern ACL reconstruction techniques typically fail to restore native ACL kinematics based on incomplete or inaccurate restoration of native ACL insertional morphology. The long and thin direct femoral ACL insertion close to the resident´s ridge is currently not accurately restored through conventional single bundle ACLR and altered biomechanics represent a common finding following ACLR. Double bundle reconstruction techniques have been introduced to improve ACL footprint coverage, but evidence of clear functional and clinical superiority of double bundle ACLR in the long term is inconclusive. Separate bundles may not restore the biomechanical principle of the native ACL. It is believed that the two bundles must represent interacting portions of a higher structure. In the present article, we describe a novel technique using a single fascia lata graft in combination with Fiber-Tag (Arthrex, Naples, FL) for complete restoration of the femoral ACL direct fiber insertional anatomy. The graft mimics the ribbon-like flat geometry of the native ACL with interacting anteromedial and posterolateral portions. This technique is recommended for all types of complete ACL ruptures. Clinical studies are needed to assess if the more complete restoration of the direct insertion may theoretically be associated with improved biomechanics, increased likelihood of RTS as well as lower risk of ACL graft failure and joint degeneration.

Surgical Technique

The patient is positioned supine under general anesthesia. The leg is secured in a leg holder and a tourniquet is applied. It is ensured that hyperflexion is possible for AM portal tunnel reaming. A single intravenous dose of 1,5 g Cefuroxim antibiotic prophylaxis is given. The leg is prepared for surgery following standard protocols.

Diagnostic Arthroscopy

Following a thorough assessment of global ligamentous integrity under general anesthesia, a high anterolateral and a low anteromedial portal is established. A diagnostic arthroscopy is performed using a standard 30 degrees optic device. Concomitant pathology is assessed and treated accordingly.

Tunnel preparation

The femoral ACL insertion site is inspected. ACL remnants and tissue are cleared from the medial side of the lateral condyle until the posterior femoral back wall and back wall-roof junction are clearly visible. A microfracture owl is used to mark the AM and PL tunnel positions. For the AM tunnel, a mark is made on a tangent connecting the cartilage-bone junction and the highest distal outlet point of the notch as far posterior as possible, leaving a 1-2 mm tunnel backwall. For the PL tunnel, a mark is made on a slightly curved line connecting the AM tunnel with the most distal point of the condylar cartilage margin, leaving a 1-2 mm tunnel wall to the cartilage margin. The long axis of the tunnel geometry needs to be measured for preparation of the corresponding graft width. A long axis distance between 1.5 - 2 cm is recommended in accordance with native anatomy and dimensions. A 2.4 mm drill pin is inserted through the AM portal and slightly inserted into the AM marking point. The knee is then brought into hyperflexion, and the drill-pin is drilled into bone reaching through the lateral femoral cortex. The drill pin is over drilled with a 6 mm reamer. The procedure is repeated for the PL marking point. With a small round bur, a curved ridge is created connecting the tunnels. The ridge should lie within the area of the direct femoral ACL insertion posterior to the resident´s ridge extending no more than 5 mm posteriorly to the resident´s ridge. Bony debris is removed with a shaver. The tibial insertion site is inspected, including visualization and resection of a potential cyclops formation. In 90 degrees of flexion, a tibial guide device, typically with a 55-degree angle, is inserted into the joint. The aimer device is placed centrally at the AM bundle position. A drill pin is inserted through the aiming device and over drilled with a 10 mm reamer.

Graft harvest and preparation

The fascia lata graft is harvested from a safe zone. The lateral boundary of the safe zone is located 4 cm anteriorly to the intermuscular septum to preserve a sufficient and functional ITB strip. The caudal boundary of the safe zone is located 10 cm superior to the lateral femoral condyle to preserve parts of the anterolateral complex of the knee. The cranial boundary of the safe zone is located 15 cm distal to the anterior iliac spine to preserve parts of the tensor fascia lata muscle (Tay 2013) [1]. Cranially within these boundaries, a 2 cm transverse incision is made, and the fascia lata is exposed through blunt dissection. An elevator is used to create a tunnel under the skin flap. The fascia lata is incised and mobilized from underlying muscle tissue. Two parallel cuts are made with long scissors along the length of the fascia lata. The free cranial edge is grasped with an artery forceps and pushed caudally. The artery tip is then held against the skin, where a small incision is made. The graft can then be fully detached through this incision. A fascia lata graft of up to 4 x 20 cm can be harvested and folded for augmentation without significant donor site morbidity (Tay 2013). The graft is folded longitudinally and transversely to create a four-layered 8-10 cm long graft. The width of the graft is then fashioned to match the long axis of the tunnel aperture geometry, typically between 1.5 and 2 cm in width. Two Fibertags (Arthrex) are mounted at one end of the graft at each side. The middle part of the graft between the Fibertags (Arthrex) is resected, creating a horizontal edge. On the other end of the graft, strong sutures are mounted. The graft is then ready for implantation.

Graft implantation

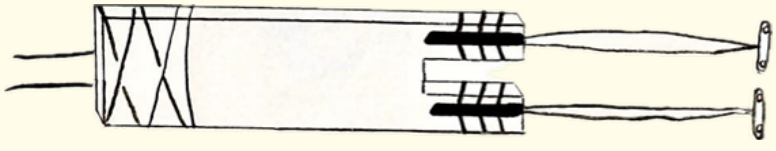

Figure 1: A four-layered 1.8 x 8 cm fascia lata graft. On the right side two Fibertags are mounted. On the left side, one or two pull sutures are mounted. The middle part of the graft between the Fibertags has been resected, creating a horizontal edge.

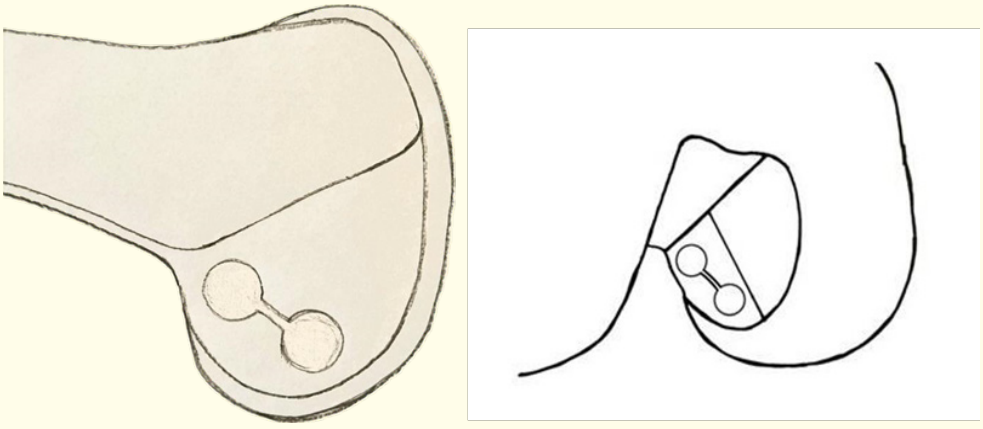

Figure 2: a: Anteromedial and posterolateral femoral tunnel location. A ridge is created between the two tunnels for the horizontal free edge of the graft. B: Arthroscopic view of the tunnel location.

Passing sutures are placed through both femoral tunnels and are retrieved through the tibial tunnel. The graft is pulled into the joint and the AM and PL portions are inserted into their respective femoral tunnels by toggling the Fiber-Tag devices. The AM and PL graft portions are pulled into the tunnels until the free horizontal edge of the graft has entered the curved ridge. The knee is extended, and the graft is positioned into an anteromedial position within the tunnel. A 10 x 30 mm interference screw is inserted into the tunnel placed in a posterolateral position while applying a one-handed maximal pull on the graft. The screw can be advanced close to the joint but screw protrusion into the joint should be avoided.

Postoperative rehabilitation

An immediate progressive structured rehabilitation protocol is recommended following ACLR. Central aspects of the rehabilitation sequence can be summarized through the acronym WORLD-CUP. Walking, One-legged squatting, Running, Landing, Decelerating/dropping, CUtting, Playing. Weight bearing is typically allowed in the absence of significant pain and effusion in accordance with relevant concomitant injury protocols. Braces may be used in specific cases, e.g. in the setting of concomitant meniscal root repair.

Discussion

This article describes a novel technique for ACL reconstruction using a fascia lata graft and Fibertags (Arthrex) for anatomic femoral direct fiber restoration. The folded fascia lata graft mimics the ribbonlike appearance of the ACL with an anteromedial and posterolateral portion. These portions are secured into separate femoral tunnels, which are connected by a ridge. Through this technique, the femoral direct fiber insertional morphology of the ACL is addressed. The direct femoral ACL insertion is thought to measure approximately 18 mm in length and 5 mm in width (Sasaki 2013) [2], located just posterior to the Resident's ridge. The distal parts of the direct femoral insertion are typically not addressed in contemporary single bundle ACLR techniques, even though these fibers are thought to be of paramount importance for the resistance of rotatory torque near full knee extension. Double bundle ACLR has been introduced in order to address this issue. However, separate bundles cannot distribute forces like connected graft portions of a higher structure. On the tibial side, screw fixation of the graft in an anteromedial position within the tibia tunnel restores the anteromedial course of the direct tibial insertion along the Parson´s Knob and medial tibial spine. This technique may be associated with superior biomechanical properties and improved clinical outcomes. Further biomechanical and clinical studies are necessary to verify these assumptions. The fascia lata graft has been shown to have

equivalent graft kinetics compared to common autografts including hamstrings and BPTB (Weninger 2022) [3]. Even when harvesting a fascia lata graft of up to 20 cm in length as performed in reconstructive surgery of the shoulder and other surgical disciplines, significant donor site morbidity is typically rare (Gomes 2021) [4]. However, muscular hernia as a potential harvest complication must be kept in mind. This article provides a novel ACLR technique with emphasis on anatomic femoral direct fiber restoration. Further research is needed to show potential biomechanical and clinical advantages compared to contemporary single bundle ACLR.

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