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A new femoral fixation device for anterior cruciate ligament reconstruction using the outside-in technique and hamstring tendon graft: A comparison between two devices in cadaveric human knee models

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ABSTRACT

Background: A new device (T-anchor) was developed for ACL reconstruction and is implanted via the outside-in technique using hamstring grafts. The purpose of this study was to compare the T-anchor with the EndoButton Direct.
Methods: This study was conducted on 30 cadaveric knees (15 matched pairs). There were two groups of 15 each in the T-anchor and EndoButton Direct groups. After the harvest of grafts, fixation site profile and graft length were measured by loading the grafts onto both devices. They were then tested on a universal testing machine to assess elongation after cyclic loading, load to failure, ultimate load, and mode of failure.
Results: The fixation site profile was lower in the T-anchor group than in the EndoButton Direct group (2.3 ± 0.4 mm vs. 4.7 ± 1.0 mm, $P < 0.001$). The length of the graft-device complex of the T-anchor specimens was longer than that of the EndoButton Direct specimens (125.0 ± 8.9 mm vs. 115.0 ± 8.7 mm, $P < 0.001$). The mean cyclic elongation was lower for the T-anchor group when compared with the EndoButton Direct group (2.4 ± 0.6 mm vs. 3.9 ± 2.6 mm, $P = 0.015$). There was no statistically significant difference in ultimate load and load to failure between the T-anchor and EndoButton Direct groups. For mode of failure, the T-anchor fared better ($P = 0.013$) with all failures attributed to specimens.
Conclusions: In this cadaveric study, the new device, T-anchor, performed better than the EndoButton Direct with respect to the above-mentioned study parameters except for ultimate load and load to failure.

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1. Introduction

The surgical factors that determine favorable outcomes following reconstruction are the anatomical placement of the femoral tunnel, choice of graft, and the fixation device. The placement of the femoral tunnel is an important factor in anterior cruciate ligament (ACL) reconstruction as it not only influences knee kinematics but also determines the graft length. The transtibial technique which produced a non-anatomical isometric graft position was previously popular but had disadvantages such as rotational instability and a limited ability to restore knee kinematics [1–5]. This resulted in a trend towards anatomical reconstruction that led to the anteromedial portal and the outside-in techniques. The anteromedial portal technique for femoral tunnel placement is technically demanding, results in short sockets, and may cause posterior blowout and iatrogenic damage to the medial femoral cartilage [1–6]. The outside-in technique, on the other hand, prevents posterior wall blowout, provides predictable near-anatomical placement of the femoral tunnel and restores knee kinematics [5,7–9]. Concerning graft choice, autologous hamstring grafts have found widespread acceptance because of the ready availability of the tendon, use of a small incision, uncomplicated harvesting technique, and minimal donor-site morbidity [10]. Although there are numerous devices for femoral fixation, an optimal device should ensure initial stability following reconstruction and allow healing and incorporation of the graft [11]. In all, an ideal ACL reconstruction technique should include the anatomical placement of the tunnel using the outside-in technique, an autologous hamstring graft, and a low-profile femoral fixation device and should also provide sufficient strength to promote graft healing.

There are several femoral fixation devices for ACL reconstruction. The EndoButton Direct (Smith & Nephew, Andover, USA) is used for ACL reconstruction and utilizes the outside-in technique in our clinical practice. However, in a biomechanical study of EndoButton Direct, the authors were concerned that it showed a reduced ultimate failure strength, which could affect the outcomes [12]. The new device, the T-anchor (TDM, Gwangju, Korea), is designed for ACL reconstruction using the outside-in technique and hamstring grafts. The T-anchor was developed considering the reported deficiencies of available femoral fixation devices and was designed with a simple reproducible surgical technique while providing stable fixation that allows early rehabilitation following ACL reconstruction. It was also designed to promote graft healing. It is a metallic device (TI-6AL-4V ELI) that consists of an oval-shaped base plate which is attached to a smooth saddle-shaped ring through which the graft passes (Figure 1). The T-anchor also comes with the option of a 10° inclination of its base plate allowing it to rest on the curved dimensions of the lateral femoral cortex. It is available in sizes of 0, 5 and 10 mm to accommodate grafts of any length. For graft healing, fixation stability and sufficient graft contact length in the tunnel are important. When short grafts are taken, T-anchors have a long body option to allow the graft to pass through the femoral and tibial tunnel and to fix it to the tibia using a washer and screw. Moreover, when a sufficient length of graft was obtained, the graft was sufficiently contacted in the femoral tunnel using a short T-anchor and since the ring part of the T-anchor is made of metal, the tunnel widening problem of the suspensory device made of the soft string can be minimized. In a study by Lind M. et al., it was reported that a soft string device was more likely to have tunnel widening than a stiff string device [13].

The purpose of the present study was to compare the newer T-anchor with the established EndoButton Direct with respect to fixation site profile, graft-length adjustability, and graft-holding performance based on elongation after cyclic loading, load to failure, ultimate load, and mode of failure. We used the EndoButton Direct as an option when implementing ACL reconstruction, as noted in a previous study [14], and the biomechanical properties of the EndoButton Direct have been well reported [12]. Moreover, Flanigan et al., reported similar results compared with other fixation instruments [15]. We hypothesized that the T-anchor would perform better than the EndoButton Direct in terms of fixation profile, graft-length adjustability, and graft-holding performance on account of its unique design features.

Figure 1. Photography of a new femoral fixation device for anterior cruciate ligament reconstruction, (A) T-anchor. (B) Implant choices available with the T-anchor. Devices showed with varying length and with 10° inclination. (C) Radiographs postoperative three months using the T-anchor.

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