ACL GRAFT INTERNAL BRACING USING A FIBER TAPE INTERNAL SUTURE BRACE, EARLY PROMISING RESULTS.

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ABSTRACT

The normal process of ACL graft healing includes a period of revascularization between 6 and 12 weeks that is reflected on the mechanical properties of the graft. During this period aggressive rehabilitation or vigorous activity can lead to graft gradual elongation and loss of tensile strength. The tensile strength of ACL graft during this revascularization period reaches as low as 30% of the native ACL. Adding an internal brace to the biological graft was found to improve these mechanical properties and prevent the gradual stretch of the graft that is considered the 2nd most common cause of ACL reconstruction failure. We described graft preparation using ToggleLoc and a tibial Titanium U-loop and internal bracing using a Fiber Tape suture. Ten patients had an ACL reconstruction and internal brace. We had an average side to side difference in KT-1000 score of 0.73 SD 0.8 mm. We had no failure and all the patients returned to their preoperative levels of sports participation.

Keywords: ACL graft elongation, Residual laxity, Fiber tape, Internal brace.

I. INTRODUCTION

An internal brace provide augmentation during ligament reconstruction where it incorporates into the biological graft giving it the much needed tensile strength during initial period of revascularization. ACL grafts pass through 3 phases of healing. Initially the early healing phase (2-4 weeks) characterized by increasing necrosis, mainly in the centre of the graft and hypocellularity. Later the proliferative phase (4th – 12th weeks) maximum of cellular activity and changes of the extra-cellular matrix, which are paralleled by the lowest mechanical properties of the reconstructed knee joint. The mechanical properties of the reconstructed ACL were significantly inferior to those of the native ACL regardless to the type of graft or method of fixation. There are significant differences in the maximum load and the stiffness postoperatively. Finally the ligamentization phase where there is gradual improvement of the mechanical properties but can never match those of native ACL.

The idea of bracing a biological graft was first introduced in the early 1980s. Kennedy proposed the use of a polypropylene braid as a ligament augmentation device (LAD) to protect patellar tendon autogenous grafts in the early postoperative period. The principle of graft bracing has since been applied to various reconstructive and repair surgeries with excellent results. In the knee joint the internal bracing principle was adopted by many authors during repair of various ligaments. Internal bracing for medial collateral, posteromedial ligament repair has also been described. The rationale behind the wide spread of the principle of bracing repairs of different ligaments is the added biomechanical stability which allows for a safe early joint mobilization without affecting the integrity of repair.

II. SURGICAL TECHNIQUE

The indication of surgery was an acute or chronic ACL injury specially in a high demand athlete and obese personnel.

From June 2018 to April 2020 ten patients underwent combined intra-articular anatomic single bundle (ASB) ACL reconstruction and internal bracing of the graft. Quadrupled Semitendinosus and Gracilis of at least 8 mm
diameter were used for ACL reconstruction. Prepared using a non-absorbable No. 0 Ethibond and a femoral ToggleLoc and a tibial Titanium U-loop used for fixation (Figure 1).

An additional looped No. 5 Ethibond suture was passed alongside with the graft in between the quadrupled loops with the looped end towards the ToggleLoc free sutures and the Ethibond free end towards the U loop (Figures 2,3). A standard ASB ACL reconstruction was done and fixed as mentioned earlier. The looped No. 5 Ethibond was used to retrieve the fiber wire of the ToggleLoc device back across the femoral tunnel through the joint and through the tibial tunnel to be retrieved at the tibial tunnel orifice (Figure 4). The free ends of the fiber wire are anchored to the tibia 1 cm away from the tibial tunnel using a 4.75 mm absorbable BioComposite SwiveLock (Arthrex) with knee at hyper extension to avoid capturing the joint and preventing full extension (Figure 5). The knee range is checked to ensure knee is not captured.
**Figure 3:** Arthroscopic view of left knee through anteromedial portal showing the Ethibond passing alongside the ToggleLoc for later retrieval of the ToggleLoc fiber wire.

**Figure 4:** The fiber wire of the adjustable loop of the ToggleLoc and retrieved again at tibial tunnel. The fiber wire of the adjustable loop of the ToggleLoc and retrieved again at tibial tunnel.

**Figure 5:** The free ends of the fiber wire were anchored to the tibia 1 cm away from the tibial tunnel using a 4.75 mm absorbable Bio-Composite SwiveLock (Arthrex) with knee at hyper extension.
Figure 6: Final arthroscopic view of left knee through anteromedial portal after tightening of the graft and the brace

III. RESULTS

Patients were followed up for an average of 24 months. Before surgery, the mean Lysholm score was 61.6 (SD 9.16). This improved to 90.7 (SD 6.1), postoperatively. There was statistically high significant difference on comparing preoperative and postoperative results in favor of postoperative results (p<0.001). Before surgery, the mean IKDC score was 65.3 (SD 7.33). This improved to 93.2 (SD 3.9), postoperatively. There was statistically high significant difference on comparing preoperative and postoperative results in favor of postoperative results (p<0.001). Before surgery, the difference of anterior tibial translation between the injured side and the healthy side ranged from 7-11mm with a mean of 8.93±1.22 mm. After surgery it ranged from 0-2mm with a mean of 0.73±0.8 mm (p 0.001).

One case had prolonged effusion up to eight weeks postoperatively. This was managed by aspiration under complete aseptic conditions, according to the degree of effusion in addition to anti-inflammatory and anti-edematous drugs. There was no residual effusion by the 12th week postoperative. All patients had full or near full ROM.

IV. DISCUSSION

There are two described techniques for graft bracing. First Dependent technique which rely on incorporating a non-absorbable or delayed absorption synthetic brace into the biological grafts with co-fixation of the augmentation device and graft that had many adverse effects related to stress shielding of the ACL graft by the more stiff internal brace which will deprive the graft from the necessary tensile stresses required for adequate Ligamentization since throughout the whole range both the graft and the brace have similar tensions thus the less elastic brace would take over with increasing degrees of stresses shielding the graft. This might explain the mild residual anterior laxity and relatively high failure rate. Another concern was the high rate of postoperative effusion 11.

Later Independent techniques were described non absorbable suture tape or wire that is passed among the strands of the ACL graft but not fixed to it. Independent fixation of the brace suture. This allows differential tensioning of graft and suture brace thus reducing the potential for stress shielding of the graft 10.

Many techniques were described for ACL graft internal bracing. Smith 10 technique used TightRope (Arthrex) was used for both femoral and tibial graft fixation with the suture brace FiberTape (Arthrex) looped through the femoral TightRope and the 2 free ends are passed among graft strands to be fixed at tibia after complete graft fixation using a 4.75-mm SwiveLock with the knee at full hyper extension. Aboalata 1 described a similar Bodendorferet used an exact technique but the fixation of the suture brace was done with knee at 30 degrees of flexion 5.

Compared to the previously mentioned techniques, our technique has the same principle with the advantage of less coast of using the fiber wire of the ToggleLoc as an internal suture brace.
The principle of independent suture bracing of ACL grafts lacks long term evidence with most of the studies describe patient reported short term outcome. No large scale randomized control trials have been conducted yet.

The study conducted by Bodendorfer et al, was the only study describing a technique similar to ours and they reported only short term patient reported outcome. They reported a statistically significant improvement in the patient reported outcome in the augmentation group compared to the standard group with a mean IKDC of 87.5, 73.4 respectively. Another clinical significant parameter was earlier return to pre-injury activity with a mean of 9.2 months, 12.9 months respectively for both groups.

They also reported a 6.7% incidence (2 patients) with developed arthrofibrosis requiring lysis of adhesions in the augmented group. This might be interpreted by the technique of fixing the brace with knee at 30 degrees of flexion which might capture the knee. They also reported 6.7% incidence of failure requiring redo which was similar to the contrast group9.

The use of a synthetic intra articular suture for augmentation had two major concerns. First is the possibility of capturing the knee short of full range of motion with over tensioning of the suture brace. In our technique and similar technique this was avoided by tensioning the suture brace with knee at full extension and avoiding over tensioning of the brace. In our study all the patient had normal or nearly normal postoperative flexion and extension range of motion.

Second is the possibility of stress shielding of graft leading to increased laxity on the long run after loss of the bracing effect of suture due to cyclic loading. This assumption was tested in several biomechanical and animal studies. The independent brace tensioning allows load sharing configuration with the biological graft. In this synergistic load-sharing configuration with soft tissue the function of the suture tape appears like a dynamic safety belt: as soft tissue graft elongation progresses, the more dominant the suture tape as secondary stabilizer will become10,12.

In our study, the suture tape is fixed at full extension whilst the graft is tensioned at 30 degree to ensure that the graft is the primary stabilizer throughout the entire range of motion.

This is evidenced by the absence of any late increase in anterior laxity. The mean KT-1000 side to side difference at 18 months postoperative in the augmented group is 0.7 mm. There were no re-injuries throughout the follow up period which averaged 24 months with 70 % of our patients having a professional sports activity.

We would like to acknowledge some limitations to our study. The scope of the current study is limited by the length of follow-up. The sample size is smaller than other studies approaching the same topic. The lack of blinded follow up of patients might be considered inherent bias although all the objective parameters of the follow up were assessed by 2 different surgeons. We think that radiological analysis of the quality of graft and the degree of synovitis may be beneficial and should be included in the further studies in this technique.

V. CONCLUSION

ACL graft internal suture bracing is a promising field for further studies that should have a larger sample size and include higher risk patients including revision cases and those with global ligamentous laxity. The principle is valid and may allow use of smaller diameter grafts with early aggressive rehabilitation.

The independent suture bracing technique doesn't carry an increased risk of knee stiffness, stress shielding of graft or aseptic synovitis.

REFERENCES


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