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IMPROVING ANTERIOR CRUCIATE LIGAMENT GRAFT POSITION WITH ANTEROMEDIAL AIMING AND USING FEMORAL TRANSFIXATION DURING RECONSTRUCTION HELPS MILITARY SERVICEMEN RETURN TO PREVIOUS ACTIVITY LEVEL

Abstract

The anterior cruciate ligament (ACL) rupture is one of the most common knee injuries. Using the anteromedial (AM) portal aiming during anterior cruciate ligament reconstruction surgery enables precise, anatomical placement of the femoral tunnel. Basic science studies have shown that an anatomically placed graft sees forces that are similar to those of the native ACL and are substantially greater than the forces on a nonanatomically placed graft.[1] Using AM aiming with cross pin fixation improves ACL graft tension in all position of the knee and reduces graft failure. These techniques help military servicemen to have accelerated rehabilitation process and reach previous activity level earlier.

Az elülső keresztszalag szakadás az egyik leggyakoribb térdízületi sérülés. Anteromedialis portálon keresztül végzett célzás segítségével az anatómiai eredési pontra helyezhető a femorális furat. Alapkutatások igazolják, hogy az anatómiai eredési pontra helyezett graftokra ható erő hasonló az eredeti keresztszalagéhoz és lényegesen nagyobb, mint a nem anatómiai pontra helyezett graftokra hatók.[1] Az anteromedialis célzás és femorális transfixáció használatával a térd minden helyzetében nő a graft feszessége és csökken a graft elégtelenségek száma. Ezen technikák alkalmazása lehetőséget ad a gyorsabb és hatékonyabb rehabilitációra és ezáltal a katonák mielőbbi szolgálathoz és teljes terhelhetőséghez való visszatérésére.

Keywords: *ACL reconstruction, femoral tunnel placement, anteromedial aiming, transfixation, accelerated rehabilitation, military servicemen ~ elülső keresztszalag pótlás, femorális furat elhelyezés, anteromediális célzás, traszfixáció, akcelerált rehabilitáció, katona*

INTRODUTION

The ACL is one of the four major ligaments in the knee. It resists anterior translation and medial rotation to the tibia in relation to the femur. (Figure 1.)

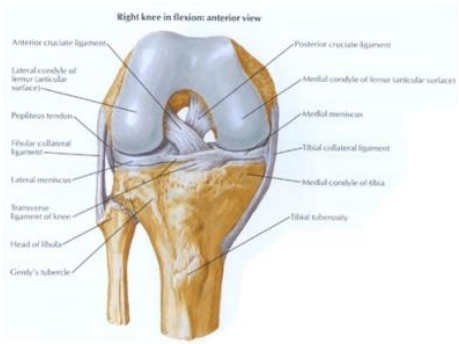

Figure 1. (Taken from: Netter, Frank H, MD. Atlas of Human Anatomy. ICON Learning Systems, New Jersey 1997. Plate 475)

Rupture of the ACL may cause permanent anterior instability of the knee which leads to insufficiency attempting to do high activity level such as daily action in the military.

The anterior cruciate ligament injury is the most common form of injury in the army. International studies have addressed this issue a priority and timeliness of proving that the amount spent on this research continues to grow. The majority of ACL injuries (~70%4) occur while playing agility sports and the most often reported sports are basketball, soccer, skiing, and football. An estimated 70% of ACL injuries are sustained through non-contact mechanisms, while the remaining 30% result from direct contact. ACL injury is most prevalent (1 in 1,750 persons) in patients 15-45 years of age.[2, 14] Necessity of prompt, professional care of the active military servicemen's anterior cruciate ligament injuries and the importance of prevention are adopted worldwide.[3] A study examining the Hungarian Defense Force's ACL ruptured military servicemen between 2007-2013 shows the same prevalence in age groups.[4] Figure 2.

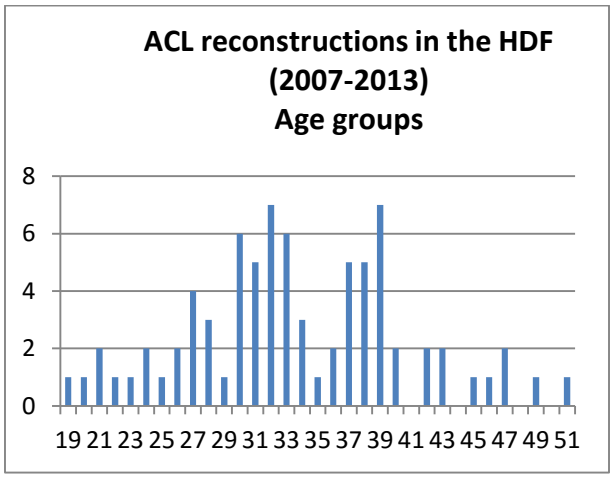

Figure 2. (from Gáspár Sz. Elülső keresztszalag sérülés előfordulása a Magyar Honvédség állományán belül és rekonstrukciós taktikák a Honvédkórházban Hadmérnök 2014/1.: pp. 277-283.)

AIMING AND FIXATION

Reconstruction of the ACL is inevitable for military servicemen to continue high activity level tasks. The more stabile the graft fixation is the earlier the rehabilitation procedure starts.

Non-anatomical ACL graft placement is the most common technical error leading to recurrent instability following ACL reconstruction. ACL reconstruction has commonly been performed using a transtibial tunnel technique in which the ACL femoral tunnel is drilled through a tibial tunnel positioned in the posterior half of the native ACL tibial attachment site. ACL reconstruction performed using a transtibial tunnel technique often results in a vertical ACL graft, which may fail to control the combined motions of anterior tibial translation and internal tibial rotation which occur during the pivot-shift phenomenon. The inability of a vertically oriented ACL graft to control these combined motions may result in the patient experiencing continued symptoms of instability due to the pivot-shift phenomenon. The anteromedial portal technique in which the ACL femoral tunnel is drilled through an anteromedial or accessory anteromedial portal allows consistent anatomical ACL tunnel placement.[5] Figure 3. shows the difference between the two aiming method.

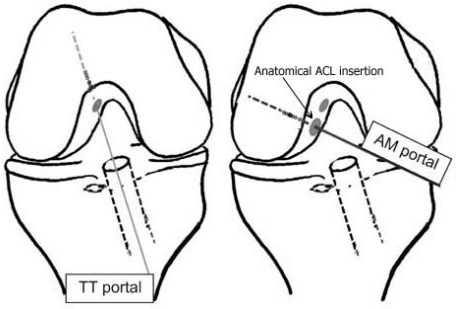

Figure 3. (made by the author) The difference between transtibial (TT) and anteromedial (AM) aiming performing the femoral tunnel

Anatomical placement of the ACL graft is considered critical to the success and clinical outcome of ACL reconstructions. [13] Anatomical ACL graft placement is defined as positioning the ACL femoral and tibial bone tunnels at the centre of the native ACL femoral and tibial attachment sites. This study focusing only on the femoral graft positioning and dealing with graft fixation options on the femoral side.

There are pitfalls when placing the graft. Too vertical placement cause rotational instability, while too anterior placement inflict loss of flexion or graft elongation.

Kato et al. studied the forces on reconstructed ACL in porcine models. They concluded that the anatomical middle point of the ACL insertion in both femoral and tibial side provided the best stability among all anatomic single bundle reconstructions and more closely restored normal knee kinematics. [6]

Different graft types have different healing time. Bone to bone healing is shorter that soft tissue to bone. Allografts share the international literature. Histological evidence suggested a delay in tendon to bone healing for radio protective allograft, which was reflected in mechanical properties. It is a fact that until the complete graft healing the fixation device secures the graft to prevent slippage or displacement. Nowadays the current rehabilitation protocol in the world is turning toward an accelerated rehabilitation process. That means early weight bearing, no crutches, and early full range of motion and to reach all of that possibly no braces to use. According to these statements there is high demand to secure graft choice and fixation.
Reconstructed ACL is subjected a force of 150 to 500 N by daily living. The ultimate load to failure is distinct in different femoral fixations. (Figure 4.)

■→Interference·screw·technique·(539·+/-·114·N)[2]·¶

■→Rigidfix·737·+/-·140·N[-2]·¶

■→Bio-Transfix·746·+/-·119·N[-2]·¶

■→Endobutton864·+/-·164·N[-2]·¶

Figure 4. Femoral fixation types [10]

No matter how well the graft has been placed there is always graft motion in the tunnels. Longitudinal motion better known as bungee effect, horizontal motions also known as windshield wiper effect and creeping or elongation of the graft occurs. The size of displacement depends on the fixation type. There was a significant reduction of tunnel widening in both the femur and the tibia using fixation points close to the joint, compared with the system where the distance between the fixation points is long. Conclusion that the position of the fixation sites and type of fixation device are major factors in the development of tunnel widening after ACL surgery. [7]

The three main biomechanical point of the fixation is the strength that gives the ultimate load to failure, the stiffness gives resistance to displace under load and replace stability and the slippage of the graft. That is the undesirable placement of the initial position under submaximal cycles.

Considering these data we can determine that the ideal femoral fixation is anatomical to restore knee kinematics, biocompatible not to cause foreign body reaction, safe to hold the graft until healing procedure come about and MRI compatible to give the chance to make control imaging and allow easy revision if necessary.

Count the force parallel to the tunnel stated that the longer the fixation point is from the aperture the greater cos& is. Where & is the angle subtended by the graft and the tunnel. (Figure 5.)

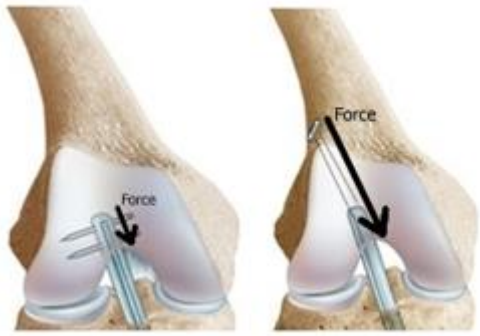

Figure 5. Forces on the grafts Force=xN*cosα (made by the authors)

The greater force is responsible for tunnel widening. [11] Using transfixation that holds the graft close to the femoral tunnel aperture will reduce graft motion in the tunnel and by diminishing α angle will minimize tunnel widening effect. Nevertheless it is still strong and stiff enough to prevent displacement and failure under early accelerated rehabilitation motions.

REHABILITATION

Accelerated rehabilitation is one of the determinative points in the treatment of ACL ruptures. This is defined as immediate full weight bearing following surgery, immediate full extension and immediate active and passive mobilization of the knee joint. [12] This is particularly important in professions such as the military service where the daily effort exceeds the average level and there is a necessity for the earliest possible return to physical activity. Early weight

bearing without braces and fast track physiotherapy can be achieved with anatomically placed grafts using Ridigfix Curve® transfixation device.

Two randomized clinical trials evaluating the efficacy of functional knee bracing following ACL reconstruction for a minimum of two years revealed no perceptible advantage in the use of these braces.[8, 9] In both studies, no differences in A-P laxity, functional testing, patient satisfaction, range of motion or strength were found between the group treated with a functional brace compared to the group that did not use functional bracing.

In our practice two days after surgery the patient starts walking with two crutches. We use these devices for five days. Afterward walking with full weight bearing and daily continuous passive motion (CPM) therapy has been applied. Closed kinetic chain exercises cause significantly less anterior tibial displacement than open kinetic change exercises therefore precise physiotherapy is one of the milestones of the rehabilitation process which last 3 times a week for 12 weeks led by a physiotherapist. 4-6 month postoperatively exercises usually adopted patient specifically. Half year after the intervention it is allowed to do sports with the protection of a brace. 9 months after the surgery the patient is allowed a full load without braces. Control by the surgeon took place on every 6th week until 6 month. We divided the rehabilitation period into 5 phases. Figure 6. shows the rehabilitation phases applied in the Hungarian Defense Forces Health Centre.

1-10 days	Maximal protection phase	CPM, crutches, closed kinetic chain exercise
10 days – 5 weeks	Moderate protection phase	closed kinetic chain exercises, muscle strengthening without body weight
5 weeks – 12 weeks	Minimal protection phase	open kinetic chain exercises, muscle strengthening with body weight
4-5 month	No protection phase	muscle strengthening with weights, jumps, sideway movements, jogging
5-6 month	Sport phase	sport specific exercises, training

Figure 6. Rehabilitation phases applied in the Hungarian Defense Forces Health Centre

SUMMARY

Using Rigidfix Curve® anteromedial femoral aiming, with femoral Rigidfix® biodegradable pins anatomical femoral graft placement can be achieved with strong and stiff graft fixation. Through these procedures accelerated rehabilitation process can be implemented with immediate full weight bearing following surgery, immediate full extension and immediate active and passive mobilization of the knee joint. Stronger femoral fixation reduces the tunnel widening effect decreasing graft failure that helps military servicemen to return previous activity level earlier.

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