

Membership ◀

Meetings ◀

Awards ◀

Directory ◀

Publications ◀

**Current
Concepts** ◀

**Teaching
Centers** ◀

Links ◀

E-mail ◀

Search ISAKOS:

Search

Graft Choice for ACL Reconstruction

[Dr. Don Johnson](#)

Assistant Professor Orthopedic Surgery
Director Sports Medicine Clinic
Carleton University
Ottawa On, Canada
Ph 613 520-3510
Fax 613 520-3974

History

The type of graft that the surgeon chooses for ACL reconstruction has evolved over the past few decades. Erickson popularized the patellar tendon graft autograft that Jones had originally described in 1960. This became the popular graft choice in the late 70's.

In the light of harvest site morbidity and post op stiffness associated with the patellar tendon graft, many surgeons began to look at other choices, semi-tendinosis, allograft, and synthetics. Fowler and then Rosenberg popularized the use of the semi-tendinosus. However even Fowler was not convinced of strength of the graft as he developed the LAD (ligament augmentation device) to supplement the semitendinosus. Gore-Tex, Leeds-Keio and Dacron were choices as an alternative synthetic graft. The initial experience was usually satisfactory. However, with the longer follow up, the results gradually deteriorated.

Allograft was another choice that avoided the problem of harvest site morbidity. The initial allograft that was sterilized with ethylene oxide had very poor results. The freeze dried, fresh frozen and cryopreserved are the most popular methods of preservation of allografts today. This has become a popular alternative to the autograft to reduce the harvest site morbidity, as well as the operative time.

The aggressive post-op rehab program advocated by Shelbourne in the 90's greatly diminished the problems associated with the patellar tendon graft. Prior to this change you had to be an athlete just to survive the rehab program.

There was renewed interest in the semi-tendinosis during the mid 90's. Biomechanical testing on the multiple bundle semitendinosus and gracilis grafts demonstrated it to be stronger and stiffer. This knowledge combined with improved fixation with devices such as the endo-button gave surgeons more confidence with no bone soft tissue grafts. The endo button made the procedure endoscopic, and eliminated the need for the second incision.

Fulkerson and others popularized the use of the quadriceps tendon graft. This again reduced the harvest morbidity, especially when only the tendon portion was harvested.

Shelbourne has described the use of the patellar tendon autograft from the opposite knee. With both the patellar tendon and the semitendinosus added to the list of graft choices, the need for the use of an allograft is minimized.

The latest twist in fixation is to use an interference fit screw to fixate the graft at the tunnel entrance. This produces a graft construct that is strong, short, and stiff. It means that now the surgeon just has to learn one technique for

drilling the tunnels and he can chose whatever graft he wishes, hamstring, patellar tendon, quadriceps tendon or allograft.

Successful anterior cruciate ligament reconstruction is dependent on a number of factors including: patient selection, surgical technique, postoperative rehabilitation, and associated secondary restraint ligamentous instability. Errors in graft selection, tunnel placement, tensioning, or fixation methods chosen may also lead to graft failure. The comparison studies in the literature show that the outcome is almost the same irregardless of the graft choice. The most important aspect of the operation is to place the tunnels in the correct position. The choice of graft is really incidental.

Evolution in Graft Choice

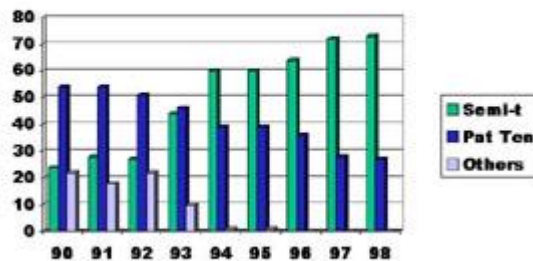


Table 1: The evolution in graft choice at the Sports Medicine Clinic.

Patellar Tendon

The patellar tendon graft was originally described as the gold standard graft. It is still the most widely used ACL replacement graft, but is not without it's problems.

Shelbourne has pushed the envelope further with the patellar tendon graft. He has recently reported on the use of the patellar tendon graft from the opposite knee, with an average return to play of 4 months post op.

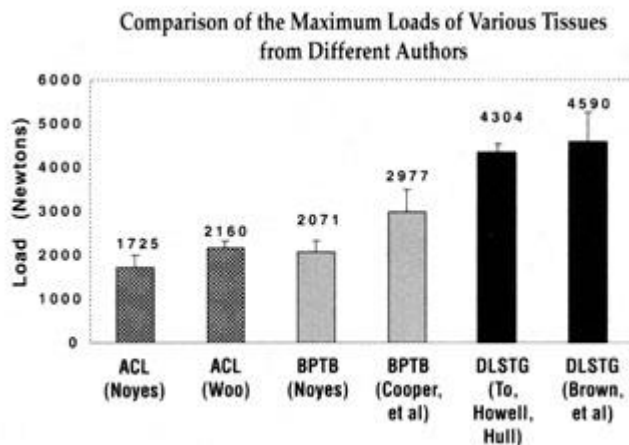
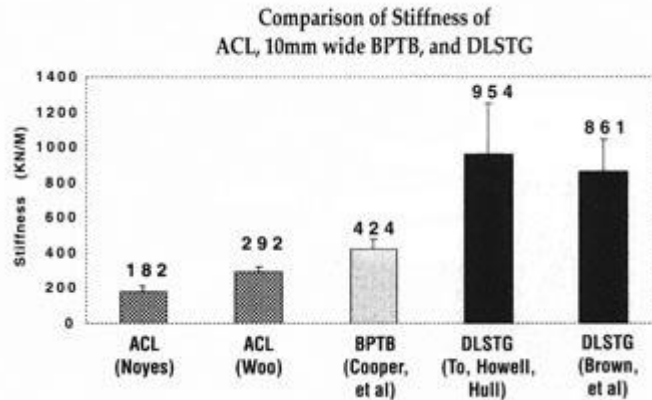
The advantages of the patellar tendon graft are early bone to bone healing at 6 weeks, consistent size and shape of the graft and ease of harvest.

The disadvantages are the harvest site morbidity of patellar tendonitis and anterior knee pain, patellofemoral joint tightness with late chondromalacia, late patella fracture, late patellar tendon rupture, loss of range of motion, injury to the infra-patellar branch of the saphenous nerve. As you can see in the reference list, most of the complications are due to the harvest of the patellar tendon. This is still the main drawback to the use of the graft.

Semi-Tendinosus

With the improvement in the technique of the preparation of the multiple bundle graft, this graft choice has become more popular.

The advantages of the multiple bundle graft is that the it now is stronger and stiffer,



Grafts courtesy Dr. Steve Howell.

The disadvantages of the graft are the various methods use to fix the graft to bone, staples, endo-button, interference fit screws, the graft harvest can be difficult, the tendons can be cut off short, and there is a longer time for graft healing to bone, approximately 10-12 weeks.

Issues in Hamstring Grafts

There are several issues with hamstring grafts that have to be dealt with, such as the graft strength, fixation to bone, donor site morbidity and length of time to heal to the bone tunnel.

Graft Strength

Noyes originally reported that one strand is only 70% of the strength of the ACL. Sepaga subsequently reported that the semi-t and gracilis composite graft is equal to an 11 mm patellar tendon graft. Marder and Larson felt that the 4 bundle composite graft that is tensioned equally is 250% the strength of the normal ACL. Howell demonstrated that 4 bundles of composite graft has 4,300 N to failure compared to 1750 N to failure for the native ACL.

Graft Stiffness

Brown has shown that a 4 bundle semi-t and gracilis composite graft is 2X the patellar tendon stiffness and 3X normal ACL stiffness.

Graft Fixation

The fixation has evolved from staples to endobutton to interference screws

and ultimately to cross pins. Both the Endo button and tying sutures over periosteal buttons may be too weak and elastic, producing the bungee effect in the graft. This leads to a layer of fibrous tissue around the graft giving the tunnel enlargement appearance. This is a weak fixation. Isabashi and Fu showed that moving the fixation closer to the tunnel entrance shortened the graft and improved the results. Pinczewski showed no difference in outcome with interference screw fixation in semi-t and patellar tendon, except for harvest site morbidity (difficulty in kneeling) Pull out strength studies by several authors, Caborn, Weiler, Paulos, showed adequate pullout strength for the interference screw soft tissue fixation. (all above 400 N)

Graft Healing

Semitendinosus takes 10-12 weeks to heal to bone. During this period of time the graft has to be protected if the fixation is not strong.

Donor site Morbidity

In follow up the semitendinosus reconstruction has 3-21% of anterior knee pain compared to 12-40% for the patellar tendon reconstruction. Lipsome found there was no demonstrable weakness of knee flexion after hamstring harvest. Injury to the saphenous nerve is an uncommon complication of the tendon stripping.

Early aggressive rehabilitation

Aligetti and Marder showed there was no difference in outcome with early aggressive rehab. Therefore, the semitendinosus graft has been shown to withstand aggressive rehab, and early return to sports. Howell has also reported early return to sports without a brace at 6 months using cross pin femoral fixation.

Allograft

The main allure of the allograft is the absence of harvest site morbidity. However, the allograft did not initially have good reviews due to the ethylene oxide sterilization process. This caused the graft to be weak and fail easily. With the advent of the freeze dried and cryopreserved process there is minimal risk of disease transmission or graft weakness.

The advantages of the allograft are no harvest site morbidity, are available off the shelf.

The disadvantages of the allograft are the risk of disease transmission, a weak graft, if radiated or from an older patient, a longer time to incorporate into the bone tunnels, the graft is not universally available, and is expensive.

Quads tendon

The quadriceps tendon has gained popularity in the late 90's due to the ease of harvest and the large cross sectional size. Fulkerson has popularized this graft source. Day, Morgan and others have advocated the use of the graft harvested without a bone block from the patella. This further reduces the morbidity of the harvest.

The advantages of the quads tendon graft is less harvest site morbidity, and a larger cross sectional area of graft.

The disadvantages are harvest site morbidity, and the graft has a bone block on only one end of graft.

Synthetic

The initial allure of the synthetic was as an alternative to the patellar tendon graft harvest problems. However, with long term follow up the failures became unacceptable.

The advantages of synthetic grafts are no harvest site morbidity, no disease transmission.

The disadvantages are a higher rate of late graft failure, an increased risk of late infection, and they are expensive