Graft Choices

When ACL surgery was first conceived in the mid-1980s, the middle third of the patella tendon was always used as the graft. 10 years later, hamstring tendons started to become used, simplifying the procedure, allowing it to be done through a single small incision, decreasing pain and decreasing the risk of long-term stiffness and loss of extension. In addition, the use of hamstring tendons avoided the defect in the tibial tubercle, thus increasing the ability to kneel following surgery.

Double bundle reconstruction

In more recent years, the normal ACL has been described as a two bundle construct, at least from a functional point of view. With that in mind, following the lead of the Japanese, many centres have tried to reconstruct it as a two bundle construct by taking each of the two individual hamstrings (gracilis and semi-tendonosis) through separate tunnels on both the femoral and tibial sides. This is in deference to standard practice, which is to use both hamstrings as a single graft, passing them through a single tunnel in the tibia and into a single tunnel in the femur. Whilst this double bundle approach looks good in the laboratory, it has proven less successful in reality. In practice, the failure rate has been quite high, usually due to the failure of the smaller gracilis tendon which tends to be used as the postero-lateral bundle. This is the bundle that prevents excessive rotation and is therefore very important in twisting and turning sports. In some studies where the knee has been re-arthroscoped, the failure of this bundle is over 50%. Whilst this does not always lead to an unstable knee initially, it can lead to a weaker construct which may fail in time. It also means that any biomechanical benefit that may have been gleaned from a double bundle construct, has been removed. In addition, after the rupture of one tendon, the volume of graft is less than it would have been with a standard single bundle construct.

To some extent the jury is still out on this technique but, the number of surgeons still performing a double bundle reconstruction has dwindled over recent years. Even it’s most
avid supporters are now saying that only 20% of people have large enough knees to be able to accommodate four tunnels, thereby significantly limiting the number of people who may be suitable for this.

Despite the above, there has been no shortage of people trying to get double bundle techniques to work. Centres have tried using hamstring tendons from both legs, allograft tendons, split quadriceps tendons, tendon augmentation with prosthetic devices etcetera. Unfortunately, none of these methods have reproduced the success, with the high return to sport and low re-injury rates, that a single graft reconstruction has. Hence, despite some theoretical advantages, these have not been born out in practice.

**Single bundle reconstruction for partial ACL rupture**

Whilst double bundle ACL reconstruction may not be the most reliable reconstruction that we can do, the theory behind it has taught us a lot about how the ACL works. As part of this process we now have a good idea about which part of the ACL controls rotation (postero-lateral bundle), and which controls anterior translation (antero-medial bundle). As a consequence of this, we are now much better at diagnosing partial ruptures of the ACL and determining which functional component is damaged. The corollary of this is that, in a partial ACL rupture, we can now reconstruct just the damaged portion of the ACL using a single hamstring tendon. In this situation, because part of the old ACL remains intact, it acts as a splint for the new portion. In addition, the new bundle often passes through part of the remaining bundle, and hence gets its new blood supply back more rapidly and heals more rapidly.

These partial ACL reconstructions are, without doubt, the best reconstruction that we do. They are sometimes a little bit stiffer for a while but, eventually, they seem to replicate normal mechanics better than any other type of graft. This means that, where previously we may have treated a partial tear conservatively and waited to see how it got on over time, we are now more encouraged to reconstruct them in the hope of restoring near normal anatomy and function.

**Hamstring tendon grafts**

These are the standard choice for the majority of Orthopaedic Surgeons worldwide. This is for all the reasons described above plus, with increasing experience, it allows treatment of the partial rupture. For the vast majority of surgeons, a single bundle graft using two tendons (gracilis and semitendonosis), doubled up to make four strands, is the graft of choice. Whilst hamstring weakness is a theoretical concern, genuine weakness at a year is uncommon, rarely representing more than 5% of total hamstring strength. For those who play hamstring dominant sports at a high level however, an alternate graft may be considered.

**Patella tendon grafts**

These remain a good choice in some individuals. They require two skin incisions, they are more painful than a hamstring reconstruction, and they may permanently prevent kneeling because of the residual defect in the tibia. On the plus side however, the fixation is a little more solid, and less protection of the graft is needed. As a patella tendon graft is stiffer (less stretchy) than a hamstring graft however, it is less forgiving, which makes loss of extension a bit more likely. This means that more therapy and more vigilance is required to ensure that the knee goes straight and that full function returns.

The reason to consider the use of a patella tendon graft is that the failure rate after return to sport is slightly lower than it is for a hamstring tendon graft. Over a large population base however, it is harder to get the same result as a hamstring tendon graft because of the somewhat higher complication rate. Thus, whilst it may be the graft of choice for a high level, male, contact sportsman with ready access to physiotherapy, it is probably not the graft of choice for the majority. Also, it is not suitable for isolated bundle reconstruction in partial ACL rupture.

**Artificial ligaments**

These have been around for over 30 years. The first one that came to the market place was the Kennedy LAD (ligament augmentation device), which was a Dacron braid, designed to be placed alongside a standard graft, to act as a splint for that graft. The theory was that this would allow early activity by holding the knee together, protecting the graft whilst it was healing. It was an augmentation device, and was never designed to be a ligament in its own right. Even when used as an augment however, the outcome was no different from using just the biologic graft tissue alone. Hence, it went out of favour.
Since then, the dream of getting people back to sport and function early, has seen the introduction of multiple other devices. These have included both whole ligaments and augmentation devices, manufactured from a variety of materials including, Dacron, PTFE, carbon fibre and polyethylene terephthalate (PET). An example of the latter is the LARS device, where LARS stands for Ligament Augmentation Reconstruction System.

To date, none of these artificial ligaments have passed the test of time. None have been shown to consistently allow an earlier return to sport, and none have shown any difference in the long-term outlook. Like anything artificial, if it is bent or stressed often enough, it will fail. Hence, whilst there are some individual cases where the LARS ligament seems to have allowed an early return sport, the overall picture is clouded by a high number of failures and a return to sport time that is statistically similar to a biologic graft. For this reason, and with a long-term outlook in mind, a biologic graft seems to be a better procedure in most situations, and one which now has over 25 years of follow-up.

Whilst no good guidelines are available for the use of artificial constructs, the use of an augmentation device (being a strip of artificial ligament that is about half the size of a full ligament) may still have a place. That place may well be in the older patient, who has to return to work early, and may have to return to a job such as scaffolding, where any failure of the reconstruction could have serious consequences. In the older patient, the graft gets its new blood supply much more slowly, and hence, it takes much longer to strengthen than in the young. This is probably the reason for the increased failure of biologic grafts with increasing age. In this group therefore, it may be appropriate to use an augmentation device as an internal splint, to protect a biologic graft whilst is recovering. This would seemingly provide some strength to the construct, allowing an earlier return to work, with a higher chance of success of the biologic graft in the longer term. In that longer term, one would then expect that the augmentation device would fail, but that the biologic graft would heal and survive. Whilst this may well prove to be the case, it is as yet unproven. This means that, whilst it may seem like a good idea in theory, it may not be vindicated by time.
Revision ACL reconstruction

This is perhaps a less common procedure than it once was because, over 25 years of experience with this operation, has made this much more reliable. It now has clear guidelines as to how it should be performed, details of which have filtered through to the general orthopaedic community, leading to a higher success rate of primary reconstruction surgery. Nevertheless, revision reconstruction is still a relatively common procedure amongst those surgeons who specialise in this type of surgery, and in our hands, the success of revision reconstruction still exceeds 90%.

Just as there are many ways of primarily reconstructing this ligament, there are many ways of revising it. In general terms, I believe that the ligament construct should be changed and, where possible, the second ligament harvest should be from the same limb. The latter consideration is both cosmetic and functional, keeping both the scars, and any loss of function associated with graft harvest, in one leg. My view therefore, is that if there has been a primary patella tendon reconstruction, then a hamstring tendon should be used to revise it, and vice versa. I believe this because often, the cause of failure of the graft is unknown, and hence, it seems to makes sense to put in a different construct, rather than to simply redo the first procedure by putting in the same construct, albeit harvested from the other knee.

Other options for revision

Where multiple grafts have been used, either for one knee or for both, alternatives include the use of quadriceps tendon, fascia lata, allograft tendon, synthetic ligament or combinations of the above. Another alternative, where reasonable tissue is still available, is to perform an extra-articular tenodesis. This is where tendon, commonly fascia lata from the side of the leg, is used to tighten up the outside of the knee, and thereby prevent rotatory instability. Before true (intra-articular) ACL reconstruction was performed, such extra-articular procedures were the mainstay of reconstructive surgery for the ACL deficient, unstable knee. They are not used as a primary reconstruction any more but, almost certainly, they have benefit as an augmentation in the revision situation, particularly when it is a second or higher order revision. This type of combination surgery, which was commonplace in the mid to late 1980’s, is now starting to win back favour amongst experienced ACL surgeons, particularly those who deal with failed ACL surgery requiring revision.

Further information

This can also be obtained on this and other related topics, such as:
- ACL reconstruction
- Knee arthritis
- Osteotomy
- Knee replacement


Questions and concerns

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