Concord Sport & Spine Newsletter

## ACL series No 1: Graft Choice for ACL Reconstruction – Latest Research 2021

This newsletter is the first in a series exploring the management of ACL injuries. It is based on information obtained from Learn.Physio ACL Rehabilitation Masterclass.

I last wrote to you on the topic of graft choice for ACL reconstruction (ACLR) in 2014. I also sent you a newsletter in 2016 detailing why the LARS graft was a poor choice for your patients. The current newsletter summarises the latest research regarding graft choices for ACLR.

The main points are:

- In real terms, there is minimal difference in success rates comparing the patellar tendon and hamstring graft.
- Allografts (donor grafts), when compared to autografts, are associated with an increased risk of failure in patients under 20 years of age.
- LARS (synthetic grafts) have proven to be a failure and have been abandoned in most circles.
- Re-injury rates after ACLR are high, both in the operated and contralateral limb. This point will be examined in the series 2 newsletter – controversies in ACL injury management.

In Australia, the main choices for the graft used in ACLR have been the hamstring (HS) autograft, and the bone patellar tendon (BPTB) autograft. 'Autograft' refers to a graft that is taken from the patient's own tissue. The HS graft is generally harvested from the ipsilateral semitendinosus and gracilis tendons. The BPTB consists of a bone plug taken from the inferior patella, tendon from the central portion of the patellar tendon, and a bone plug from the tibial tuberosity. In Australia, HS grafts are the most popular choice, compared to most other developed countries where BPTB is preferred. A third choice – quadriceps tendon graft, has become gradually more popular in Australia over the past 5 to 10 years. This graft is taken from the central part of the quadriceps tendon, with a bone plug excised from the superior patella. A recent systematic review of 15 studies showed that quadriceps tendon reconstruction resulted in comparable knee stability, functional outcomes, donor site morbidity and re-rupture rates compared to BPTB and HS grafts (Hurley et al 2018).

Factors to consider in graft choice include the following:

**Graft failure rates**

There is minimal difference in failure rates between the graft choices mentioned above. A 2017 meta-analysis of over 47,000 subjects across 25 studies found a slightly higher rate of failure for HS compared to BPTB grafts. This difference was negligible - in the order of one extra HS graft failure compared to BPTB for every 235 reconstructions performed (Samuelsen et al 2017).

**Donor site morbidity**

For HS grafts, patients often encounter problems within the first three months post-surgery. This will be in the form of donor site discomfort, or acute 'strains' due to scar tissue tearing. These events are usually minor and settle quickly.

Patients may also experience problems toward the end of their rehab, as they resume high speed

running. This generally indicates that the 'scar/tendon' unit has not regained adequate strength. With targeted strengthening, the hamstring will eventually regain good strength and normal function.

For BPTB grafts, long term discomfort on kneeling and with strenuous activity, and an increased incidence of anterior knee pain are commonly reported. There has also been data suggesting a slightly higher incidence of longer-term arthritis after BPTB compared to HS reconstruction (Kirsten et al 2017).

Functionally, there is little difference between the two techniques regarding rates of return to sport and long-term success. With the increased incidence of anterior knee pain associated with BPTB grafts, some experts recommend against this choice for jumping-related sports such as basketball or volleyball. Similarly, skiers place a high load on the anterior knee, so might opt for a HS graft. Alternatively, for sports that place high demands on the hamstrings – such as repetitive sprinting sports like soccer or AFL, some argue that the BPTB or quadriceps tendon may be a better choice. The same consideration would apply for patients with a history of hamstring injuries.

**Allograft vs Autograft**

An allograft is a graft consisting of natural human tissue taken from a donor. This will be from a cadaver, or from a living donor such as a parent. This is often a hamstring graft or tibialis anterior tendon. Stated advantages of this procedure are a less invasive and shorter operation time, and the absence of donor site morbidity. This may lead to a faster early recovery.

The problem with this procedure is that studies have shown there is a significantly increased risk of re-rupture when allografting is performed in young patients (under 20). The rate of graft re-rupture for allograft was up to four times higher in the 10-to-19-year age group (Kaeding et al 2011). Conversely, in patients 24 to 40 years of age, there was no significant differences between failure rates or other outcome measures for allograft versus autograft (Mariscalco et al 2014). Therefore, on current evidence allograft should not be considered as a first-choice graft for patients under 20 years of age.

**LARS Graft**

The Ligament Augmentation Reconstruction System (LARS) is a synthetic material made of polyethelyne terephtelate (PET). Use of the LARS became popular in Australia 10 to 15 years ago. This artificial material is subject to unavoidable wear, releasing PET particles into the joint which result in inflammation & accelerated degeneration. When this material inevitably ruptures, further and more extensive joint damage is likely. There have been no quality longitudinal studies examining outcomes for LARS reconstruction. Fortunately, most reconstructive knee surgeons have abandoned this technique, due to the high failure rates and evidence of accelerated joint degeneration.

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# Choice of Graft for Reconstruction - 2014

**Choice of ACL Graft**

As you know there are two main options for the graft used for ACL reconstruction - bone-patella tendon-bone (BPTB), or hamstring / gracilis tendon (HG). In the past 15 years there has been a shift towards greater use of hamstring grafts, because of the long-term complications with BPTB – anterior knee pain & inability to kneel on the affected knee. For the recreational athlete (most of the patients you & I see), HG is probably the better option. However proponents of BPTB (such as Dr Merv Cross) still claim this is the best procedure for elite athletes & particularly those involved in collision sports, claiming that HG can lead to short to medium-term loss of hamstring strength & function. It is also suggested that BPTB grafting may lead to less laxity in the short-term, so be preferred by elite athletes seeking early return to sport. However studies show that at 1 & 2 years plus, there is no significant difference in laxity. So the argument will continue. In the May 2009 issue of the British Journal of Sports Medicine, some of the top surgeons from both camps have argued the case for their procedure. Here is a summary of their main arguments.

**BPTB** (1): [This procedure involves taking a bone block from the distal patella, the medial third of the patella tendon, and a bone block from the tibial tuberosity. This allows bony stabilisation proximally & distally, and a short graft healing time of 6 weeks.]

*Advantages*:

1. The authors claim there is a marked reduction in knee laxity, particularly side to side.
2. Tibial sided graft fixation is potentially problematic because this area that has naturally lower bone density. Bony fixation may offer a more stable attachment.
3. "the surgeon using the HG is presented with a baffling array of fixation options, whereas the vast majority of BPTB grafts are fixed with interference screws*." This is considered a much more secure method.
4. In '2002' 97% of surgeons treating professional athletes in the American NFL used BPTB grafts (16) [The paper was publishwed in 2002, but the actual study period was 1994 to 1998, so trends may have changed]
5. There is known to be an increased incidence of contralateral knee ACL injury in patients who have had BPTB. They interpret this to show that this population is more likely to return to at-risk sports.

*Disadvantages*:

1. Where discomfort on kneeling will be a significant hinderance (e.g. occupationally), or in a skeletally immature patient, there is no question that a HG should be the procedure of choice.
2. They claim that quadriceps weakness is due to poor rehab rather than operative procedure.
3. They acknowledge pain on kneeling, but claim that this tenderness can be reduced by impacting bone grafts into the bony defects
4. They dispute an increased incidence of anterior knee pain, except with kneeling.
5. Sensory disturbance is due to operative damage to the infrapatellar branch of the saphenous nerve, & is a complication described for both procedures. They claim that the nerve lies close to the gracilis tendon, and is therefore harder to avoid with HG.
6. Arthritis. There has been published research showing greater incidence of OA after BPTB. The authors can see no logical reason why this would be the case, and quote their own research to dispute this.
7. They acknowledge that BPTB is a technically more difficult operative procedure than HG.

*Disadvantages with HG*:

There are complications associated with HG which include knee laxity, hamstring deficit & pain, tunnel widening, anterior knee pain & sensory deficit.

1. Tunnel widening. The mechanism for this in not well understood, but they claim there is an increased incidence with the use of soft-tissue grafts.
2. It has been suggested that hamstring graft healing to bone is slower than BPTB.
3. Hamstring weakness in flexion & rotation is reported. Functional weakness of the hamstrings may be persistent & contribute to reduced return to full activity.
4. They claim anecdotal experience that HG are associated with a greater re-rupture rate.

**HG** (2): Reported complications with BPTB include quadriceps deficit, a greater degree of arthritis, post-op stiffness, anterior knee pain, an inability to kneel, & sensory disturbances. There have also been reports of fixed flexion deformities (loss of terminal extension) at the 2 & 5 year mark associated with degenerative changes in the patellofemoral & medial compartments.

*Arthritis*: The eitiology of OA after BPTB graft is two-fold: firstly due to patellar ligament contracture (~5-10% of its overall length) causing patella baja, altering patellofemoral contact pressures. Secondly, decreased knee flexion moments during the stance phase results in higher impact loads on the medial compartment.

*Perceived laxity with HG*: The authors argue that since 1995 interference screw fixation (*used by the authors), reverse threaded screws for femoral fixation, supplementary tibial fixation to prevent slippage, & increased length & diameter of the screw have addressed this deficiency. If fixation is secure, patellar tendon is shown to be joined to the tunnels within 6 weeks, compared to 8 weeks for HG. Thus the earlier fixation of the BPTB graft may be only 2 weeks. They feel any laxity in recent years will be a function of surgical technique & placement of the graft rather than graft type.

*Rates of re-rupture*: The authors state that large scale meta-analysis & systematic reviews report no difference in rupture rates. The rate of re-rupture is 20% over two years (2 per year for 100 patients followed up) for both groups.

*In summary:*the authors state that the major advantage of HG over BPTB is that the patient will have a better outcome "for the rest of their life", if not for the short period of their sporting career.

So what does the rest of the literature say? Several studies & meta-analyses have been published over the last 10 years, looking at the results for both procedures. The majority of these report no significant differences (see particularly 4, 5, 6, 11, 15). Differences in ROM were in the order of 0.7 to 3º, & laxity differences approx 1mm (11). Rates of graft failure were also not-significantly different (5, 9, 11). The initial strength of the 4-strand HG is stronger than the BPTB (5, 10) but the difference at 3 months+ is probably insignificant. Only 1 study that I read, performd in Sweden, compared the different operations, performed by different surgeons, within the one study (6). There were no significant differences between the groups, although the HG group had better ability on a 1 leg-hop test (at av. 26 months). There was no difference in subjects ability to return to their previous sporting level (4)

Hamstring strength deficits, up to 11% in HG group, were of "questionalble clinical significance" (11), and after 1 year there was no strength differences (3, 6 ). Hamstring strength was found to be reduced in the HS compared to BPTB at 9 months (12). A study with 2 year follow-up (8) found some weakness at 90º, but not at lesser angles where functional strength is required for most sports. The weakness at 90º may have been due to the fact that rehabilitation would be likely to target strength between 0 & 90º , and often not beyond. One study specifically looked at hamstring strength, & found isometric strength returned to normal at 3 months, & isokinetic strength returned to normal at 12 months (13). Ferretti et al (3) examined biopsies of the hamstring / gracilis to assess the extent of regeneration, and found that the tendons showed complete regeneration, particularly at 24 & 27 months. (Ultrasound studies suggested regeneration back to normal at 18 months). The difference was that the regenerated tendon(s) were found to insert approx 3cm higher than the original pes anserinus insertion point, - in the 'gastrocnemius fascia'. But regardless of this there were no significant strength deficits.

While the BPTB procedure results in quicker graft to bone healing (approx 6 weeks) the HG procedure takes approx 8 (2) to 12 weeks (4) to reach good graft to bone strength. However this is not a disadvantage under conventional rehabilitation protocols, where the graft is subject to only minimal stresses during the first 3 months.

There is no question that the BPTB group have more pain on kneeling (5, 6, 9, 11). And anterior knee pain was found to be greater in the BPTB group in 4 studies (6, 9, 12, 14). This may have been partly due to damage to the infrapatellar branch of the saphenous nerve. However, it may also be due to prolonged deficits in extension strength, even at 7 years post-op after BPTB graft (14). This deficit was found to correlate strongly with anterior knee pain & with patellofemoral arthritis. Certain studies showed a greater chance of some loss of extension range with BPTB (4).

An increased incidence of OA in patients having the BPTB graft has been reported (9, 14). It has been suggested this is due to altered knee kinematics resulting in decresed knee flexion moment & increased loading of the medial compartment. One study (4), which looked at gait patterns between the two groups, found the BPTB group had less knee flexion on heel strike (probably to reduce patellar tendon or joint stress). This would result in reduced shock absorption, thus potentially contribute to OA. A Swedish study looked at OA incidence in the two groups, using radiographic & clinical examination (7). They had a median follow-up of 86 months. There was a small but statistically insignificant increased OA incidence in the BPTB group.

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