BTB Vs Hamsrtings – Is There a Winner Yet?

Sachin Tapasvi¹ Sachin Jain², Ashok Shyam²³

Abstract

Bone patella tendon bone (BPTB) graft versus Hamstring (HT) Graft is still an issue that is debated. Both the graft have stood the test of time with high patient satisfaction however each have their own advantages and disadvantages. BPTB has advantages of good stability and bone to bone healing and disadvantage of anterior knee pain, numbness and quadriceps weakness. HT graft have advantage of less donor site morbidity, less extension deficit and disadvantage of having a slightly higher failure rate and hamstring weakness. Irrespective of these named advantages and disadvantages the patient reported outcomes are similar with both graft and difference in choice of graft is poorly understood. In this review we simply try to bring our reader up-to-date with the current literature on this controversy.

Keywords: Bone patella tendon bone graft, hamstring graft, anterior cruciate ligament reconstruction.

Introduction

Anterior cruciate ligament (ACL) is required for static and dynamic stabiliser of the knee joint and purpose of ACL reconstruction is to stabilize and to resume function to maximum extent (1, 2). The ideal graft for use in anterior cruciate ligament reconstruction should have structural and biomechanical properties similar to those of the native ligament, permit secure fixation and rapid biologic incorporation, and limit donor site morbidity (3). Moreover, these properties should be present at the time of graft implantation and persist throughout the incorporation period too (3).

Graft options available are broadly grouped into autograft such as bone patellar bone tendon graft (BPTB), hamstring graft, Quadriceps graft and allograft such quadriceps, patellar, Achilles, hamstring, and anterior and posterior tibialis tendon graft (3-6).

Allografts are useful to minimize donor site morbidity but are associated with increased cost, slower incorporation time, increased risk of disease transmission, and a higher failure rate (2). The synthetic grafts are yet to prove themselves and currently the most commonly used graft used for ACL reconstruction are autografts namely hamstring or BPTB graft. With BPTB graft comes with advantages of excellent initial fixation, biomechanical properties, durability, success at long-term follow-up with reduced pivot shift test (7, 8) and disadvantage of few reports suggesting donor site morbidity of patellofemoral osteoarthritis, scar formation with shortening of the patellar tendon, loss of terminal knee extension, and patellofemoral pain(2,9,10).

Semitendinosus and gracilis tendons (quadrupled hamstring tendon [HT]) have found to minimize donor site morbidity causing less anterior pain(8) with disadvantage of numbness of the anterior knee caused by injury to the infrapatellar branch of the saphenous nerve during graft harvest (2), longer rehabilitation period (3,10) and persisting pivot shift test at long term follow up (7).

There are multiple extrinsic and intrinsic confounding variables (11) while studying the results of ACL reconstruction out of which isolated effects of a single extrinsic variable of graft choice is to be made.

Method of Review

There are several review articles published in literature including Pubmed, Medline and Cochrane database to compare of graft superiority (hamstring versus BPTB) in ACL reconstruction. We primarily did a pubmed search with Bone-Patellar Tendon-Bone Grafting as the Mesh major keyword. Two hundred and eighty five article were found and reviewed. There were 51 articles that either compared the two grafts or were meta-analysis of such articles. These 51 articles were then further reviewed to construct this review.

There were 9 metanalysis among these 51 articles and 3 additional systematic reviews (1,4,7, 11-20). The Cochrane review of 2011 and a systematic summary of systematic reviews was also added to this list (21,22). Results of all these reviews were compiled and presented in Table 1. Other relevant articles were added to the review depending on the significance of their findings.

It was noted that in most article the main areas of comparison between the two grafts were stability, donor site morbidity, complications, rehabilitation status, functional outcomes and revision rates due to graft. The present review is also arranged in this format.


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Table 1: Comparative analysis of meta-analysis comparing BPTB and HT autograft

**Functional outcome**

Functional outcome was measured in most of the articles using scores like Lysholm knee score, Tegner activity level, International Knee Documentation Committee (IKDC) scores etc. None of the studies found any difference in functional outcome measured (1,4,7,11-19,23-25) and hence both the grafts are equally effective in terms of restoring the functional ability of the patients. Pinczewski et al noted that Level 1 and 2 sports activities were significantly reduced from 73 to 85% (short term) to 45-57% (long term results) in both HT and BPTB groups (11). Recent review mentions that patients with HT graft are almost twice more likely to return to sports than for BPTB and HTB were superior to HT in resuming stability of the knee joint.

<table>
<thead>
<tr>
<th>Study</th>
<th>Functional outcome</th>
<th>Stability</th>
<th>Failure</th>
<th>Overview</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Xie et al. Knee. 2015 (12)</td>
<td>No difference</td>
<td>No difference</td>
<td>No difference</td>
<td>BPTB graft achieve better rotational stability and patients can return to activity early. HT graft had lower complications like knee pain.</td>
<td>Insufficient Evidence to establish superiority of either graft</td>
</tr>
<tr>
<td>2: Xie et al. Eur J Orthop Surg Traumatol. 2015 (14)</td>
<td>No difference</td>
<td>No difference</td>
<td>No difference</td>
<td>BPTB autografts resulted in increased anterior knee pain and kneeling pain and also increased incidence of osteoarthritis. There was no difference in return to activity</td>
<td>More studies are required before drawing a reliable conclusion.</td>
</tr>
<tr>
<td>4: Li et al. Arch Orthop Trauma. 2012 (15)</td>
<td>No difference</td>
<td>BPTB was superior to HT</td>
<td>-</td>
<td>HT autografts were inferior to BPTB autografts for restoring knee joint stability, but were associated with fewer postoperative complications.</td>
<td>Insufficient evidence to favour either</td>
</tr>
<tr>
<td>5: Li et al. Knee. 2011 (1)</td>
<td>No difference</td>
<td>BPTB was superior to HT</td>
<td>No difference</td>
<td>Outcomes favouring BPTB autografts were found in terms of KT 1000 arthrometer values, negative rates of Lachman tests and negative rates of Pivot tests. Outcome measures that favoured HT autografts included anterior knee pain, kneeling pain and extension loss. Postoperative complications were lower for HT than for BPTB and HTB were superior to HT in resuming stability of the knee joint.</td>
<td>Insufficient evidence.</td>
</tr>
<tr>
<td>6: Mohtadi et al. Cochrane Database Syst Rev. 2011 (21)</td>
<td>No difference</td>
<td>BPTB was superior to HT</td>
<td>No difference</td>
<td>BPTB had more knee pain. BPTB reconstructions resulted in significant loss of extension and loss of knee extension strength. HT reconstructions demonstrated a trend towards loss of flexion range of motion and a statistically significant loss of knee flexion strength.</td>
<td>Insufficient evidence.</td>
</tr>
<tr>
<td>7: Reinhardt et al. Ortho Clin North Am. 2010 (4)</td>
<td>No difference</td>
<td>No difference</td>
<td>HT has higher failure rate</td>
<td>When only high-quality randomized clinical trials are evaluated, the risk of graft failure is significantly higher with hamstring tendon reconstruction compared with patellar tendon autograft.</td>
<td>More failure when HT was used.</td>
</tr>
<tr>
<td>8: Blau et al. Am J Sports Med. 2009 (7)</td>
<td>-</td>
<td>BPTB has better rotational stability</td>
<td>-</td>
<td>Postoperative knee instability was less common after ACL reconstruction BPTB</td>
<td>HT is more unstable.</td>
</tr>
<tr>
<td>9: Poolman et al. Acta Orthop. 2007 (17)</td>
<td>-</td>
<td>HT is as stable as BPTB</td>
<td>-</td>
<td>Reduced morbidity using HT with modern techniques improving stability</td>
<td>Poor quality of the studies calls into question the robustness of the analyses.</td>
</tr>
<tr>
<td>10: Blau et al. BMJ. 2006 (18)</td>
<td>BPTB offered better stability</td>
<td>-</td>
<td>Morbidity was lower for HT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11: Anderson et al. Orthop J Sports Med. 2016 (22)</td>
<td>No difference</td>
<td>BPTB has greater improvement in stability</td>
<td>No difference</td>
<td>Anterior knee pain and kneeling pain occur more frequently with BPTB and there is possibly a decrease in quadriceps isokinetic strength</td>
<td>BPTB is more stable but has more knee pain and kneeling pain.</td>
</tr>
</tbody>
</table>
but patient with BPTB Graft are more likely to return or exceed the preoperative sports level [22]. Other also indicate that patients with BPTB graft return to activity earlier than the HT graft [12]. This may be probably because BPTB graft provide more static and rotational stability [1,15]. Poolman et al [17] commented that modern techniques of HT graft will further increase stability and improve return to activity. However this is not confirmed by recent articles and possibly better controlled trials will be needed to eventually answer the question.

Donor site morbidity and complication after graft harvesting
When overall incidence of morbidity was reviewed, HT graft patient have lower incidence of morbidity (12,15). Anterior knee pain and kneeling pain was significant in BPTB group as compared with HT group(1–3,11,23). Anterior knee pain is related to the secondary chondromalacia patella which happens after ACL reconstruction regardless of graft type but it is noted that it can be five times greater in BPTB group versus HT group(2). There was a significant extension loss of >5 degrees in BPTB group versus HT group(1). It is noted that there was a concentric and eccentric reduction in Quadriceps power which was related to poor satisfaction rates (23). The Cochrane review in 2011 noted that BPTB Graft resulted in loss of knee extension range and strength while HT graft showed trend toward loss of flexion range and strength [21]. There was a slight risk of patellar fracture which was mainly related to the errors in the surgical technique or use of unnecessary deeper saw cuts or osteotomies(23). Other donor site problems noted were patellar tendinitis, rupture of patellar tendon, increased joint stiffness, late chondromalacia and injury to infrapatellar branch of saphenous nerve(2,3,23). Reduced ultimate range of motion may be related to the rigid construct used in fixing BPTB graft (2). Other disadvantage of hamstring graft are injury to the superficial branch saphenous nerve and weakness of the hamstring muscles after operation (23, 24).

Stability
Stability has shown varied results in different studies and possible is a function of surgical technique and rehabilitation [Table 1]. Stability was assessed by Lachman test, pivot shift test and KT -1000 arthrometer in most series. Some authors reported no significant difference between either HT or BPTB group at long term follow up (11, 2). However, in mid-term follow up the side-to-side instrumented laxity (>2 mm) was greater in HT group as compared to BPTB group (7). BTPB is also found to be more rotationally stable with respect to pivot shift test (1).

Stability in case of HT graft was based on the number of strands used during surgery when compared with BPTB graft (1). When a 2 strand HT graft was used a statistical difference was noted in case of KT – 1000 and pivot shift test in favour of BPTB graft whereas Lachman test was not significant in both groups. If a 4 strand HT graft with a suspensory fixation like endobutton was used then the statistical difference was not significant in both the groups and had near normal Lachman, pivot shift tests and KT – 1000 testing(1,10,26–28). There is a slightly higher degrees of laxity noted in quadrupled hamstring graft as compared with BPTB graft especially in females in long term studies(2,20). Cochrane review noted that BPTB reconstructions are more likely to result in statically stable knees but they are also associated with more anterior knee problems. However there is insufficient evidence to predict superiority of one graft over other in long results in respect to functional outcome(21). In a study, comparing double bundle reconstruction with HT graft and anatomical BPTB graft positioning equal results are found with respect to stability and laxity throughout the range of motion(29). The recent summary of metaanalysis however concluded that BPTB graft are more stable as per the current available evidence (22).

Rehabilitation
It is noted that integration of bone to bone healing with direct insertion is much faster in BPTB graft as compared to bone to soft tissue healing by means of indirect insertions with sharpey’s fibres in case of HT graft(23). So with rapid incorporation with graft healing to bone, there is potential for accelerated rehabilitation in BPTB graft and may be earlier return to play sports activities(3,23).

Failure rates
There is no obvious difference in the occurrence of ligament failure between HT group and the BPTB group after ACL reconstruction in long term studies but a
few studies demonstrate reduced failure rates with BPTB graft (1). Hamstring graft harvest weakens the knee flexor strength leading to slightly higher degrees of graft failure (2,4). However, these studies had a selection bias which had included studies using double or triplestrand graft which gave slightly higher failure rates. Long term studies have shown to have equal success rates with quadrupled hamstring graft or BPTB graft (8,20). Moreover, it is also noted that the fixation modality and anatomical placement of ACL is responsible for low failure rates (20). It has been noted that contralateral ACL tear with BPTB graft is statistically significant as compared to HT graft in short term studies whereas in long term studies there is no increase in contralateral ACL tear (8). A risk factor for contralateral ACL rupture was a return to sports that involved sidestepping, pivoting, and jumping (8). In a registry study based on 45,998 primary ACL Reconstructions in Scandinavia it was found that patients receiving patellar tendon autografts have a statistically significantly lower risk of revision compared with patients receiving hamstring autografts (5).

Conclusions

As per current reviews and evidence, both graft achieve good functional outcome in patients. BPTB graft may offer a more stable knee and possible achieve rapid and effective return to preinjury activity level. HT graft have less donor site morbidity and with new effective fixation modalities, they may also match the stability achieved by BPTB grafts. However there is insufficient evidence to clearly establish a winner and probably more robust future studies will be better able to define the role of each of these autograft options.


