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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| For a 21 year-old male soccer player with an anterior cruciate ligament (ACL) rupture, does a patellar tendon or hamstring tendon autograft provide more knee stability post-surgery? |

**AUTHOR**

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| **Prepared by** | Thomas Reid Medlin | **Date** | 11/22/2014 |
| **Email address** | Thomas\_medlin@med.unc.edu | | |

**CLINICAL SCENARIO**

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| My reason for asking this question comes from a personal experience when my younger brother tore his ACL at the age of 18. I remember the surgeon talking to my brother and father about the different outcomes of using a hamstring versus patellar tendon autograft. The surgeon didn’t seem to have a good reason for using one over the other, and this always left me wondering if one provided more knee stability after surgery. This findings from this research question could allow me to offer evidenced-based suggestions to patients or families of patients who may be unsure as to which type of autograft to use. If one type of autograft can provide more knee stability, this might allow athletes to return to sport with fewer complications and possibly decrease the incidence of re-injury. |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| * A total of 16 relevant studies were located that met the inclusion/exclusion criteria and categorised as shown below in the table (based on Levels of Evidence, Centre for Evidence Based Medicine, 2011) and (PEDro and AMSTAR) quality assessment rating scales. Studies include 5 systematic reviews or meta-analyses or randomized controlled trials (RCTs), 6 RCTs, and 5 low-quality RCTs, individual cohort studies, and case-control studies. Three studies providing the supporting evidence were reviewed and discussed. * Statistically and clinically significant differences were found in favor of patellar tendon autografts over hamstring autografts in regards to static knee joint stability measures. In general, patellar tendon autografts were associated with increased amounts of anterior knee pain and pain with kneeling. * Hamstring tendon autografts are generally associated with decreased extension range of motion, while patellar tendon autografts are associated with more restrictions in flexion range of motion and decreased flexion strength. * Key points for future research included higher and longer-term follow-up of outcome measures and inclusion of more well-designed, high-quality RCTs to address ligament failure in order to address bias and reasons for failure. Strict methodology, conduct and reporting are needed in future trials in order to help resolve the existing controversy of the issue of autograft type of surgical reconstruction of the ACL deficient knee. |

**CLINICAL BOTTOM LINE**

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| There is insufficient evidence to draw conclusions on differences between patellar tendon and hamstring tendon autografts for long-term functional outcome. While PT reconstructions are more likely to result in statically stable knees, they are also associated with more anterior knee pain and pain during kneeling. Future research is required to determine the optimal choice for autograft type in regards to functional stability of the knee. |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

*The above information should fit onto the first page of your CAT* **SEARCH STRATEGY**

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| **Terms used to guide the search strategy** | | | |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| Athlete\*  Male  Female  Young adult  Adolescent\*  ACL  Anterior cruciate ligament  Rupture  Tear | Autograft  Graft  Surgery  Reconstruction  Ligament  Anterior  Cruciate  Knee | Patella  Tendon  Knee  Surgery  Autograft  Graft  Reconstruction  Hamstring  Semitendinosus | Stability  Knee  Return to activity  Return to sport |

**Final search strategy:**

*Show your final search strategy from one of the databases you searched. In the table below, show how many results you got from your search from each database you searched.*

I initially included the following search terms in PubMed:

1. athlet\* OR male OR young adult OR adolescent\*
2. ACL OR anterior cruciate ligament OR rupture OR tear
3. autograft\* OR graft OR surgery OR reconstruction OR ligament OR anterior OR cruciate OR knee
4. patella\* OR hamstring OR semitendinosus OR tendon OR knee OR surgery
5. stability OR return to sport OR return to activity OR function\* OR knee

The advanced search option that I used automatically connected each line above with “AND.”

I then sorted results by relevance and applied the following limits: published in the last 10 years, English, RCTs, and Human. I kept getting thousands of unrelated results and I figured out it was due to my inclusion of “function\*,” so I removed it.

After searching through PubMed, CINAHL, and SPORTDiscus, and reviewing articles, I was only able to find 1 study (Mohammadi et al.) looking exclusively at male subjects that met my inclusion criteria. Because of this, I decided to make it less specific and altered my research question to include both genders. Including both genders in my search allowed me to include more studies and critique them for my CAT. I took “male” out of my search and lifted the limit of male gender as well.

At first, the inclusion of both genders produced many relevant and irrelevant results. To help filter out irrelevant results, I used the Boolean term NOT with “Achilles,” “platelet,” and “allograft.” These three terms were being included in articles that were not studying my intervention of interest. I also added an age filter, only including adolescents (13-18 years), Adults (19+ years) and Young Adults (19-24 years). This allowed me to capture studies that included participants in the young-adult age range that I wanted, with 320 final search results.

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed**  **CINAHL**  **SPORTDiscus** | 14,597 initial results  2,591 initial results  1,552 initial results | Published in last 10 years, English, RCTs, Human  🡪 **320 total results** Published 1998-2014, English only, RCTs, Human, Ages 13-18 & 19-44  **🡪 130 final results**  Published 1998-2014, English, Publication type: Academic journal & electronic resource, RCTs  **🡪 186 final results** |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| * Randomized controlled trials, controlled trials, meta-analysis, systematic reviews * Published up to September 2014 * Studied a population of athletic young adults, with average patient age < than 30 * Published in English * Individuals who used autografts vs allografts |
| **Exclusion Criteria** |
| * Case studies or case series * Abstracts, conference proceedings, letters to the editor, dissertations, narrative review articles * Individuals who used allografts * Articles published before 1998 * Animal subjects * Studies on non-surgical interventions for ACL ruptures * Average patient age > 35 |

**RESULTS OF SEARCH**

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| A total of | **16** | relevant studies were located and categorised as shown in the following table (based on Levels of Evidence, Centre for Evidence Based Medicine, 2011) and (PEDro and AMSTAR) quality assessment rating scales |

**Summary of articles retrieved that met inclusion and exclusion criteria**

*Note that this table is arranged differently from the example CAT on Sakai. For each article that meets your inclusion and exclusion criteria, score for methodological quality on an appropriate scale, categorize the level of evidence, and note the study design (e.g., RCT, systematic review, case study). Add more rows as necessary.*

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| **Author (Year)** | **Study quality score** | **Level of Evidence** | **Study design** |
| **Aune et al. (2001)** | **9** | **1b** | **RCT** |
| **Biau et al. (2009)\*** | **7** | **1a** | **Meta-Analysis** |
| **Ejerhed et al. (2003)** | **9** | **1b** | **RCT** |
| **Gifstad et al. (2013)** | **7** | **2b** | **Low quality RCT** |
| **Gobbi, A; Francisco, R. (2006)** | **5** | **2b** | **Low-Quality RCT** |
| **Goldblatt et al. (2005)\*** | **7** | **1a** | **Meta-Analysis** |
| **Heijne, A; Werner, S. (2010)** | **6** | **2b** | **Individual Cohort Study** |
| **Li et al. (2012)\*** | **8** | **1a** | **Systematic Review** |
| **Magnussen et al. (2011)\*** | **6** | **1a** | **Systematic Review** |
| **Mascarenhas et al. (2012)** | **4** | **3b** | **Case-Control Study** |
| **Mohammadi et al. (2013)** | **7** | **1b** | **RCT** |
| **Mohtadi et al. (2011)\*** | **10** | **1a** | **Cochrane Review  (Meta-Analysis)** |
| **Roe et al. (2005)** | **6** | **2b** | **Individual Cohort Study** |
| **Sajovic et al. (2006)** | **7** | **1b** | **RCT** |
| **Taylor et al. (2009)** | **8** | **1b** | **RCT** |
| **Zaffagnini et al. (2011)** | **8** | **1b** | **RCT** |

**\*** Study quality was scored using the AMSTAR. All other studies scored using the PEDro scale. Both scales range from 0-11, with 11 being the highest quality.

**BEST EVIDENCE**

The following 3 studies were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were:

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| * **Mohtadi et al. (2011)**: This Cochrane review included 19 high-quality RCTs, with average follow-up ranging from 24-102 months. Knee joint stability measures, as well as return to activity/sport participation, were included outcome measure. Risks of multiple sources of bias from each study were analyzed as well. Overall, 91.4% of the total participants that were recruited into the included studies were included in follow-up analyses. Four high-quality RCTs were included in this review, which is another reason why I chose it. * **Li et al. (2012):** This newer systematic review, reviewing 11 RCTs, takes into account more recent publications that were not available at the time when some of my other systematic reviews were published. It includes one of my RCTs that was not included in the above Cochrane review. Excluding quasi-RCTs helped this review decrease the risk of selection bias where allocation is not concealed. Overall, 10 outcome measures were assessed, including multiple ones for knee stability. * **Taylor et al. (2009):** This high quality RCT was chose as one of my “best” evidence for a few reasons. It not only had numerous functional and knee stability outcome measures, but it also used orthopaedic surgeons for parts of the objective assessment that were blinded. Stockinettes were used to cover the patients’ knees, preventing the evaluator from determining graft type based on location. In addition, the population of subjects included in the study had a combined average age of 21.9 years old, which is very close to the population I am interested in researching. I chose this RCT over Ejerhed et al. because the average ages were closer to 30, it did not assess as many outcome measures relating to stability, and there were more potential sources of bias. Aune et al. was not included because of its older publication date and more out-dated information. |

**SUMMARY OF BEST EVIDENCE**

**(1)** Description and appraisal of Patellar Tendon Versus Hamstring Tendon Autografts for Anterior Cruciate Ligament Reconstruction: A Randomized Controlled Trial Using Similar Femoral and Tibial Fixation Methods by Taylor et al. (2009).

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| **Aim/Objective of the Study/Systematic Review:** |
| To compare different outcomes of ACL reconstructions using similar fixation methods with patellar tendon and 4-strand hamstring-tendon autografts. The hypothesis is that after ACL reconstructive surgery, no significant differences in outcomes between patellar tendon and hamstring tendon autografts will be found. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * A randomized control trial involving 64 young adults with diagnosis of a complete ACL tear. * Participants were randomized using a concealed allocation procedure into either a hamstring tendon (HS, n=32) or bone-patellar tendon-bone (BTB, n=32) autograft group after diagnostic arthroscopy. * All participants underwent similar dual fixation techniques on both the tibial and femoral surfaces, regardless of the type of autograft used. * All postoperative knees were placed in an immobilizer in a hyperextended position for 2-3 weeks and until adequate quadriceps control was gained with a limp-free gait. * Rehabilitation began for all participants on post-operative day 1 and all participants underwent identical strengthening and stretching protocols until return to full activity was achieved (but no sooner than 6 months postoperatively). * Participants were assessed preoperatively and at 2,3,and 4 years postoperatively using the Lysholm score, Tegner activity score, Single Assessment Numeric Evaluation (SANE), International Knee Documentation. Committee (IKDC) evaluation system, and Knee Injury and Osteoarthritis Outcome Score (KOOS). * Objective components of the 2000 IKDC evaluation were completed by blinded orthopaedic surgeons, using stockinettes to cover the knee to prevent the assessor from figuring out graft type. * Non-blinded physical therapists who were not involved in participants’ rehabilitation performed additional objective examinations and data collection. * Available postoperative radiographs were assessed for significant differences in tunnel placement between groups. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| * The study was conducted through the Keller Army Hospital in West Point, New York between 2000 and 2003, with most pre- and postoperative evaluations completed at this same location and a few at other evaluation sites. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| * 64 active military participants, 11 females and 53 males, with a confirmed diagnosis of an ACL-deficient knee from both a physical examination and MRI. * Recruitment procedures were not mentioned, sample of convenience; participants were “enrolled” from Keller Army Hospital * BTB group: N=32; 25 male, 7 female, mean age= 21.7 years, range 18-37; 20 patients with other associated injuries noted. * HS group: N=32; 28 male, 4 female, mean age= 22.1 years, range 17-44; 21 patients with other associated injuries. * Both groups were similar in terms of age, gender distribution, and time from injury to surgery. * 65.6% of ACL tears were due to noncontact injuries, with 27.0% of injuries occurring in football, 9.5% in basketball, 7.9% in both soccer and track and field. * Follow-up data was not included for 8 participants in final analysis due to graft rupture (n=7) and graft removal following infection (n=1). * Overall study follow-up was 83% for greater than 2 years, with 11 participants being lost to follow-up. * Sample size of 60 patients determined with a 5% probability of a type I error and a power of 80%. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| The authors considered the patellar tendon autograft to be the standard for ACL reconstruction, so this group of 32 participants served as the control. Post-surgical rehabilitation was uniform for both the control and experimental groups. |
| *Experimental* |
| The hamstring tendon autograft group (n=32) is considered to be the more experimental autograft, and is the intervention group in this study. Post-surgical rehabilitation was uniform for both the control and experimental groups. |
| **Outcome Measures** (Primary and Secondary)  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| All measures completed preoperatively and at 2, 3 and 4 years postoperatively, with both subjective and objective evaluation tools. All subjective assessments were self-administered.  Subjective measures:   * Single Assessment Numeric Evaluation (SANE): considered by the authors to be the primary outcome measurement. Patients answer the question “On a scale from zero to 100, how would you rate your knee today (with 100 being normal)?" * Lysholm score: measures the effect of ACL reconstruction on ADLs. Range is 0-100, with higher scores representing less dysfunction in daily activities. * Tegner scale: measure that provides a standardized method of grading work and sporting activities. It is a graduated list of activities of daily living, recreation, and competitive sports. Pre-injury and current scores are obtained. Range is 0-10, with higher scores representing participation in higher-level activities. * Subjective/symptoms portion of the 2000 IKDC evaluation system: assesses domains of symptoms, functions of daily and sports activities, current function of the knee, and participation in work and sports. Subscale scores are transformed to a scale with a range from 0-100, with higher scores representing higher levels of function. * Knee Injury and Osteoarthritis Outcome Score (KOOS): assessment of knee-related quality of life, ADLs, sport and recreation function, symptoms, and pain. Each of the scores from the 5 subscales is normalized to a 0-100 scale with higher scores equalling better status.   Objective measures: (compared to non-involved contralateral knee)   * Objective portion of the 2000 IKDC evaluation system: conducted by blinded orthopaedic surgeons, using stockinettes to cover patients’ knees. Components include effusion, passive motion deficit, ligament examination, compartment findings, harvest site pathology, x-ray findings, and single-legged hop functional test. Each component has 4 possible grades, A, B, C, or D, with A being “normal” and D being “severely abnormal.” The worst group grade determines the final evaluation grade for acute and subacute patients, while and pre- and postoperative evaluations are compared for chronic patients. * Additional objective data collection conducted by non-blinded physical therapists included differences in: * Knee and thigh girth (at mid-patella level, 10 cm superior to patella, and 15 cm superior to patella) * Heel height (nearest half-centimeter) * Range of motion (nearest 5°) * Isokinetic strength (concentric knee extension and flexion torques at 60deg/s and 300 deg/s speeds) * Functional performance (single-legged hop for distance and 6 min single-legged hop for time) * Anterior tibial displacement with the KT-2000 arthrometer (at 134 N of pull; done at Keller Army Hospital). |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| * No statistically significant differences were found between the 2 groups on subjective outcomes from the SANE (P=0.53), KOOS (P= .57) or Lysholm (P=.97) * SANE score (primary outcome measure) for HS group was 88.5 (95% CI: 83.1, 93.8) and 90.1 (95% CI: 85.2, 96.1) for BTB group * There was no significant difference between groups in joint laxity (anterior tibial displacement) (P=.85) * Overall Tegner score at follow up for the BTB group was 6.8 and was 5.3 for the HS group, which was significant (P=.04). This means that BTB patients were able to return to a higher level of pre-injury activity. (p. 1952) * No statistically significant differences were found between groups in both subjective and objective outcomes on the IKDC, including patient-reported pain with kneeling (subjective assessment P=.33, overall objective evaluation P=.22) * No statistically significant differences were found between the 2 groups in the 6-meter single-legged hop test (least-squares means (LSM): BTB= 100.4, HS=104.7, P=.38) or single legged hop for distance (LSM: BTB= 97.0, HS= 96.7, P=0.94) * No statistically significant differences were found between groups in differences in heel height (P=0.55), range of motion, girth, or peak torque knee extension or flexion (isokinetic strength). * Radiographic evaluation of tunnel placement revealed no significant difference for femoral tunnel placement (P=.99) and coronal tibial tunnel angle (P=.51) between the 2 groups. * A significant difference did exist in coronal tibial tunnel angle between the 7 patients who suffered ruptured grafts and the 44 who did not (P=.03). (p. 1952) * 3 BTB graft ruptures occurred after 1 year; 4 HS grafts ruptured, with 3 occurring before 1 year. No significant difference in estimated time to graft failure between groups was found (hazard ratio of 0.75, P=.69). * No statistically significant difference was found in the number of associated injuries between the control and intervention groups. * No significant differences in average follow-up time were found between the 2 groups (P=.16) * Average follow-up was 2.7 years for the BTB group (95% CI: 2.2, 3.1) and 3.2 years for the HS group (95% CI: 2.6, 3.7) |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| “At midterm follow-up averaging 3 years, we found that the BTB group had higher Tegner activity scores than the HS group. Further study is warranted on this finding. More horizontal tibial tunnel angles were associated with graft ruptures, independent of graft choice. Aside from these results, we found no other significant differences in patient-reported outcome measures, objective evaluations, and functional testing after ACL reconstruction when using either a BTB or HS autograft. Both grafts provided acceptable results in this very active military population, allowing our patients to return to strenuous activities in demanding environments.” (Taylor et al., 2009, p. 1956).  “Interestingly, we did find that the 7 patients whose grafts ruptured had a smaller (more horizontal) mean coronal tibial tunnel angle (62.2°) than the 44 (69.3°) whose grafts were intact at follow-up.” (Taylor et al., 2009, p. 1955). This led the authors to conclude that some of their graft failures may have been due to tibial tunnels with orientations too horizontal in the coronal plane; they suggest that tibial angles less than 65° may contribute to an increased risk of graft failure. |
| **Critical Appraisal** |
| **Validity**  [Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]  Comment on missing information in original paper. |
| * PEDro Score: 8/10 based on Eligibility Criteria: Yes; Random Allocation: Yes; Concealed Allocation: Yes; Baseline Comparison: Yes; Blind Subjects: No; Blind Therapist: No; Blind Assessors: Yes; Adequate Follow-up: No; Intention-to-treat analysis: Yes; Between Group Comparison: Yes; Point Estimates and Variability: Yes. (Eligibility score does not contribute to total score.) * Further minimized bias by performing all surgical operations in the same manner, utilizing the same fixation methods, and making sure all postoperative rehabilitation and bracing were identical for all participants. * Major weakness was lack of follow-up on objective measures, with 11 patients lost to overall follow-up. In addition, active duty participants who moved overseas during follow-up made the number of subjective examinations obtained greater than the number of objective evaluations (this was noted throughout the authors’ results). * Data from the 8 participants who suffered graft rupture or failure was not included in the final analysis. * Even though both groups were similar in terms of gender distribution, there were far fewer females than males in the study, which could have created bias in the selected patient population. * The authors address the possibility of transfer bias by stating, “… the reason for incomplete follow-up is unlikely related to poor results. In the close military system health system, patients with poor results limiting their performance would be more likely to be identified and included in follow-up than those with good results. Nevertheless […] we acknowledge that the limited follow-up does reduce power in our objective data and weakens the study, especially with results showing no significant differences between the 2 groups.” (Taylor et al., 2009, p. 1956). * Interestingly, one of the authors (Dr. DeBerardino) declared a potential conflict of interest. He received research support from Arthrex unrelated to this study, and has also been an instructor for Arthrex-supported courses. * Limitation in generalizability of results given 100% military population * Included subjective measures may introduce bias |
| **Interpretation of Results**  [Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| * Hamstring and patellar tendon autografts provide similar results on patient-reported outcome measures, objective evaluations, and functional testing after ACL reconstruction. * The only statistically significant finding from this study was that BTB patients had greater Tegner activity scores, meaning BTB patients able to return to a higher level of pre-injury activity level. * Clinical significance related to the study suggests that patients with BTB autografts are more likely to return to pre-injury activities versus HS autografts. * Another clinically significant find is related to the surgical revision technique. Specifically, the authors found that a more horizontally oriented tibial tunnel angle (less than 65°) in the coronal plane increased the likelihood of graft rupture. * Authors used the SANE score as their primary outcome measure, due to high correlation with other included outcome measures. Using other highly correlated outcome measures allowed the authors to capture both overall as well as specific outcome data, depicting more comprehensive conclusions. * Even though the authors calculated a needed sample size of 60 patients with an 80% power level, the lack of follow-up decreases this power. This could have contributed to the authors’ finding no statistically significant differences between graft types (a possible type II error). * The outcome most relevant to my clinical question is anterior tibial displacement (or joint laxity, as measured by the KT-2000 arthrometer). While statistically significant differences between graft types were not found in objective measurements on the IKDC (ligament laxity and examination via manual, instrument and x-ray), 86% of BTB patients were rated normal or nearly normal, while 78% of HS patients were achieved this rating. The authors claim that this is consistent with previously published data; however, this previously published data found 73.5% of BTB groups and 80.8% of HS groups to be scored as normal or nearly normal on the IKDC. While the differences between the previously published means and this current study’s means may not be statistically significant, their differences do seem to have clinical significance. |

**(2)** Description and appraisal of A systematic review of randomized controlled clinical trials comparing hamstring autografts versus bone-patellar tendon-bone autografts for the reconstruction of the anterior cruciate ligament by Li et al (2012).

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| **Aim/Objective of the Study/Systematic Review:** |
| To conduct a meta-analysis of RCTs to compare the effectiveness of ACL reconstruction using either BPTB autografts or HT autografts. The hypothesis is that ACL reconstructions using either type of autograft will offer similar stability and functional outcomes, with the BPTB autografts being associated with more post-operative complications. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * Systematic review and meta-analysis of 9 RCTs pertaining to ACL reconstruction comparing BPTB autografts with HT autografts.   **Methods**  Inclusion Criteria   * Patients with a unilateral ACL injury requiring reconstruction. * RCTs pertaining to ACL reconstruction comparing BPTB autografts to HT autografts. * Number of HT strands and type of graft fixation technique were not limited.   Exclusion Criteria   * Quasi-randomized RCTs. * Patients with ACL revision or with abnormal radiographs or with injury of the contralateral knee. * Patients with an extra-articular augmentation procedure and those with a follow-up time of < 24 months.   Literature Search   * Databases searched included the Cochrane Central Register of Controlled Trials, MEDLINE, and EMBASE for eligible trials up to December 2011. * Search terms included: ACL, transplants, reconstructive surgical procedures, autologous, patellar ligament, HS, hamstrings, semitendinosus, and gracilis. * Results then combined with the Cochrane highly sensitive search strategies for identifying RCTs (strategies not described in paper).   Selection of Studies and Data Extraction   * Independent screening of search results performed by 2 authors, comparing articles to ensure that included data was not repeated. * Articles were then selected independently according to inclusion criteria and data was extracted and crosschecked mutually. * Disagreements were resolved by discussion or adjudication by a third author. For the RCTs that were reported in multiple publications, data was extracted from the articles that included the same trial.   Data Synthesis   * Two authors reviewed data during entry to eliminate errors. Relative Risk (RR) used as a summary statistic to perform statistical analysis of variables and was reported with a 95% confidence intervals (CI). * A Chi-squared test was used to assess heterogeneity between studies, with a P value < 0.1 considered significant. * A fixed-effect model analysis was adopted when there was no statistically significant heterogeneity; a random-effect model was adopted if statistically significant heterogeneity was detected. * A per-protocol analysis was first conducted on all outcome measures, and then verified by an intention-to-treat analysis. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| Unspecified |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| * Nine RCTs with 798 patients were included, with 397 patients randomized to treatment (HT) groups and 341 patients randomized to control (BPTB) groups. * Meta-analysis was available for all included outcome measures except for patellofemoral crepitation (10 of 11 outcome measures). Data from the different outcomes was pooled from all 9 studies (9 of 9 studies). * Treatment groups included two trials of two-strand HT, 2 trials of three- or four-strand HT, and 5 trials of four-strand HT. * The range of ages in the included studies was 12-64 years, with male:female ratios ranging from 1.2-4.8 (no report of average ages included). * Follow-up ranged from 24 to 105 months * The number of patients in each study that were randomly allocated to either a HT or BPTB group were similar, with one exception. Laxdal et al (2005) reported 90 patients in the HT group and 44 patients in the BPTB group. * No report of patient recruitment methods for included studies was made. * Three trials reported a drop out/withdrawal/loss to follow up rate of > 20% (Beynnon et al, Laxdal et al, and Wipfler et al).   Assessment of Methodological Quality of Included Studies   * Evaluated independently by 2 authors using a tool for assessing risk of bias (described by Higgins et al 2008). The tool is composed of a description and judgment for each entry, with a “yes” meaning low risk of bias, “no” indicating a high risk of bias, and “unclear” meaning lack of information or uncertainty over the potential for a bias (6 point scale). Scores ranged from 3 to 6, with an average of 4.6. * Questions assessing quality included: * Was the allocation sequence adequately generated? * Was allocation adequately concealed? * Was knowledge of the allocated interventions adequately prevented during the study? * Were incomplete outcome data adequately addressed? * Are reports of the study free of suggestion of selective outcome reporting? * Was the study apparently free of other problems that could put it at a risk of bias? |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| The authors considered the BPTB autograft to be the control for this systematic review. No mention of post-surgical rehabilitative procedures in the included studies was made. |
| *Experimental* |
| The authors considered the HT autograft to be the intervention or treatment groups for this systematic review. No mention of post-surgical rehabilitative procedures in the included studies was made. |
| **Outcome Measures** (Primary and Secondary)  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| * 1995 IKDC (primary outcome measure, 7 trials) and 2000 IKDC (1 trial) scores; only the 7 trials using the 1995 IKDC were pooled for analysis. Scores were treated as dichotomous variables: normal and nearly normal versus abnormal and severely. * Lachman test (primary outcome measure, 5 trials); only 3 trials were pooled for analysis. Data treated as dichotomous variables: grade 0 versus grade >0. Measures anterior translation of proximal tibia on the femur at 25 degrees of flexion, can be measured in mm, usually positive or negative result. * Pivot test (primary outcome measure, 6 trials); only 5 trials pooled for analysis. Data treated as dichotomous variables: grade 0 versus grade >0. Valgus and internal rotation force is applied to extended knee, which is flexed past 30 degrees, positive or negative result. * Anterior knee pain (4 trials); no further description of outcome measure reported. * Kneeling pain (7 trials); only 6 trials pooled for analysis. No further description of outcome measure reported. * Extension loss (7 trials); 5 trials reported ≥ 5° compared to opposite lower extremity. * Flexion loss (9 trials); 3 trials reported data for flexion loss of ≥ 5° compared with opposite lower extremity. * Graft failure (8 trials); no further description of outcome measure reported. * Infection rate (6 trials); no further description of outcome measure reported. * Reoperations related to the meniscus (5 trials); no further description of outcome measure reported. * Patellofemoral crepitation (3 trials); definitions varied across studies and pooling of studies was not feasible. |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| Results from the meta-analysis revealed:   * A statistically significant difference was found (RR 0.87, 95% CI 0.79-0.96, P= 0.004) between groups on the Pivot test, indicating that BPTB autografts are superior to HT autografts in providing rotational stability. However, the authors report that the relationship between stability and Pivot test results needs further clarification. Test for heterogeneity showed that results were consistent across trials (P=0.11, I2= 47%). * There was a significantly lower rate of anterior knee pain (RR 0.66, 95% CI 0.45-0.96, P=0.03) as well as kneeling pain (RR 0.49, 95% CI 0.27-0.91, P=0.02) for the HT group. This indicates that BPTB autografts were associated with more post-operative complications, specifically anterior pain and kneeling pain. Significant heterogeneity across studies for kneeling pain was found (P=0.002, I2=73%), but exclusion of heterogeneous trials did not significantly alter results (RR 0.54, 95% CI 0.39-0.76, P= 0.0003). * No statistically significant difference was found in IKDC scores (restoration of knee joint function) after ACL reconstruction with HT autografts compared to BPTB autografts (RR 1.05, 95% CI 0.93-1.19, P=0.41). Heterogeneity was found among trials (P=0.05), but results after removing the study supplying heterogeneity did not change significantly (RR 1.08, 95% CI 0.99-1.18, P=0.07). * No statistically significant difference was found from the pooled analysis on the Lachman test between groups, indicating that both types of autografts provide similar effects in terms of restoring anterior stability of the knee (RR 0.65, 95% CI 0.18-2.34, P=0.51). Significantly heterogeneity was found (P < 0.0001), but exclusion of the heterogeneous trial did not significantly change the results (RR 0.94, 95% CI 0.77-1.14, P= 0.52). * No statistically significant differences were found between autograft types in regards to extension loss (RR 0.63, 95% CI 0.39-1.01, P= 0.05) and flexion loss (RR 1.03, 95% CI 0.78-1.35, P= 0.85). Results were consistent across trials for both extension loss (P= 0.50) and flexion loss (P= 0.80). * There was no significant difference between graft types in regards to graft failure (RR 1.37, 95% CI 0.67-2.81, P= 0.38). * No statistical difference was found between groups for post-operative infection (RR 1.04, 95% CI 0.46-2.35, P= 0.93). * Analysis of the incidence of reoperations related to the meniscus revealed no statistical difference between autograft types (RR 1.78, 95% CI 0.75-4.22, P= 0.19). * Pooling of 3 studies for post-operative patellofemoral crepitation was not performed due to differences in study definitions. |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| “The combined results of this meta-analysis, considering the limitations described above, indicate a statistical difference between HT autografts and BPTB autografts in terms of negative outcomes of Pivot tests, anterior knee pain and kneeling pain.” (Li et al., 2012, p. 1295).  “Thus, it is concluded from nine RCTs that ACL reconstruction with HT autografts achieved similar postoperative effects in terms of restoring knee joint function to BPTB autografts. However, HT autografts were inferior to BPTB autografts in restoring stability of the knee joint, although postoperative complications were less frequent with HT autografts.” (Li et al., 2012, p. 1295). |
| **Critical Appraisal** |
| **Validity**  [Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]  Comment on missing information in original paper. |
| * AMSTAR Score: 8/11 based on ‘a priori’ design: Yes; Duplicate study selection/data extraction: Yes; Comprehensive literature search: Yes; Status of publication used as inclusion criteria: Yes; List of included/excluded studies: No; Characteristics of included studies provided: Yes; Scientific quality of included studies assessed/documented: Yes; Scientific quality of included studies used appropriately in formulating conclusions: Yes; Methods used to combine the findings of studies appropriate: Yes; Likelihood of publication bias assessed: No; Conflict of interest stated: No. * As mentioned, the authors performed tests for heterogeneity on outcome measures and performed sensitivity analyses in order to remove those RCTs that contained the heterogeneity. That being said, there were multiple outcome measures with significant heterogeneity, suggesting that heterogeneity may be a problem in this systematic review. * Although this systematic review included only RCTs with correct participant allocation methods and randomization techniques designed to avoid bias, only 3 of the 9 trials utilized adequate allocation concealment. This provides an opportunity for allocation bias in the results. * Selection bias may exist, as the authors excluded patients with ACL revision or with injury to the contralateral knee. * The authors also utilized multiple statistical testing, including several primary outcome measures, which could have affected the Pivot test and kneeling pain results. * Three RCTs reported a drop-out/loss to follow-up rate > 20%; even though an intention-to-treat analyses were used in these 3 trials, statistical results may have been influenced in some way * Because non-English, meeting reports and unpublished trials were not included, some publishing bias may exist. * Most of the included studies had follow-up times of 2-3 years. This may not provide enough insight into the “long-term curative effect of ACL reconstruction with HT or BPTB autografts.” (Li et al. 2012, p. 1295). * The authors provide very general demographic data on patients from the included studies (age ranges, gender ratios). No mention of average ages for participants was made. * No list of excluded studies was provided, only reasons as to their exclusion (being a quasi-randomized trial, time of follow-up < 24 months). * While assessment of methodological quality of included studies was performed, the authors did not comment on the assessment tool’s reliability and validity. * Incomplete outcome data was not adequately addressed in 5 of the 9 trials, leading one to wonder which data were missing and why. The authors do not mention this at all in the systematic review. * Ligament failure data may have been affected by factors causing inevitable bias, such as trauma, failure-necrosis rupture of the graft, and loose fixation of the graft. Studies reported different reasons for ligament failure; the authors suggest a high-quality RCT to assess ligament failure. * Sometimes it was confusing whether the authors were reporting statistically significant results, or just statistical differences in their results. Their wording and reporting was confusing at times. The authors report that there was no statistical difference of postoperative incidence of anterior knee pain between the 2 groups, and then later conclude that post-operative knee pain after ACL reconstruction is lower in the HT group than in the BPTB group. |
| **Interpretation of Results**  [Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| * Hamstring and bone-patellar tendon-bone autografts provide similar results on knee joint function, anterior stability, flexion and extension loss, graft failure, infection rate, and reoperations related to the meniscus. * Statistically significant differences were found in regards to the Pivot test, with HT autografts being inferior to BPTB autografts in maintaining knee joint stability. This is the outcome most relevant to my clinical question, in addition to the Lachman test of anterior knee stability. * Statistical differences were found in anterior pain and kneeling pain outcomes, with HT autografts having less post-operative pain complications. * The authors reference previously published data and state that their results concerning higher knee stability and kneeling pain with BPTB autografts are consistent with these previously published reports. However, in one of these studies, quasi-randomized RCTs were included. * Cautious interpretation of these knee joint stability measures must be made, as the authors reported nothing of the post-rehabilitative efforts of the included studies. If participants in the included studies were subjected to increased loads before sufficient healing had occurred, the decrease in tension that follows may affect outcomes on the Pivot and/or Lachman tests. * Screw fixation techniques are predominately used in BPTB autograft procedures and a suspensory fixation is commonly used in HT autograft procedures. Suspensory fixation may lead to tunnel enlargement and influence knee stability due to their exhibition of longitudinal motion stemming from the distance from graft and fixation point. This may also play a role in results obtained on the Pivot and Lachman tests. * While this systematic review and meta-analysis is attempting to increase sample size and improve statistical power, issues with the included studies limit the strength and reliability of the results. The lack of adequate allocation concealment, in addition to inadequate addressing of incomplete outcome data of included trials, puts this systematic review and meta-analysis at risk for potential sources of bias. |

**(3)** Description and appraisal of Patellar tendon versus hamstring tendon autograft for anterior cruciate ligament rupture in adults by Mohtadi et al (2011).

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| **Aim/Objective of the Study/Systematic Review:** |
| The aim of this review was to compare the outcomes of ACL reconstruction using patellar tendon versus hamstring tendon autografts in ACL deficient patients.  “A key reason for performing this Cochrane review was to include more recent trials that utilize modern surgical techniques.” (Mohtadi et al 2011, p. 3). |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * Cochrane review and meta-analysis of 19 RCTs and quasi-randomized controlled trials comparing outcomes of patellar tendon versus hamstring tendon autografts for ACL reconstruction in ACL deficient patients.   **Methods**  **Inclusion Criteria**  Types of Studies   * RCTs and quasi-randomized controlled trials   Types of participants   * Skeletally mature patients with documented ACL deficiency in one knee that required ACL reconstruction   Types of Interventions   * Arthroscopically assisted ACL reconstruction using either a HT or PT autograft. * Single or double incision techniques, as well as double or multiple stranded HT grafts were included, as well as any fixation method of the graft.   Timing of Outcome Assessment   * Based on long-term follow-up, defined as greater than 2 years after ACL reconstruction. Minimum 2- year follow-up necessary for inclusion.   **Exclusion Criteria**   * Skeletally immature patients. * Interventions including allografts, synthetic materials and revision ACL reconstructions.   **Search Methods of Study Identification**  Search Strategy   * Electronic search consisted of the Cochrane Bone, Joint and Muscle Trauma Group Specialized Register (April 2008), the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE (1966 to April 10, 2008), EMBASE (1980 to April 10, 2008), and reference lists of articles. No constraints based on language or publication status. * Bibliographies of all papers identified by the search strategy were hand-searched. Proceedings of knee and arthroscopic surgeries and sports medicine meetings (1997 to 2006) were searched from the following organization: European Society of Sports Traumatology Knee Surgery and Arthroscopy, American Orthopaedic Society for Sports Medicine, International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine, American Academy of Orthopaedic Surgeons, World Congress on Orthopaedic Sports Trauma, and Arthroscopy Association of North America. To avoid bias, investigators of identified trials were contacted to retrieve results and data from unpublished studies.   **Data Collection and Analysis**  Study Selection   * Four review authors from either Calgary or Toronto independently applied the inclusion criteria to relevant citations for retrieval of full articles. If disagreement or doubt surfaced, the full article was obtained and each center independently assessed each full study to see if it met the review inclusion criteria.   Data Extraction and Management   * The same 4 review authors used pre-developed data-extraction forms to independently extract the data; data was then compared for each study to achieve consensus. Authors of individual trials were contacted for additional data or clarification if needed. * When missing data surfaced, trial authors were contacted. If standard deviations were missing, the mean SDs for the 2 groups from the other trials were used in an exploratory analysis.   Measures of treatment effect   * Risk ratios with 95% CIs were calculated for dichotomous outcomes and mean differences with 95% CIs for continuous outcomes   Data Synthesis   * Results of comparable groups of trials were pooled using a fixed-effect model; if heterogeneity existed, a random-effects model was used. * Heterogeneity was tested using a chi-squared test with significance (P value) <0.10 and the I-squared statistic >50%.   Sensitivity Analysis   * Sensitivity analysis conducted to compare randomized to quasi-randomized controlled trials and another on the effects of using inputed standard deviations. * Authors assumed that an exaggerated estimate of treatment effect would come from studies of lower quality.   Assessment of Risk and Bias in Included Studies   * Six domains of bias from The Cochrane Collaboration’s ‘Risk of bias tool’ were assessed: sequence generation, allocation concealment, blinding, completeness of data, selective reporting, and other bias. * The 4 review authors independently scored the methodological quality of the included studies, discussed within their center, and then reached consensus agreement between centers. * Scores ranged from 0/6 criteria met (8 studies) to all 6 criteria met (1 study).   Allocation   * Only 1 trial was rated low risk of bias from adequate sequence generation and allocation concealment. * 11 trials used forms of randomization, but were considered at high risk of bias from inadequate sequence generation and lack of allocation concealment.   Blinding   * Independent, blinded outcome assessors were involved in only 2 trials, using a stockinette to cover incision sites. * Independent, but non-blinded assessors were used in 8 trials, with the remaining studies not utilizing blinded or independent assessors. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| * 10 countries were represented: Australia, Finland, Germany, Italy, Japan, Kuwait, Norway, Slovenia, Sweden and USA. All settings were referral-based practices. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| * 19 studies reporting outcomes for 1597 patients were included in the final analysis and each reported long-term results (24+ months). * Authors included a table with the number of patients in each study who were lost to follow-up or withdrew. 89 total participants were lost to follow up, 25 were unaccounted for, and 2 died during follow up; none of these were included in the meta-analysis. * Average follow-up ranged from 24 to 102 months. * 8 studies used computer-generated randomization, sealed envelopes, or random number tables for randomization process. * 11 trials used a quasi-randomization process for allocation of treatment including birth date, alternating sequences, surgery date, or surgical register sequence. * Ages in the included studies ranged from 14-59 years, with the mean age in the trials ranging from 21.5 to 32 years. * Data from 17 of the 19 trials revealed 946 males and 477 females. * Gender comparison between PT and HT reconstructions was nearly identical (RR 0.98, 95% CI 0.91-1.05). * Sample sizes for the 19 trials ranged from 40 to 229 participants, with 6 trials utilizing an “a priori” power analysis to determine sample size. Five of these used KT arthrometer measurements for sample size calculations, while one based it on KT arthrometer measurement (134 N) with a side-to-side difference of 1.0 mm and SD of 1.5 mm. * The authors reported that there were unable to replicate all sample size calculations based on available information, mainly due to inconsistency with what was defined as the MCID, DS of the KT arthrometer measurement, and the power needed to show a difference between groups. * Details of specific study recruitment efforts were not described, but the authors do mention that due to the diverse geographical make-up of included studies, access to care and rehabilitation may have affected recruitment of participants into the trials. * Overall, 91.4% of the total participants recruited into included studies were included in the follow-up analyses * No differences were found with respect to the number of patients, gender distribution or chronicity of ACL deficiency at the minimum two-year follow-up period. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| The majority of studies considered the PT autograft to be the standard (control) intervention (13 studies). No mention of post-operative rehabilitative protocols was made for either group. |
| *Experimental* |
| The majority of studies considered the quadruple-looped HT autograft as the comparison, or intervention group (13 studies). No mention of post-operative rehabilitative protocols was made for either group. |
| **Outcome Measures** (Primary and Secondary)  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| **Primary outcomes**   * **Single-leg hop test** (9 studies): reported as the number of participants able to hop less than 90% of the non-operative leg * Return to activity / level of sport participation * **IKDC** (4 trials: reported as proportions of patients who returned to light/sedentary activity): assesses domains of symptoms, functions of daily and sports activities, current function of the knee, and participation in work and sports. Subscale scores are transformed to a scale with a range from 0-100, with higher scores representing higher levels of function. * **Tegner** **activity** **level** (9 studies)**:** measure that provides a standardized method of grading work and sporting activities. It is a graduated list of activities of daily living, recreation, and competitive sports. Pre-injury and current scores are obtained. Range is 0-10, with higher scores representing participation in higher-level activities. * **Lysholm** scores (9 studies): measures the effect of ACL reconstruction on ADLs. Range is 0-100, with higher scores representing less dysfunction in daily activities. * **Cincinnati score** (1 study): 6 subscales including symptoms, daily and sports activities, physical exam findings, radiographic findings, and functional testing. Out of 100 points, higher scores indicate better outcomes. * Subjective knee scores * **Patient satisfaction** (6 studies): reported in various ways, including a 100-point scale, 10-point scale, VAS, 4-point Likert scale, and a detailed questionnaire.   **Secondary outcomes**   * **Re-ruptures** (13 studies): cause of re-rupture not clearly defined in any study * Static stability measures * **KT arthrometer** (17 studies): varying amounts of force used during testing (maximal manual force, 134N/30 lbs) were reported. Provides objective measurement of the sagittal plane motions of the tibia relative to the femur. * **Lachman** **test** (8 studies): measures anterior translation of proximal tibia on the femur at 25 degrees of flexion, can be measured in mm, usually positive or negative result. * **Pivot shift test** (14 studies): valgus and internal rotation force is applied to extended knee, which is flexed past 30 degrees, positive or negative result. * **IKDC composite scores** (15 studies, both the 1995 and 2000 versions were used): Components include effusion, passive motion deficit, ligament examination, compartment findings, harvest site pathology, x-ray findings, and single-legged hop functional test. Each component has 4 possible grades, A, B, C, or D, with A being “normal” and D being “severely abnormal.” * **Range of motion** * Proportion of patients achieving extension deficits > 3° pooled in 14 trials * Proportion of patients achieving flexion deficits > 5° pooled in 12 trials. * Heel height differences (3 trials). * **Strength Testing** * Speeds of testing varied from 60, 120, 180, 240 and 300 degrees/second * Dynamometers used included the Cybex I and II , Lido Multijoint II, and the Biodex. * Results reported as average strength measurements (5 studies), normal strength deficits (1 study), median measurements (1 study), percentage of the opposite side (3 studies) and proportion of patients within defined deficit ranges (1 study). * Pain/anterior knee symptoms (inconsistently reported across trials) * **Anterior knee pain, kneeling pain, and patellofemoral problems** were reported in different trials using measurements consisting of VAS, Likert scales, Patellofemoral Pain score, measuring disturbance areas of knee sensitivity, and direct reports of incidence of knee pain |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| \* Due to inconsistencies in measurement or reporting of outcomes across trials, the primary and secondary outcomes in many studies were unable to be pooled for meta-analysis. This is reflected in the main findings.   * Pooled data for primary outcomes, which were reported in a minority of trials, revealed no statistically significant differences between PT and HT autografts on: the single-leg hop test (RR 1.17, 95% CI 0.84-1.63, P=0.36), return to activity level (RR 1.23, 95% CI 0.81-1.85, P=0.33), Tegner activity score (mean diff= 0.23, 95% CI -0.12 to 0.59, P=0.20), Lysholm score (mean diff=0.00, 95% CI -1.72-1.72, P=1.0), subjective knee scores (pooled analysis of patient satisfaction was not possible due to lack of standardization across studies), and Cincinnati knee scores: mean diff=-1.30, 95% CI -4.95-2.35, P=0.49). * No statistically significant differences between groups were found for re-rupture rates (RR 0.78, 95% CI 0.41-1.50, P=0.46) or on IKDC composite scores (knee laxity, swelling and loss of motion; 2000 version RR 0.94, 95% CI 0.84-1.06, P=0.32; 1995 version RR 0.99, 95% CI 0.94-1.06, P=0.85). * Patellar tendon autografts demonstrated significantly more stability as measured by KT arthrometer at 134 N in randomized trials (RR-1.68, 95% CI -3.03 - -0.32, P=0.016) and with manual maximum forces in randomized and studies with full data (mean diff= -0.51, 95% CI -0.95 - -0.07, P=0.022). * PT autografts demonstrated significantly more static stability on the Lachman test (RR 0.83, 95% CI 0.71-0.99, P=0.033) and Pivot shift test at follow-up (RR 0.70, 95% CI 0.54-0.89, P=0.0036). * Statistical significance in favour of HT autografts was found for range of motion as determined by heel height differences, but this was not significant when the random-effects model was used (mean diff=3.72mm, 95% CI -1.38mm- 8.82 mm, P= 0.15). * Statistical significance was found between autografts favouring the HT group on the proportion of patients with extension deficits greater than 3 degrees (RR 1.71, 95% CI 1.25 to 2.33, P=0.00078). Pooled data on flexion deficits greater than 5 degrees favored PT autografts, but this was not significant (RR 0.88, 95% CI 0.70-1.10, P=0.27). * Pool analyses showed that PT autografts demonstrated significantly less flexion strength at 60 degrees/sec (mean diff= 6.63%, 95% CI 3.12%-10.13%, P= 0.000011) and at 180 degrees/sec (mean diff= 5.58%, 95% CI 1.52%-9.65%, P= 0.0071). * Because of variations in how pain outcomes were reported, pooled data consisted of proportions of patients with general anterior knee symptoms and kneeling discomfort. PT patients had significantly higher amounts of anterior knee symptomology (RR 1.45, 95% CI 1.05-2.01, P=0.025). Kneeling discomfort was also significantly higher in patients with PT autografts (RR 4.46, 95% CI 2.97-6.69, P=0.00001). |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| “There is insufficient evidence to draw conclusions on differences between the two grafts for long-term functional outcome. While PT reconstructions are more likely to result in statically stable knees, they are also associated with more anterior knee problems.” (Mohtadi et al 2011, p. 2). |
| **Critical Appraisal** |
| **Validity**  [Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]  Comment on missing information in original paper. |
| * AMSTAR Score: 10/11 based on ‘a priori’ design: Yes; Duplicate study selection/data extraction: Yes; Comprehensive literature search: Yes; Status of publication used as inclusion criteria: Yes; List of included/excluded studies: Yes; Characteristics of included studies provided: Yes; Scientific quality of included studies assessed/documented: Yes; Scientific quality of included studies used appropriately in formulating conclusions: Yes; Methods used to combine the findings of studies appropriate: Yes; Likelihood of publication bias assessed: No; Conflict of interest stated: Yes.   Assessment of Risk and Bias in Included Studies   * Six domains of bias from The Cochrane Collaboration’s ‘Risk of bias tool’ were assessed: sequence generation, allocation concealment, blinding, completeness of data, selective reporting, and other bias. * As mentioned, 4 review authors independently scored the methodological quality of the included studies, discussed within their center, and then reached consensus agreement between centers. * Scores ranged from 0/6 criteria met (8 studies) to all 6 criteria met (1 study). * Selective reporting is a potential source of bias in this study, as some trials chose to report on some outcomes and not on others. An example is when studies publish results where no patients were lost to follow up; the authors report that one would expect a small percentage loss of ACL deficient patients due to their very mobile nature (Mohtadi 2011, p. 13). * Imbalances in baseline characteristics causes a source of bias, as many of the included trials did not adequately describe the population they studied (# of patients that declined participation or met clinical and intra-operative exclusion criteria). * While all authors were contacted in regards to missing outcome data or confusing methodology, only 7 studies replied with their original raw data; this causes a potential source of bias, as the included data in the analyses can only be based on published and reported results. * Lack of clarification on randomization methods exists, which could have allowed inappropriate studies to be included. * Due to the high variability in outcome reporting, the data in many studies was not able to be pooled for meta-analysis. * Collaboration efforts between the 2 centers during the review process resulted in the date of last search being 3 years before publication of this Cochrane review. The authors admit that months from their publication date, they identified 5 articles that had the potential to be included in this review. They concluded that the inclusion of the data from these 5 trials would not have dramatically affected their review findings. * None of the studies were population based, meaning that specific selection biases for surgical indications could not be determined and could represent a potential source of clinical heterogeneity between studies. * The authors performed tests for heterogeneity on outcome measures and performed sensitivity analyses in order to identify RCTs that contained the heterogeneity. That being said, there were multiple outcome measures with significant heterogeneity, suggesting that heterogeneity may be a problem in this systematic review. The authors admit that this is one major issue with the review, but stated that the results were consistent (I-squared values were zero or low) for most of the outcomes presented in the forest plots (Mohtadi 2011, p.18). * Authors reported that the current standard of reporting clinical trials (CONSORT) was not followed in the majority of studies, as many did not report the reasons for refusal or lack of participation were not consistently reported. |
| **Interpretation of Results**  [Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| * There were numerous outcomes reported in this review. The outcomes most relevant to the clinical question deal with joint stability/laxity. This includes KT arthrometer measurements, results from the Lachman, Pivot shift, and re-rupture rates. * PT autografts demonstrated more static stability on Pivot shift, Lachman tests, and KT arthrometer measurements at 60 degrees and 180 degrees, making this type of autograft more superior than HT autografts for static knee joint stability. * In addition, PT autografts causes more post-operative anterior knee pain and pain while kneeling. * The importance of the loss in extension ROM and strength after PT reconstruction and loss in flexion ROM and knee flexion strength following HT reconstruction needs further investigation. * While static stability is a clinically important measurement, functional stability can be argued to be a more important outcome measurement, as functional movements are more likely to cause increased stress on the ACL and have more potential for graft failure. * Knowledge of the risk and chance of a particular type of autograft resulting in failure and subsequent re-rupture is something almost every patient inquires prior undergoing ACL reconstructive surgery. Based on this Cochrane review, there is no increased risk of re-rupturing one of these autografts over the other. This is an important finding to report to patients before they undergo reconstructive surgery. * While these results are statistically relevant, their application to real-world, functional situations is limited. * Almost all included trials were rated at high risk in at least 1 of the seven listed domains, with the 12 quasi-randomized trials at particularly high risk of bias. This somewhat limits the amount of weight that can be placed on the results and conclusions from these trials. * This review made no mention of rehabilitation protocols following ACL reconstructive surgery. The inclusion of this data could have strengthened the study results by providing insight as to which rehabilitative parameters were most successful for patient outcomes. This could also be said for how measurements were made and reported, surgical techniques, and the lack of a universal method of assessment. |

**IMPLICATIONS FOR PRACTICE and FUTURE RESEARCH**

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| ***Current implications to practice:***  The evidence reviewed in this appraisal provides limited evidence to draw significant conclusions for long-term functional outcomes between patellar and hamstring tendon autografts. Limited evidence was found to help distinguish which type of autograft can provide more functional strength, as single-leg hop tests and other functional stability measurements were not significant.  Based on the evidence provided in the above studies, neither type of autograft stands out as the clear choice for superior ACL reconstruction. That being said, most of the evidence presented supports the use of patellar tendon autografts over hamstring autografts in regards to static stability measures. Evidence also shows that patellar tendon autografts are associated with increased anterior knee pain and pain with kneeling. This makes sense, as the harvest site for the patellar tendon is on the anterior aspect of the knee, which would be subjected to increased amounts of stress during knee flexion. Patellar tendon autografts also cause increased limitation in knee extension range of motion. The above evidence also supports previous findings that hamstring tendon autografts provide less statically stable knee joints, less anterior knee pain and pain associated with kneeling, and increased restriction of knee extension range of motion.  When asked by patients as to which type of autograft to use, physical therapists should take into account and review with the patient their pre-injury and desired post-operative activity levels. While the surgeon may have his/her own reasons for choosing a particular type of autograft, physical therapists can also help guide their patients into making the best personal and clinical decision.  The results from the Cochrane review by Mohtadi et al (2011) can be directly compared to a similar meta-analysis by Biau (Biau 2007). The above Cochrane review used a more detailed strategy to assess study quality, the review by Biau included 18 trials, as compared to the 19 by Mohtadi.  ***Current implementations to research:***  Future research should aim to have high and longer-term follow-up of outcome measures, as this increases the power of the study. The study by Taylor et al (2009) had less than 85% overall follow-up, limiting power and the ability to draw significant conclusions. The review by Li et al (2011) demonstrates the need for future studies/systematic reviews to limit the number of RCTs they include with missing outcome data or incomplete or non-existent allocation concealment procedures. Well-designed, high-quality RCT to address ligament failure in order to address bias and reasons for failure.  Future studies analyzing specific knee control activities (pivoting, cutting, etc) might help researchers identify factors that lead to higher rates of return to pre-injury activity level.  Because of the reported differences in graft failure and tibial tunnel angles obtained in the study by Taylor et al(2009), future research looking at the impact of these angles on graft failure could better help identify optimal angles for graft fixation.  Strict methodology, conduct and reporting are needed in future trials in order to help resolve the existing controversy of the issue of autograft type of surgical reconstruction of the ACL deficient knee. Allocation concealment, assessor blinding and increased consistency in regards to choosing and performing outcome measures is needed in future trials. In addition, patients should be stratified into treatment groups based on ACL deficiency acuity, gender, patient activity level, and associated knee pathologies, as this proved to be problematic in the review by Mohtadi et al (2011). |

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