



Why autologous hamstring tendon reconstruction should now be considered the gold standard for anterior cruciate ligament reconstruction in athletes

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- reconstruction. *Clin Orthop Relat Res* 2000;**(376)**:278–86.
17. **Laxdal G**, Sernert N, Ejerhed L, *et al*. A prospective comparison of bone-patellar tendon-bone and hamstring tendon grafts for anterior cruciate ligament reconstruction in male patients. *Knee Surg Sports Traumatol Arthrosc* 2007;**15**:115–25.
 18. **Bradley JP**, Klimkiewicz JJ, Rytel MJ, *et al*. Anterior cruciate ligament injuries in the National Football League: epidemiology and current treatment trends among team physicians. *Arthroscopy* 2002;**18**:502–9.
 19. **Bartlett RJ**, Clatworthy MG, Nguyen TN. Graft selection in reconstruction of the anterior cruciate ligament. *J Bone Joint Surg Br* 2001;**83**:625–34.
 20. **Marder RA**, Raskind JR, Carroll M. Prospective evaluation of arthroscopically assisted anterior cruciate ligament reconstruction. Patellar tendon versus semitendinosus and gracilis tendons. *Am J Sports Med* 1991;**19**:478–84.
 21. **Nakamura N**, Horibe S, Sasaki S, *et al*. Evaluation of active knee flexion and hamstring strength after anterior cruciate ligament reconstruction using hamstring tendons. *Arthroscopy* 2002;**18**:598–602.
 22. **Yasuda K**, Tsujino J, Ohkoshi Y, *et al*. Graft site morbidity with autogenous semitendinosus and gracilis tendons. *Am J Sports Med* 1995;**23**:706–14.
 23. **Segawa H**, Omori G, Koga Y, *et al*. Rotational muscle strength of the limb after anterior cruciate ligament reconstruction using semitendinosus and gracilis tendon. *Arthroscopy* 2002;**18**:177–82.
 24. **Torry MR**, Decker MJ, Jockel JR, *et al*. Comparison of tibial rotation strength in patients' status after anterior cruciate ligament reconstruction with hamstring versus patellar tendon autografts. *Clin J Sport Med* 2004;**14**:325–31.
 25. **Cross MJ**, Roger G, Kujawa P, *et al*. Regeneration of the semitendinosus and gracilis tendons following their transection for repair of the anterior cruciate ligament. *Am J Sports Med* 1992;**20**:221–3.
 26. **Eriksson K**, Kindblom LG, Hamberg P, *et al*. The semitendinosus tendon regenerates after resection: a morphologic and MRI analysis in 6 patients after resection for anterior cruciate ligament reconstruction. *Acta Orthop Scand* 2001;**72**:379–84.
 27. **Ferretti A**, Conteduca F, Morelli F, *et al*. Regeneration of the semitendinosus tendon after its use in anterior cruciate ligament reconstruction: a histologic study of three cases. *Am J Sports Med* 2002;**30**:204–7.
 28. **Roe J**, Pinczewski LA, Russell VJ, *et al*. A 7-year follow-up of patellar tendon and hamstring tendon grafts for arthroscopic anterior cruciate ligament reconstruction: differences and similarities. *Am J Sports Med* 2005;**33**:1337–45.
 29. **Lephart SM**, Kocher MS, Harner CD, *et al*. Quadriceps strength and functional capacity after anterior cruciate ligament reconstruction. Patellar tendon autograft versus allograft. *Am J Sports Med* 1993;**21**:738–43.
 30. **Stringham DR**, Pelmas CJ, Burks RT, *et al*. Comparison of anterior cruciate ligament reconstructions using patellar tendon autograft or allograft. *Arthroscopy* 1996;**12**:414–21.
 31. **Tsuda E**, Okamura Y, Ishibashi Y, *et al*. Techniques for reducing anterior knee symptoms after anterior cruciate ligament reconstruction using a bone-patellar tendon-bone autograft. *Am J Sports Med* 2001;**29**:450–6.
 32. **Kartus J**, Ejerhed L, Sernert N, *et al*. Comparison of traditional and subcutaneous patellar tendon harvest. A prospective study of donor site-related problems after anterior cruciate ligament reconstruction using different graft harvesting techniques. *Am J Sports Med* 2000;**28**:328–35.
 33. **Spindler KP**, Kuhn JE, Freedman KB, *et al*. Anterior cruciate ligament reconstruction autograft choice: bone-tendon-bone versus hamstring: does it really matter? A systematic review. *Am J Sports Med* 2004;**32**:1986–95.
 34. **Eriksson K**, Anderberg P, Hamberg P, *et al*. A comparison of quadruple semitendinosus and patellar tendon grafts in reconstruction of the anterior cruciate ligament. *J Bone Joint Surg Br* 2001;**83**:348–54.
 35. **Figueroa D**, Calvo R, Vaisman A, *et al*. Injury to the infrapatellar branch of the saphenous nerve in ACL reconstruction with the hamstrings technique: Clinical and electrophysiological study. *Knee* 2008;**15**:360–3.
 36. **Sanders B**, Rolf R, McClelland W, *et al*. Prevalence of saphenous nerve injury after autogenous hamstring harvest: an anatomic and clinical study of sartorial branch injury. *Arthroscopy* 2007;**23**:956–63.
 37. **Liden M**, Sernert N, Rostgard-Christensen L, *et al*. Osteoarthritic changes after anterior cruciate ligament reconstruction using bone-patellar tendon-bone or hamstring tendon autografts: a retrospective, 7-year radiographic and clinical follow-up study. *Arthroscopy* 2008;**24**:899–908.
 38. **Harilainen A**, Linko E, Sandelin J. Randomized prospective study of ACL reconstruction with interference screw fixation in patellar tendon autografts versus femoral metal plate suspension and tibial post fixation in hamstring tendon autografts: 5-year clinical and radiological follow-up results. *Knee Surg Sports Traumatol Arthrosc* 2006;**14**:517–28.
 39. **Pinczewski LA**, Lyman J, Salmon LJ, *et al*. A 10-year comparison of anterior cruciate ligament reconstructions with hamstring tendon and patellar tendon autograft: a controlled, prospective trial. *Am J Sports Med* 2007;**35**:564–74.
 40. **Pinczewski LA**, Deehan DJ, Salmon LJ, *et al*. A five-year comparison of patellar tendon versus four-strand hamstring tendon autograft for arthroscopic reconstruction of the anterior cruciate ligament. *Am J Sports Med* 2002;**30**:523–36.

Why autologous hamstring tendon reconstruction should now be considered the gold standard for anterior cruciate ligament reconstruction in athletes

L Pinczewski, J Roe, L Salmon

The aim of anterior cruciate ligament (ACL) reconstructive surgery is to provide the patient with a timely return to sport allowing them to participate without any further meniscal damage and having a

normal knee function which results in neither clinical nor radiologic evidence of osteoarthritis later in life. Long term study of both endoscopically performed patellar tendon and hamstring tendon graft reconstructions show that this is more likely to be achieved with hamstring tendon graft rather than patellar tendon graft.

ACL reconstruction carried out endoscopically with the patellar tendon graft was popularised last century in the late 1980s and early 1990s due to the advent of easily

performed interference screw fixation, and the rapid bone to bone healing of the graft. However donor site ACL morbidity was common, persistent, occasionally severe and particularly disabling in females and trades people who knelt. Longitudinal follow-up demonstrated the development of fixed flexion deformities at the 2 and 5 year post-operative mark associated with the development of Grade B changes in the patellofemoral and medial compartments.^{1,2} These changes were noted on side to side comparative radiographs. The aetiology of this osteoarthritis was found to be two fold, firstly related to patellar ligament contracture resulting in patella baja of 5–10% of overall patella ligament length. This results in altered patellofemoral contact pressures. As well, authors³ have noted ACL reconstruction with the patellar tendon graft is associated with decreased knee flexion moments during the stance phase of gait resulting in higher impact loads in the medial compartment, when compared to hamstring tendon grafts. These findings may explain the aetiology of medial compartment degenerative change associated with the patellar tendon graft.⁴

The major argument against hamstring tendon graft reconstruction was the

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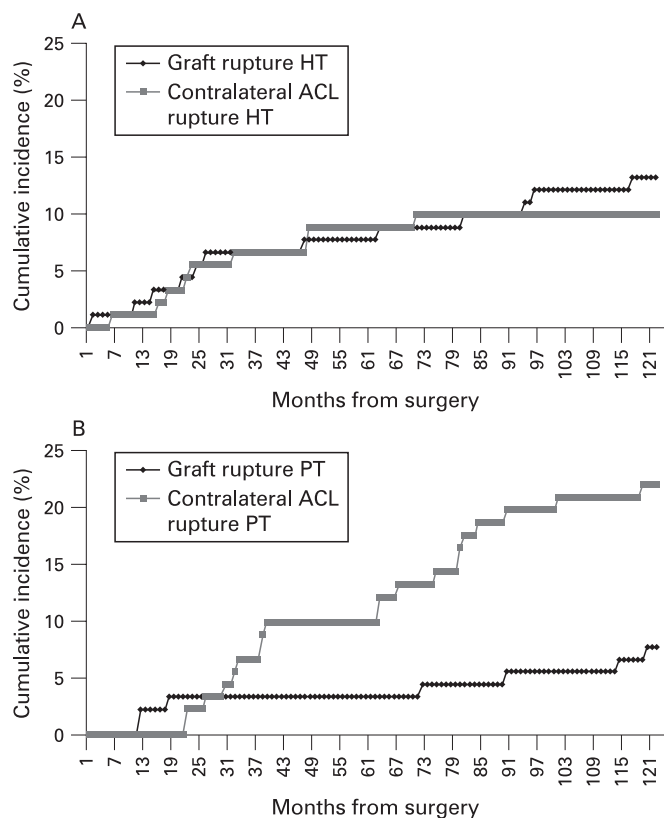


Figure 1 Incidence of anterior cruciate ligament graft and contralateral anterior cruciate ligament rupture in the (A) hamstring tendon (HT) group and the (B) patellar tendon (PT) group.

perception of graft laxity. Since 1995 the technical aspects of the surgical fixation of hamstring tendons has evolved to equal stability measures in the post reconstruction knee utilising interference screw aperture fixation, reverse threaded screws for femoral fixation, supplementary tibial fixation to prevent slippage and increasing screw and diameter length. Hamstring tendon, like patellar tendon, is collagen, and collagen does not stretch. Both have 1–2% of elongation due to the natural crimp of collagen fibres. If fixation is secure, patellar tendon is shown to be

joined to the tunnels within 6 weeks and hamstring tendons by 8 weeks. Frequently quoted laxity results utilising hamstring tendons are not a function of the graft material, but rather of the surgical technique and placement of the graft and of fixation techniques. When fixation is standardised, no significant differences in laxity is noted.^{5–7} Comparison of suspensory fixation techniques for hamstring tendons and interference screw techniques are not valid, due to the inherent lack of stiffness of the former graft construct.

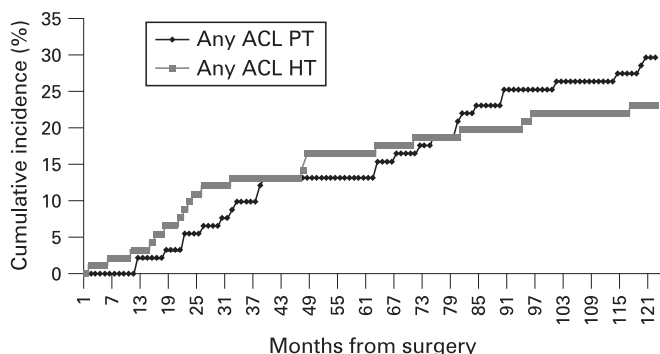


Figure 2 Combined incidence of anterior cruciate ligament graft or contralateral anterior cruciate ligament injury in the patellar tendon (PT) and hamstring tendon (HT) groups.

Some surgeons' preference to stay with patellar tendon graft in athletes is not totally without foundation. Anecdotally, it is felt that patellar tendon graft reconstructions fail less often than hamstring tendon graft reconstructions. Large scale meta analysis^{5, 8, 9} and systematic reviews¹⁰ report no difference in graft rupture rates between hamstring and patellar tendon grafts when fixation is standardised. From our own prospective series of hamstring and patellar tendon ACL reconstructions followed for 10 years we have found for every 100 patients undergoing an ACL reconstruction and returning to active sport over a 10 year period approximately 20% or 2 per year will suffer a further cruciate injury whether they have a hamstring tendon or patellar tendon graft (fig 2). The difference lies in the distribution of injuries. With patellar tendon graft reconstructions the index knee has a lower re-injury rate but a significantly higher contralateral ACL rupture rate (fig 1b). Following the use of hamstring tendon reconstruction the incidence of graft rupture and contralateral ACL rupture remains equal (fig 1a). While the effective outcome for the patient is the same regardless of graft choice, the surgeon with the lower graft re-rupture rate would understandably feel that his reconstruction has withstood the challenges of re-injury better than the native contralateral knee ligament. But apart from the surgeons' perception, the result for the patient is equally catastrophic and compounded later in life with a higher incidence of osteoarthritis if the patellar tendon is used.

The gold standard for ACL reconstructive surgery is to obtain an ideal outcome for the patient for the rest of their life, not for the short period of their career. This is more likely to be seen following hamstring tendon graft and interference screw fixation of that graft rather than any other form of fixation for hamstring tendon graft or for patellar tendon graft.

Accordingly hamstring tendon ACL reconstruction with interference screw fixation should now be considered the gold standard for ACL reconstructive surgery.

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REFERENCES

1. **Deehan D**, Salmon L, Webb V, *et al.* Endoscopic reconstruction of the anterior cruciate ligament with an ipsilateral patellar tendon autograft. A prospective longitudinal five-year study. *J Bone and Joint Surg* 2000;**82-B**:984–91.
2. **Roe J**, Pinczewski L, Russell V, *et al.* A 7-year follow-up of patellar tendon and hamstring tendon grafts for arthroscopic anterior cruciate ligament reconstruction: differences and similarities. *Am J Sports Med* 2005;**33**:1337–45.
3. **Webster K**, Wittwer J, O'Brien J, *et al.* Gait patterns after anterior cruciate ligament reconstruction are related to graft type. *Am J Sports Med* 2005;**33**:247–54.
4. **Pinczewski LA**, Lyman J, Salmon LJ, *et al.* A ten-year comparison of hamstring tendon and bone-patellar tendon-bone anterior cruciate ligament reconstructions. A controlled, prospective trial. *Am J Sports Med* 2007;**35**:564–74.
5. **Prodromos C**, Joyce B, Shi K, *et al.* A meta-analysis of stability after anterior cruciate ligament reconstruction as a function of hamstring versus patellar tendon graft and fixation type. *Arthroscopy* 2005;**21**:1202.e1201–9.
6. **Beard D**, Anderson J, Davies S, *et al.* Hamstrings versus patella tendon for anterior cruciate ligament reconstruction: a randomised controlled trial. *Knee* 2001;**8**:45–50.
7. **Laxdal G**, Kartus J, Hansson L, *et al.* A prospective randomized comparison of bone-patellar tendon-bone and hamstring grafts for anterior cruciate ligament reconstruction. *Arthroscopy* 2005;**21**:34–42.
8. **Goldblatt J**, Fitzsimmons S, Balk E, *et al.* Reconstruction of the anterior cruciate ligament: meta-analysis of patellar tendon versus hamstring tendon autograft. *Arthroscopy* 2005;**21**:791–803.
9. **Yunes M**, Richmond J, Engels E, *et al.* Patellar versus hamstring tendons in anterior cruciate ligament reconstruction: a meta-analysis. *Arthroscopy* 2001;**17**:248–57.
10. **Spindler KP**, Kuhn JE, Freedman KB, *et al.* Anterior cruciate ligament reconstruction autograft choice: bone-tendon-bone versus hamstring: does it really matter? A systematic review. *Am J Sports Med* 2004;**32**:1986–95.