

Research Project

Advantages and Disadvantages between Allograft versus Autograft in Anterior Cruciate
Ligament Replacement

Submitted by

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in partial fulfillment of the
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of Master of Physician Assistant

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Wichita State University
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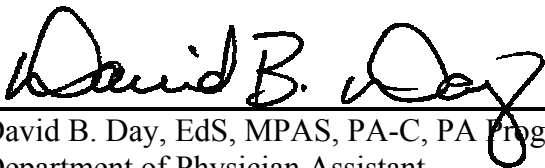
We hereby recommend that the research project under our supervision by Pete Vang entitled

Advantages and Disadvantages between Allograft versus Autograft in Anterior Cruciate Ligament Replacement be accepted as partial fulfillment for the degree of Master of Physician Assistant.

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Abstract

Introduction: As the number of ACL surgeries performed each year rise, giving patients a detailed look at their options for replacement is critical. To accomplish this, the best alternative of allograft or autograft, needs to be identified. A systematic literature review has been conducted on the Advantages and Disadvantages of Allograft vs. Autograft in Anterior Cruciate Ligament (ACL) replacement. Methodology: The purpose of this literature review is to determine whether there is an advantage to the use of an Allograft vs. Autograft in ACL replacement. Over twenty four peer reviewed articles were reviewed with a primary focus the graft donor site, specifically the patellar tendon and the hamstring tendon. Outcomes were evaluated in three to six month increments for up to five years. Results: The literature review showed that there was very little statistical significance in the presence of pain, giving away, effusion, Lachman, and pivot shift results. Conclusion: The main concern with Autograft was graft site morbidity. The main concern with Allograft was risk of disease transmission. The choice of Allograft vs. Autograft ultimately comes down to physician and patient preference.

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INTRODUCTION

The number of Anterior Cruciate Ligament (ACL) injuries keeps rising year after year. The annual incidence of more than 100,000 anterior cruciate ligament tears has increased with the rise of participation in sports in the general population, especially in females and older participants.¹ With the rise in ACL injuries, researchers are trying to identify the options available for ACL reconstruction. To accomplish this, the best alternative of allograft or autograft, needs to be identified. A literature review has been conducted on the advantages and disadvantages of allograft vs. autograft in anterior cruciate ligament (ACL) replacement. There are a few options available for ACL repair, one being an allograft reconstruction, and the other an autograft reconstruction. In an allograft reconstruction the surgeon uses a harvested cadaver tendon that has been preserved to maintain its freshness. Preservation of these grafts can be done through cryopreservation. This process of freezing and freeze drying allows for prolonged storage of the graft and prevents host rejection.² Tissue grafts amenable to use in ACL reconstruction include the tibialis anterior, patellar bone-patella tendon-bone (BPTB), fascia lata, hamstring tendon, and achilles tendon with a bone plug.³ The graft usually used depends on the patients' preference and the personal preference of the surgeon. The other option for a reconstruction graft is the autograft. In an autograft reconstruction the graft is taken from the patient themselves and used as the new ACL. Autograft options include bone-patella tendon-bone, quadrupled semitendinosus/gracilis tendons, achilles tendon, and quadriceps tendon with and without bone.⁴ In this procedure, the tendon is harvested from the patient prior to the ACL reconstruction. The harvested tendon grafts

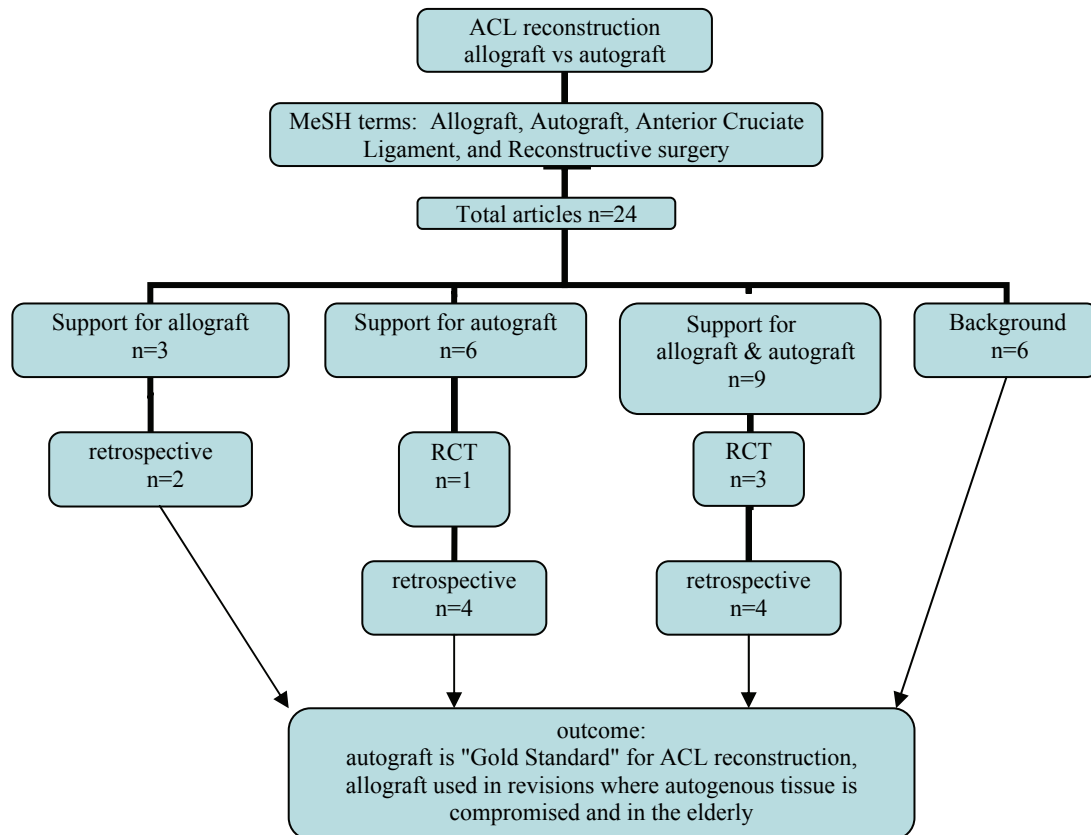
are tubed and sized to accommodate the bone tunnels of both the tibia and the femur. As both surgeries have their pros and cons, this research review will identify the most up-to-date advantages and disadvantages for both allograft and autograft procedures in ACL replacement. The purpose of this literature review is to determine whether there is an advantage to the use of an allograft vs. autograft in ACL replacement. Over twenty four peer reviewed articles were reviewed with a primary focus on the graft type used and graft donor site, specifically the patellar tendon. Outcomes were evaluated in three to six month increments for up to five years.

Since its initial description, the central third of the patella tendon with bone on either end of the graft (BPTB) has become the “gold standard” for primary ACL reconstruction.⁴ Bone-to-bone healing in the femoral and tibial tunnels is more predictable and reliable than the healing of soft tissue to bone with other graft sources. In addition, soft tissue healing to bone with fibrous tissue or scar may take up to 12 weeks, whereas bone to bone healing should be accomplished in 6-8 weeks.⁴ Since the patella tendon is considered the gold standard for ACL reconstruction we will focus our attention on this graft site. Once the right graft site has been chosen, then the decision needs to be made to use an autograft or an allograft. There are advantages and disadvantages to either choice. The questions that need to be asked are:

- How long is the recovery period with each choice?
- What are the pros and cons involved with an allograft?
- What are the pros and cons involved with an autograft?
- Do both grafts hold up equally over time?

LITERATURE REVIEW

Figure 1: Literature Review Flow Sheet



A review of literature was collected from a variety of sources including MedLine, FirstSearch, and PubMed using the following MeSH terms: Allograft, Autograft, Anterior Cruciate Ligament, and Reconstructive surgery. All articles reviewed were from peer reviewed journals. Articles were selected based on their information regarding allograft versus autograft in ACL reconstruction. All articles used were from 1993 to current literature.

Throughout the literature review, many authors compared allograft versus autograft by following two different groups of patients who underwent ACL replacement

with either an allograft or an autograft tendon and then followed those patients for a minimum of 2 years. There were a minimum of fifty patients followed in each of these studies. In three of the studies no significant difference in the results were noted between two groups of equally matched allograft and autograft ACL reconstruction at a minimum of 2-year follow-up.⁵⁻⁷ There were two studies that followed patients for two years post-op and suggested that the result of the two surgeries were comparable but the results of the autograft were better than that of the allograft. Based on these results the authors recommend that autograft should remain the gold standard for ACL replacement.^{8,9}

Kleinpool et al., and Peterson et al., studied patients with ACL replacement for 3-5 years. Both studies included a minimum of sixty non-randomized patients. In both studies the results were similar, resulting in a conclusion that BPTB allograft can be considered a good alternative in the reconstruction of a deficient ACL.^{10,11} A third study that followed patients for 3-5 years¹², also concluded that there were no significant clinical differences in outcome in those patients who received an autograft compared with those who received an allograft. However, they stated that their non-randomized study was compromised because their patient groups were not randomly assigned allograft or autograft. Differences between the groups, other than graft type may have accounted for the observed results.¹²

Victor et al., studied the long term effects of autograft BPTB ACL reconstruction. They concluded that using the central third of the patella tendon does not cause harmful long-term effects on the extensor mechanism in most patients. They also found no difference in anterior knee pain between allograft and autograft.¹³

Several studies looked at the possibilities of using different graft sites for allograft ACL reconstruction. These graft sites included hamstring tendon, anterior tibialis tendon, and the achilles tendon. All graft selections were compared to the “gold standard” patellar tendon graft. These studies concluded that each graft was a strong reproducible choice for ACL reconstruction, but that BPTB grafts should remain the gold standard for ACL reconstruction.^{1, 14-16}

Finally a major portion of literature review consisted of non-evidence based articles that discuss the difference between an allograft and an autograft replacement. There are informative articles about graft selection, types of surgeries, and rehabilitation of surgically repaired ACL's.^{2-4, 17-21}

METHODOLOGY

For this study an evidenced-based literature review was conducted to gather information to help answer the research question. The articles were collected from a variety of sources including MedLine, FirstSearch, and PubMed using the following MeSH terms: Allograft, Autograft, Anterior Cruciate Ligament, and Reconstructive surgery. All articles were from peer reviewed journals. Articles were selected based on their information regarding allograft versus autograft in ACL reconstruction. All articles used were from a search from 1996 to current literature

RESULTS

Recovery:

On average the recovery time for both allograft and autograft is about 7 to 9 months by which time, patients will have enough strength and healing time to return to full activities.⁹ Full muscle strength and endurance may take up to 2 full years to reach

pre-operative states.^{4, 6, 13} Quadriceps strength for both groups show a larger percentage deficit compared with the nonoperative side, than did the hamstring testing.^{4, 6} Although most patients have returned to full activity by 7 to 9 months, their muscle strength may not reach pre-injury strength for several years following surgery.

Autograft has a disadvantage in initial recovery from surgery because the patient has two sites to recover, the graft site and the ACL reconstruction site. Since autograft patients may suffer from surgically induced tissue morbidity, and more patellofemoral complication, allograft patients may be released to cutting/agility sports earlier than autograft patients.²¹

On the other hand, allograft tendons have been proven to have slower graft incorporation than autograft.^{3, 21} Slower graft incorporation may equal out the recovery time for patients to be released to cutting/agility sports in both allograft and autograft.

Allograft:

When an allograft is chosen, the patient avoids having a graft taken from somewhere else on their body, but there are other concerns involved. The specific concerns related to allograft are tissue availability, sterilization, graft cost, delayed graft incorporation, disease transmission, and long term graft strength.^{3, 7, 10-12, 15} Tissue availability and graft cost should be concerns but are not high on the list.

Although graft incorporation may be similar in allograft and autograft, the process occurs more rapidly and completely with autograft tissue. Biopsies performed on goat models have found that full graft maturity does not occur until 18 months postoperatively.¹¹ Substantial evidence from animal and human investigations has shown that the central core of BPTB grafts is the last portion to heal and this process is

further delayed in allografts.^{3,21} BPTB allograft have weaker mechanical properties and lesser histological maturity at similar postoperative time intervals than autografts.²¹

Disease transmission is definitely a concern with allograft tissue. The two diseases most feared with allograft tissue are human immunodeficiency virus (HIV) and hepatitis,^{4,5} and although the risk of obtaining these is small, it still exists. A detailed medical, social, and sexual history questionnaire is completed by tissue bank personnel for any potential cadaveric donor. A physical examination is then done. Laboratory tests required by the FDA and the American Association of Tissue Banks are done on serum from the donor. They include aerobic and anaerobic blood cultures, cultures from the tissue harvested, antibodies to HIV Types 1 and 2, hepatitis B surface antigen, hepatitis C antibodies, syphilis antibodies and human T cell lymphotropic virus antibodies. Unfortunately, there still is a window of vulnerability between infection and the production of detectable antibodies by the donor.²² Techniques of secondary sterilization have not solved the problem. Ethyl oxide has been associated with chronic effusions and graft failure, and the amount of gamma radiation necessary to guarantee graft sterilization is detrimental to the mechanical properties of collagenous tissue.^{4,8} Irradiation with doses >3 Mrads has been shown to affect the material properties of the graft.¹² Balancing the amount of gamma radiation required for sterilization of the graft without changing the mechanical properties of the tissue is a difficult problem. Several studies have attempted to determine the appropriate dose of radiation to sterilize the graft but not damage the tissue. The International Atomic Energy Agency has adopted a standard dose of 2.5 Mrad for biological tissues, with most medical banks using doses anywhere from 1.5 to 2.5 Mrad.^{4,8} With all this in mind, no cases of disease

transmission have been reported in the literature since the introduction of donor screening tests for HIV.¹¹ Recently, virus screening procedures have been improved and the detection free-window periods are significantly shorter, reducing the risk of disease transmission.⁵

The concern over long term graft strength has been around for a long time; however research has not proven either way whether an allograft will lose strength over time. In part, some of the blame for decreased tissue strength has to do with the sterilization process. Both gamma radiation and ethyl oxide have been the cause of graft failure. Ethyl oxide is effective for nonbiologic substances but can cause graft failure when used to sterilize allografts.⁴ Consequently this form of sterilization is no longer used. Gamma radiation is now used, and is safer and more effective. The only concern with gamma is that of the Mrad level. The other reason for graft ruptures in allograft transplants is delayed graft incorporation. Delayed graft incorporation occurs because the body fails to accept the foreign tissue that it is presented. Because of this the graft will not take and once the patient returns to activity the graft will give way. In a few studies there have been reports of traumatic graft ruptures in late follow up.^{5, 8-11, 13} Due to these ruptures, late allograft failure has been a concern for many surgeons considering their use in ACL reconstruction.^{8, 9, 11}

The advantages for allograft are pretty simple. Using an allograft tendon will allow the patient to avoid donor site morbidity, surgical time is reduced, smaller incisions, availability of larger grafts and no weakening of the extensor or flexor apparatuses.^{7, 15} The most common candidates for allograft tendons are those over 45 years of age, those requiring revision, and skeletally immature athletes.³ Those over 45

years of age make good candidates because they tend to recover more quickly as the graft site morbidity is eliminated and the possibility of extensor mechanism problems are decreased.³ Patients who must kneel as a part of their occupation or chosen sport are particularly good candidates for allograft reconstruction. ACL injury is occurring in youth more frequently because of the increased athletic participation of the adolescent age group, higher level of competition within this age group and, finally, increased awareness and better diagnostic tools to evaluate this injury in the sports medicine population.¹⁸ The skeletally immature athlete is a good candidate for allograft because you reduce the risk of damaging the growth plate is reduced with a BPTB graft.³ An autograft in a skeletally immature athlete could cause damage to the tibial growth plate when the BPTB graft is taken from the tibia.

Allograft reconstruction also provides a safer alternative to those patients who are at higher risk of complications under anesthesia. Considering that the surgeon would not have to take time to harvest and prepare the autograft, he would be able to complete the reconstruction faster thus avoid having the patient under anesthesia for longer periods of time.

Taking all the data into consideration and looking at the advantages and disadvantages of allograft, theoretically the BPTB allograft provides a excellent alternative to the BTB autograft.

Autograft:

The standard with which all other grafts used in ACL reconstructions are compared is autograft BPTB.^{2, 4, 9-11} The major disadvantages are donor site morbidity, patellar fractures, patella tendonitis, scar formation, alteration of quadriceps function, and

numbness caused by the division of the infrapatellar branch of the saphenous nerve.^{3, 4, 7-9, 11, 13, 20, 23} These potential disadvantages are related to the tendon harvest site, as the patients own tendons are used. Since the gold standard is the BPTB an incision has to be made over the top of the central third of the patella tendon and a graft with a bone plug on either end has to be taken. The bone plugs come from the patella and the tibia. Considering a portion of the patella with bone on either end is surgically removed, there will be risks for patella fractures, patella tendonitis, a patch of numbness lateral to the incision from cutting the saphenous nerve, and a tender residual scar. Fortunately, these conditions usually improve, if not resolve completely, over time and rarely cause functional impairment. Patients who choose autograft tendons also need to be aware of the increased surgery time and the number of scars on the knee.

The advantages of autograft ACL reconstruction are the absence of risk of disease transmission, the human body tends to accept its own tendons better than tendons from a donor, and that autograft BPTB is the “gold standard” for ACL reconstruction. The fact that there is no risk of disease transmission is a very big positive for autograft. The patient has the understanding that they do not have to worry about the risk of HIV and Hepatitis disease transmission. Even though recent virus screening have been improved, and the detection free –window periods are significantly shorter, the risk is still there.⁵

DISCUSSION

The issue of allograft vs. autograft is a heavily debated topic in the orthopedic field, which has been studied by many surgeons as well as patients looking for the best possible option for surgery. Many studies have been done to determine which graft is the

best option for ACL replacement. Although these studies provide good insight into the different options, it is still unclear which is the best, and in the end, leaving the decision for graft type up to the surgeon as well as the patient. Until a study is conducted that looks at the long term results of each graft, and risks associated with disease transmission in allograft is eliminated, patients and surgeons are going to be left to sift through the evidence themselves. The purpose of this paper was to organize studies in an understandable and presentable fashion that clearly shows the results and clarifies the options for ACL reconstruction.

After evaluating the data from articles used in the study, the majority come up with the same conclusion that allograft is a good graft option for ACL reconstruction, but autograft should remain the “Gold Standard” for ACL reconstruction.

CONCLUSION/IMPLICATION

It is estimated that between 75,000 to 100,000 ACL reconstructions are being performed each year in the United States alone.^{1, 17, 24} With the number of ACL surgeries performed each year on the rise, giving patients a detailed look at their options for replacement is critical. The ideal graft for ACL reconstruction should reproduce the complex anatomy of the ACL, provide the same biomechanical properties as the native ACL, permit strong and secure fixation, promote rapid biological incorporation, and minimize donor site morbidity.⁴ To accomplish this we need to identify the type of graft, whether it is allograft or autograft, which can meet these standards. In conclusion, autograft is still considered the “Gold Standard” for ACL reconstruction but, allograft should be considered in the elderly and for revision procedures were suitable autogenous

tissue has been compromised. There are pros and cons of both allograft and autograft. This information should provide patients the information they are looking for when choosing a graft for ACL reconstruction. Ultimately the graft choice is up to the patient. Once that patient has decided on the graft that they want, they need to present that choice to their surgeon.

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Study/Year	Research Addresses 1.allograft 2. autograft 3. both	Level of Evidence 1. random control 2. retrospective 3. background	Demographics main idea	Findings	Supportive of Research 1. Yes for allograft 2. Yes for autograft 3. Yes for both 4. Background
Graham & Parker 2002	1	3	Review the basic science and clinical data regarding hamstring tendons in ACL reconstruction	background	4
DiStefano 1993	3	3	ACL reconstruction allograft or autograft.	background	4
Strickland et al 2003	1	3	ACL reconstruction with allograft tendons.	background	1
Miller & Gladstone 2002	3	3	Graft selection in ACL reconstruction.	background	3
Kustos et al 2004	3	1	79 arthroscopy-assisted ACL reconstruction	Allograft is a good alternative to Autograft	3
Saddemi et al 1993	3	1	50 arthroscopic BPTB ACL reconstructions performed by the same surgeon (S.R.S.)	No significant difference between autograft and allograft in ACL reconstruction	3
Shelton et al 1997	3	2	60 endoscopic ACL reconstructions performed by the same surgeon	No statistically significant differences between allograft and autograft evaluated at 3,6,12 & 24 months postoperatively	3

Stringham et al 1996	3	2	Retrospective review of 78 arthroscopically assisted ACL's	Given the increased traumatic rupture rate of our allograft cohort, autograft tissue remains the graft of first choice for ACL reconstruction	2
Chang et al 2003	3	2	79 ACL reconstructions using BPTB performed by the same surgeon followed for a minimum of 2 years	Results of allograft BPTB ACL's were comparable but not as good as the results of autograft BPTB ACL's. For this reason they believe autograft BPTB ACL's should remain "gold standard"	2
Kleipool et al 1998	3	1	62 ACL reconstructions using BPTB performed by the same surgeon followed for an average of 46 months	The use of allograft BPTB can be considered a good alternative for autograft BPTB reconstruction of deficient ACL's	3
Peterson et al 2001	3	2	Two groups of 30 patients, 1 group allograft, 1 autograft, who underwent ACL reconstruction were evaluated subjectively and objectively at an average follow-up of 63 months	Autograft or allograft BPTB grafts used for ACL reconstruction and followed-up over 5 years produce similar results. The use of allografts is an acceptable choice for ACL reconstruction	3
Harner et al 1996	3	2	64 allograft ACL's were compared to 26 autograft ACL's 3-5 years after their operation	No significant clinical differences in outcome in patients who received autograft compared to those who received allograft	3

Victor et al 1997	3	2	48 autograft ACL's compared to 25 allograft ACL's using the central one third of the patellar tendon and followed for a minimum of 2 years	No harmful longterm effects on the extensor mechanism in most patients. Functional results at 24 months do not favor the use of allograft, although they do avoid tenderness of the tuberosity	2
Adachi et al 2004	2	1	108 autograft ACL's using hamstring single or double bundle multistranded tendons and followed for a mean of 32 months	No clinical difference between the single versus the double stranded tendon, thus they suggest no need for double-bundle reconstruction	2
Siebold et al 2003	1	2	251 fresh frozen patellar vs. achilles tendon allografts for primary ACL reconstruction and followed-up for a mean of 37.7 months	Autograft remains the graft of first choice for ACL reconstruction. They advise allograft be reserved for revision procedures were suitable autogenous tissues have been compromised.	2
Caborn & Selby 2002	1	2	Surgical outcome of Anterior tibialis tendon in allograft ACL's compared to BPTB allograft, Achilles allograft, and autograft reconstruction.	Anterior tibialis tendon allograft provides a strong reproducible choice for ACL reconstruction and decreases the morbidity of a comparable autograft procedure	1
Fu & Musahl 2001	3	3	The future of ACL surgery	In the next decade, the difference in grafts will be less pivotal as biological and biomechanical advancements continue to evolve.	4
Fehnel & Johnson 2000	3	3	ACL injuries in the skeletally immature athlete	background	4

Kocher et al 2002	3	2	Patient satisfaction with outcome after ACL reconstruction	background	4
Grant & Mohtadi 2003	2	3	Autograft reconstruction	background	2
Nyland et al 1998	3	2	Background information of BPTB autograft and allograft frequency and fixation methods. Also including differences in rehabilitation progression, bracing, and timing to release to cutting/agility sports.	Conflicting results on whether rehab. protocol and timing of release to cutting/agility sports should differ based on graft type indicate that factors other than delayed allograft maturation may be influencing the clinical decision-making process.	3
Indelli et al 2004	1	2	Compare primary ACL reconstruction using cryopreserved allografts against the published reports on the use of autologous tissues.	Allografts do at least as well as autografts in primary ACL reconstruction, when reviewing several parameters, including subjective assessment, ROM, ligament stability, IKDC score, sport activity level, radiologic findings and complication rate.	1

Lawhorn & Howell 2003	3	3	Scientific justification for double-looped, semitendinous and gracilis autografts and single-looped anterior tibialis and posterior tibialis allograft for reconstructing a torn ACL.	The double-looped semitendinous graft is the strongest and stiffest autogenous graft source available for ACL reconstruction. Harvest morbidity is low compared to the BPTB graft. Soft tissue allograft provide an excellent alternative for patients requiring revision surgery or for those trying to avoid morbidity associated with autogenous graft harvest.	3
Sgaglione & Douglas 2004	1	3	Bone augmentation in allograft ACL reconstruction	Background into a bone grafting method that could be useful in addressing potential ACL tunnel enlargement.	4

Vita

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