Clin Sports Med 26 (2007) 607–623

CLINICS IN SPORTS MEDICINE

ELSEVIER
SAUNDERS

Fresh-Frozen Allograft Anterior Cruciate Ligament Reconstruction

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Reconstruction of the anterior cruciate ligament (ACL) with allograft tissue has emerged as an excellent option for a variety of patients. This article reviews the indications for allograft ACL reconstruction, graft options, and technique for allograft use.

INDICATIONS FOR ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

For most active patients, reconstruction of the ACL provides an excellent chance of functional recovery and is preferred to activity modification and bracing. The literature is replete with numerous series of successful reconstructions using a variety of graft choices [1–16]. The decision to proceed with reconstruction should be made only after determining the patient's occupation, activity level, and expectations. Sedentary patients and those willing to attempt activity modification can consider nonoperative treatment [17]. No specific chronologic age is a contraindication [18,19]. Longitudinal studies traditionally have demonstrated that active patients have not been able to return to unrestricted function with an ACL-deficient knee [20–23]. The authors' indications for surgical reconstruction of the ACL-injured knee are outlined in Box 1.

GRAFT CHOICE

Once the decision has been made to proceed with reconstruction, graft choice becomes the next important factor to consider. At Rush University Medical Center, bone-patellar tendon-bone (BTB) autograft has been the primary graft choice for more than 20 years. The percentage of patients receiving allograft

Research performed at Rush University Medical Center, Chicago, Illinois.

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0278-5919/07/$ – see front matter
doi:10.1016/j.csm.2007.06.001

Box 1: Indications for ACL reconstruction

Active lifestyle, sport, and/or occupation
Participation in hard-cutting, decelerating sports for more than 5 hours/week
Associated repairable meniscus tear
Recurrent instability
High skill level
Social considerations
Multi-ligament knee injury
KT-1000 (MEDmetric Corporation, San Diego, California) side-to-side differences of more than 3 mm
Failed conservative treatment with bracing

reconstruction has increased from 2% our between 1986 and 1996 to almost 50% in 2006 [4]. The option of using allograft typically is discussed with patients who are more than 40 years of age, have evidence of degenerative joint disease or patellofemoral pain, or have insufficient or poor-quality donor tissue for autograft [4]. Patients who have multi-ligament knee injuries those who hope for an accelerated rehabilitation are others for whom the use of allograft tissue is an option (Box 2) Although available data indicate excellent clinical results in the population of older (age > 30 years) patients undergoing allograft reconstruction [4,10,24–26], this information cannot be extrapolated to patients aged 16 to 25 years involved in collision sports. Because long-term data on allograft use in this population are lacking, the authors do not routinely recommend allograft use for these patients.

TISSUE BANKING AND ALLOGRAFT PREPARATION

Fresh-frozen allograft tissue is the most common preparation technique [27]. In this process, the tissue is harvested under sterile conditions, cultured, and then is frozen while serologic tests are performed. After soaking in antibiotic solution, it is packaged and can be frozen for up to 5 years [28]. Cells do not survive this

Box 2: Considerations for allograft reconstruction

Age greater than 40 years
Radiographic evidence of mild degenerative joint disease
Moderate patellofemoral crepitation or pain symptoms
Petite stature
Donor graft tissue of questionable quality
Request for allograft tissue
Multi-ligament injuries
Need for accelerated rehabilitation

process [28]. Freeze-dried allografts also are commonly used. Also known as "lyophilization," this process begins with sterile harvest of the tissue, which is frozen while serologic tests are performed and then is soaked in antibiotic solution. The tissue is refrozen and lyophilized to reduce the moisture content to less than 5%. It is packaged and stored for up to 5 years [28]. It must be rehydrated before use [29].

The possibility of disease transmission is an issue paramount to the patient and the surgeon. Significant numbers of musculoskeletal allografts are used in a variety of procedures each year (650,000 in 1999) [30]. The American Association of Tissue Banks [31] and the Food and Drug Administration have set guidelines for tissue harvest and processing; however, multiple case reports from the Centers for Disease Control and Prevention have demonstrated possible disease transmission [30,32]. HIV transmission has been reported as well [33]. Secondary sterilization with irradiation conceivably could eliminate viral vectors. A dose of 3 megarads (30,000 Gy) of gamma irradiation is necessary to sterilize fresh-frozen allograft [34], but this dose causes significant mechanical and material deficiencies in allograft tissue [35]. Therefore, irradiation at this dose as an effort to sterilize the graft terminally is not recommended [36]. Lower-dose irradiation is used commonly to sterilize tissue without compromising biomechanical function [27]. Despite the federal guidelines for allograft tissue banking and harvesting, the harvest, processing, and storage of allograft tissue continues to evolve [37]. The surgeon must be aware of the tissue bank used at his or her institution and be sure that appropriate precautions are taken during harvest and preservation to ensure that contaminated or mechanically compromised tissues are not used [38]. Allograft safety issues are discussed further elsewhere performed in this issue.

ALLOGRAFT CHOICE

The authors' preferred allograft tissue is a fresh-frozen BTB graft. They use this graft for several reasons. Fresh-frozen tissue does not require rehydration and has been well studied, clinically [39] and from a basic science standpoint [40]. It allows use of identical instrumentation for autograft or allograft procedures. It also allows bone-to-bone healing and rigid interference fixation. In addition, the authors have had success with its use in both primary and revision situations [4,41]. Other allograft options include a hemipatellar tendon, quadriceps tendon, Achilles tendon, or soft tissue graft, such as hamstring or tibialis tendons. Each of these choices has potential benefits and potential shortcomings. Graft–construct mismatch can be a significant problem with the use of BTB grafts, especially if a graft from a tall donor is used for a shorter patient. This difference can be magnified if a hemipatellar tendon is used. A hemipatellar tendon is a longitudinally bisected whole patellar tendon, allowing one extensor mechanism to provide two useable grafts. This technique results in a tendon that has a functionally longer soft tissue component than a central-third graft. When a hemipatellar allograft, is used, the discrepancy in length must be accounted for: the surgeon should order a graft that is several millimeters shorter than typically ordered for a whole tendon, because the functional soft tissue length will be longer once is it prepared. It is advisable to inform the