Anterior cruciate ligament (ACL) reconstruction is now widely accepted and routinely performed. It is estimated that 60,000 to 75,000 surgical procedures are performed annually in the United States. Several graft sources have been employed since the development of current reconstruction techniques in the 1980s. Ligament substitutes included autogenous tissue, allografts, and synthetic materials. Initially, synthetic devices were popular. Early results appeared promising and the concerns of graft-site morbidity and disease transmission were nonexistent. However, as long-term follow-up became available, there were unacceptably high failure rates from synthetic reconstructions, with many associated problems. Subsequently, many patients have had additional surgery including revision ACL reconstruction or simply graft removal.

At the present time in the United States, synthetic substitutes have been removed from the market and are no longer indicated for use in primary ACL reconstruction. However, several patients still have synthetic ligaments and these patients may require additional treatment. This chapter discusses the various synthetic ligaments that may be encountered, and a treatment plan and technique for revision.

HISTORY

In 1914, Corner presented one of the earliest descriptions of prosthetic ACL reconstruction. He replaced the torn ACL of a football player with a loop of silver wire. This description predated Hey-Groves by 3 years; in 1917, he gave what is felt to be the first true description of an ACL reconstruction.

Since then there have been many advances in ACL surgery, and multiple synthetic substitutes have been introduced and subsequently removed from the market. History has shown many potential problems related to prosthetic ligaments. Problems from early breakage due to repetitive loading, to fixation failures, and to reactions of the synovial host tissue to the implant have all occurred.

SYNTHETIC LIGAMENT CLASSIFICATION

Prosthetic ligaments are designed to function in one of three ways. Permanent ligaments, such as the Gore-Tex and Stryker Dacron ligaments, are designed with high strength and are built to resist fatigue failure. They rely on inherent mechanical properties to resist load over a prolonged period of time. They receive no contribution from the host tissue or new tissue growth.

The second type of prosthesis is designed to augment the strength of the autogenous intraarticular graft tissue. These augmentation devices or stents improve the security of fixation and provide greater strength during the early healing and rehabilitation phase. The autogenous tissue increases its strength over time and the augmentation device becomes less important.

The final type of prosthetic ligament is a scaffold or ingrowth type of device. These ligaments rely on the host's collagen derived from the fibroblasts present in the knee. The collagen may fill in spaces within the existing graft, as with the Leeds-Keio, or may actually replace the scaffold as it is degraded over time as in a carbon fiber ligament. Theoretically, the newly developed tissue can last indefinitely without fatigue failure.
Figure 11.1. Gore-Tex ligament is composed of polytetrafluoroethylene (PTFE). The prosthesis is constructed from a single strand of material wound into multiple loops.

Permanent Grafts

Gore-Tex

The Gore-Tex ligament graft was one of the most popular grafts used in the United States. The ligament is composed of polytetrafluoroethylene (PTFE). The prosthesis is constructed from a single strand of the material wound into multiple loops. The strands are then woven into a three-bundle braid with fixation at each end (Fig. 11.1). Permanent fixation is thought to occur by tissue ingrowth into the strands of the graft within the bony tunnels over a period of 6 months. The ultimate strength of the graft is 5,300 N, which is roughly 2½ times that of the native ACL. It is also much stiffer than the ACL, with only 2% to 5% strain at failure compared to 25% for the ACL.3

The graft was approved by the Food and Drug Administration (FDA) in October 1986 for general use in patients with failed previous ACL reconstructions. The early reports on this ligament were promising. Indelicato et al4 presented a satisfactory outcome in 87% of his patients at 2 year follow-up, and a study from our institution looking at 61 patients showed improved subjective and objective criteria.5 However, there were still problems. Indelicato et al had nine patients with effusions, and on a follow-up study at 36 months they noted 11 failures.6 In our study there were five complete ruptures, three infections, and 16 sterile effusions, five of which became chronic.

Paulos et al7 found less than 50% improvement in subjective and objective factors in his series of 188 patients followed for 4 years. They had a total complication rate of 76% in those patients who had a previous intraarticular ACL reconstruction. Sledge et al8 found a 29% failure rate in their 5-year follow-up and recommended that the graft no longer be used.8

The ligament was removed from the market by its manufacturer in 1993. The Gore-Tex CD, the second-generation ligament, which was still in multicenter trials, was similarly removed at the same time.3

Stryker Dacron

The Stryker Dacron prosthetic ligament was a composite of four Dacron tapes surrounded by a Dacron velour sleeve. It was originally designed as an augmentation device for use with the iliotibial band. However, the ligament had an ultimate tensile strength of 3,600 N and it became commonly used as a permanent prosthesis.9 When used in this fashion, no significant ingrowth was noted intraarticularly.

The graft, too, appeared promising in the early results and short-term follow-up. However, long-term studies again identified problems. Wilk and Richmond10 reported a failure rate of 35.7% at 5 years in 84 patients. This was a dramatic increase from the 20% failure rate they saw at 2 years.10 Gillquist and Odensten11 prospectively followed 70 patients for 5 years and reported good to excellent results in only 56%, and a 23% graft rupture rate. In 1997, they presented long-term follow-up of the same patients. The overall rupture rate increased to 44%, 29% had undergone second reconstructions, and five had third reconstructions; 83% had radiographic arthritic changes and only 14% had acceptable knee stability and function.12

Stryker discontinued this product in 1994.

Scaffold Prostheses

Leeds-Keio

The Leeds-Keio (LK) graft is popular internationally. It was designed in a collaboration between Leeds University in England and Keio University in Japan. It is a polyester fiber graft woven to form a mesh structure (Fig. 11.2). The open weave was designed to promote ingrowth. The graft is secured with two bone plugs in a press-fit application. Without ingrowth, the ultimate