The use of an anterior cruciate ligament (ACL) graft is a common and well documented technique utilized in restoring anterior laxity to the knee. An ACL graft is composed of a graft construct that is fixated to the distal femur and proximal tibia (Figure 1). Various methods are currently available that involve securing soft tissue or bone plugs within a bone tunnel via fixation within the tunnel or distally on the cortex. The location of graft fixation, not the graft material itself, is considered the weakest link in clinical efficiency.

The following discussion is to be utilized as a rationale for selecting an appropriate soft tissue fixation device and reconstruction technique. Several factors that must be addressed include fixation device stiffness, slippage resistance of the graft construct, and placement of fixation.

**Fixation Considerations**

There are several current methods and techniques for fixing grafts to the bone tunnels in ACL reconstruction. It is significant to understand that anterior knee laxity following ACL reconstruction is determined by the stiffness and length, not the strength and tension, of the ACL graft. The fixation location of the graft in reference to the joint line must likewise be considered.

**Graft Stiffness** It is important to consider the stiffness of the fixation device when restoring anterior laxity to the knee. The overall stiffness of the ACL graft construct is increased by the use of stiffer fixation devices, not by shortening the graft length. High stiffness fixation devices provide fixation that is greater 400 N/mm, in contrast to low stiffness devices which provide less than 400 N/mm.
Graft Length It is equally important to maintain the length of the graft construct after initial fixation, requiring the use of fixation devices that resist slippage during cyclical loading. Those fixation devices which engage cortical bone, versus intratunnel devices that purchase cancellous bone, are more effective in preventing graft slippage. Cortical bone is significantly stronger than cancellous bone and will not experience the resulting softening after fixation.

Graft Fixation Location The fixation location of the ACL graft in regards to the joint line has been debated. Several have argued graft placement at the level of the joint line, utilizing intratunnel fixation with an interference screw. Results demonstrated improved restoration of anterior laxity due to shorter graft length. However, results were determined with the use of a porcine knee, which is not an adequate substitute for human bone. Porcine bone overestimates the stiffness and strength and underestimates the slippage of the interference screw.

Low stiffness cortical fixation does not restore laxity as well as intratunnel fixation, demonstrating that anterior laxity is determined by the stiffness of the fixation device, not where the device is placed in reference to the joint line (Figure 2). In contrast, high stiffness cortical fixation has been shown to restore anterior laxity as well as intratunnel fixation with an interference screw.

Biological and Mechanical Advantages
There are several biological and mechanical advantages when utilizing high stiffness, slippage resistant cortical fixation when compared to intratunnel fixation. The strength of the biologic bond is improved by the use of a longer tunnel and by creating a tighter fit between the tendon and tunnel wall. Also, with cortical fixation all sides of the tendon are allowed to heal with bone, resulting in circumferential healing (Figure 3). In contrast, intratunnel fixation with screw blocks may interfere with healing, resulting in reduction of graft stiffness, slippage, and strength.

Fixation Device (Figure 4) is an ideal choice for tibial fixation, allowing access to the tibial tunnel if the use of a bone dowel or bone graft is required. The use of distal fixation allows circumferential healing of the graft to the tunnel wall.

Summary
It is important to utilize ACL graft fixation devices that engage cortical bone at the distal end of the femoral and tibial tunnels in order to provide high stiffness and resist future slippage of the graft. Stiffness of the fixation device, not the length of the graft construct or its location in reference to the joint line, is a more significant predictor of the restoration of anterior knee laxity. Although stiff, the use of intratunnel fixation devices do not adequately resist slippage, may interfere with tendon tunnel healing, and reduce graft effectiveness as cancellous bone softens.

Fixation Device (Figure 4) is an ideal choice for tibial fixation, allowing access to the tibial tunnel if the use of a bone dowel or bone graft is required. The use of distal fixation allows circumferential healing of the graft to the tunnel wall.

References