

rotation (23.9 ± 15 Nm). Forward and medial hop tests failed to identify significant differences between extremities. Lateral hopping revealed a 4.9 ± 13 cm involved side decrease. IKDC Subjective Knee Evaluation scores were 86.4 ± 11 . Current Health Assessment physical function subscale scores were 94.2 ± 6 . Sensation scores were 7.6 ± 2.3 (range = 2-10). Multiple regression revealed that involved side prone isokinetic hamstring work at 60° sec and patient activity level predicted 68% of lateral hop performance ($R^2 = 0.68$). Involved side sensation score and prone isokinetic hamstring work at 60° sec predicted 61% of medial hop performance ($R^2 = 0.61$) and isometric hamstring torque at 90° knee flexion predicted 42% of forward hop performance ($R^2 = 0.42$). Prone isokinetic hamstring work at 60° sec, isometric hamstring torque at 90° flexion, and sensory score were related to patient function at 2 years following ACL reconstruction using a hamstring autograft.

John Nyland, Ed.D., Brian S. Elmlinger, M.S., Ed Tillett, M.D.

High School and College Female Athletes: Intermediate-Term Comparison of Bone-Patellar Tendon-Bone Versus Hamstring Anterior Cruciate Ligament Reconstruction (SS-12)

Female athletes are at greater risk for anterior cruciate ligament (ACL) injury than males. Recently, hamstrings (HT) have been a more popular graft choice for this gender and age population. This is in part due to improved cosmesis and potentially less harvest site morbidity. We hypothesize there is no difference in outcome between hamstring versus bone patellar tendon bone (BPTB) ACL reconstruction. Methods: A case-control study of athletic related ACL reconstructions in female high school and college athletes was performed. Participants underwent either HT or BPTB ACL reconstruction and were matched on age at injury, pre-injury activity level, time from injury to surgery (chronicity), and number of giving way episodes prior to surgery. Participating patients completed the IKDC Subjective Knee Form; the Activities of Daily Living (ADLs) and Sports Activity Scale (SAS) of the Knee Outcome Survey; and the SF-36 general health status questionnaire. Patients were seen in follow-up for X-ray evaluation, physical examination, KT-1000 testing, quadriceps torque using Biodex testing, and assessment of functional strength using one-legged hop and vertical jump tests. Paired *t* tests and Bowker's test for correlated proportions were used to compare the HT versus BPTB. Results: Twenty-four matched pairs were included. Average length of

follow-up was 5.5 for BPTB and 3.9 years for HT. The side-to-side difference in passive extension was significantly greater in the BPTB (3°) compared to the HT (0°) group. There was a trend for an increased maximal manual KT-1000 in the BPTB group (2.4 vs. 1.2 mm, $P = .08$). The BPTB group had significantly greater avoidance of kneeling and numbness/dysesthesia. There were no significant differences on IKDC, ADLS, or SAS. However, there was a trend for the BPTB group to have higher SF-36 physical component summary scores (56.8 vs. 54.6, $P = .06$). Conclusions: HT grafts for ACL reconstruction in the high school female athlete appear to be at least as effective as BPTB graft reconstructions. This study reinforces that HT is an acceptable alternative with less numbness/dysesthesia, kneeling pain, and loss of extension compared to BPTB.

Suzanne L. Miller, M.D., Derrick Fluhme, M.D., Francis Kimberly, M.S., M.P.A., Jay Irrgang, Ph.D., P.T., A.T.C., Freddie Fu, M.D., Christopher D. Harner, M.D.

Anterior Cruciate Ligament Reconstruction With Quadriceps Tendon Allograft (SS-13)

As the frequency of anterior cruciate ligament (ACL) reconstruction increases, so does the demand for suitable allograft. The purpose of this study was to evaluate the results of ACL reconstruction using a quadriceps tendon allograft. ACL reconstruction with quadriceps tendon allograft has not been previously reported. Twenty-seven patients were evaluated that underwent ACL reconstruction using quadriceps tendon allograft. One surgeon performed all of the ACL reconstructions. The bone plug was placed on the femoral side. The femoral fixation consisted of bioabsorbable interference screw fixation. Bioabsorbable interference screw fixation was also used on the tibial side. Tibial-sided graft fixation was augmented with the use of screw and washer post fixation. An accelerated rehabilitation protocol was utilized for all patients. The average follow-up was 32 months (range 22-50 months). Results were measured with the International Knee Documentation Committee (IKDC) grade, Lysholm score, Tegner scale, single leg hop test and KT-1000. The average patient age was 34 years at the time of surgery. The mean preoperative Lysholm and Tegner scores were 44.4 and 2.9 respectively. These improved to a mean of 91.9 and 5.5 postoperatively. The IKDC grade was normal or nearly normal in all patients. The postoperative single leg hop score averaged 95.0% of the uninjured leg. The KT-1000 evaluations demonstrated a mean side-to-side difference of 1.1 mm (range

0-4 mm). No patient had undergone or had revision surgery planned at the latest follow-up. We conclude that quadriceps tendon allograft is a suitable graft source for ACL reconstruction.

Randy S. Schwartzberg, M.D., Sean R. Dingle, M.D.

Arthroscopic Anterior Cruciate Ligament Reconstruction With Quadriceps Tendon Autograft—Minimal 4-Year Follow-up (SS-14)

Surgical reconstruction of the anterior cruciate ligament (ACL) is indicated in the ACL-deficient knee with symptomatic instability and multiple ligaments injuries. In the present study, we describe the clinical results of quadriceps tendon-patellar bone autograft for ACL reconstruction. From 1996 to 1998, the graft has been used in 38 patients. Thirty-four patients with complete final follow-up for minimal 4 years were analyzed. The average follow-up time was 62 (48 to 84) months. Thirty-two (94%) patients achieved good or excellent results by Lysholm knee rating. Twenty-six (76%) patients could return to moderate or strenuous activity after reconstruction. Twenty-eight (82%) patients had ligament laxity of less than 2 mm. Finally, thirty-one (91%) patients were assessed as normal or nearly normal rating by IKDC guideline. Twenty-five (73%) patients had less than 10 mm difference in thigh girth between their reconstructed and normal limbs. Thirty-two (94%) and Thirty-one (91%) patients could achieve recovery of the extensor and flexor muscle strength in the reconstructed knee to 80% or more of normal knee strength respectively. A statistically significant difference exists in thigh girth difference, extensor strength ratio, and flexor strength ratio before and after reconstruction. Our study revealed satisfactory clinical subjective and objective results at minimal 4 years follow-up. Quadriceps tendon autograft has the advantage of being self-available, relatively easier arthroscopic technique, and having a suitable size, making it an acceptable graft choice for ACL reconstruction. There is little quadriceps muscle strength inhibition after quadriceps harvest. There is quicker return to sports with aggressive rehabilitation. A quadriceps tendon-patellar autograft is a reasonable adequate graft choice to ACL reconstruction.

Chih-Hwa Chen, M.D., Shih-Wei Chou, Ph.D., Wej-Jer Chen, M.D., Chun-Hsiung Shih, M.D., Wen-Nung Ueng, M.D.

Quadriceps Tendon Anterior Cruciate Ligament Reconstruction (SS-15)

From April 1996 to August 2001, 302 patients underwent ACL reconstruction using a central quadriceps tendon autograft with a bone plug and bioabsorbable interfer-

ence screw fixation. Fifty-seven patients were available for long-term follow-up. Associated injuries were 20 medial meniscal tears, 29 lateral meniscal tears, and 8 significant (grad 2 or higher) articular cartilage injuries. At an average follow-up of 44.4 months (range 8 to 101 months), patients were assessed for ROM, stability, swelling and pain. KT values were 0.3 mm/47 patients, 3-5 mm/5 patients, 5-10 mm/5 patients and >10 mm/0 patients. Average KT value was 1.04 mm. Five patients had pain at final follow-up while one patient had an effusion. Fifty-four patients lost 0°-3° of extension and four lost 3°-5° of extension. No patient lost more than 5° of extension. No arthrofibrosis was seen in the 54 patients in the 0°-3° extension loss group, 3 patients in the 3°-5° extension loss group, and no patients in the over 5° extension loss group. IKDC scores at follow-up were 31 normal, 16 nearly normal, 8 abnormal, and 2 severely abnormal. There was no donor site morbidity. Good and excellent results were obtained in 55 or 57 patients. We feel that the central quadriceps tendon graft offers an excellent reconstruction option which yields excellent results and stability equal to bone-patellar tendon-bone graft. Patient satisfaction was very high.

Walter R. Shelton, M.D., Shaun Holt, M.D.

Residual Pivot Shift After Anterior Cruciate Ligament Reconstruction Using Quadriceps Tendon Autograft (SS-16)

This retrospective study was performed to determine the clinical significance and the causes of residual pivot shift after ACL reconstruction using central quadriceps tendon autograft. Methods: 93 knees of 92 patients who underwent an arthroscopic ACL reconstruction using quadriceps tendon autograft were reviewed with a minimum two years of follow-up. Clinical results were evaluated by Lysholm score and Cybex dynamometer. Anterior laxity was assessed using KT-2000 arthrometer. Patients were classified into three groups by postoperative pivot shift and Lachman test; Group 1 (all negative), Group 2 (negative in Lachman and positive pivot shift), Group 3 (all positive). The radiographic analysis was performed by 1) the angle between tibial and femoral tunnel on plain A-P image, 2) the angle between tibial tunnel and anterior tibial cortex on lateral image, 3) the femoral and tibial tunnel location using Aglietti method. Postoperative knee MRIs were obtained and 1) the angle between joint line and the graft on sagittal and oblique coronal view, 2) the angle between Leo's line and femoral tunnel on axial view were measured. Results: The number of patients in each group was 75, 8, and 10 respectively. Patients in group 1 showed greatest im-