INTRODUCTION:

No data has been reported on the anterior cruciate ligament (ACL) function during gait. This knowledge is critical for designing the ACL reconstruction technique and post-operative rehabilitation regimens since gait is the most common daily activity of the knee. Our objective was to measure the kinematics of the anteromedial (AM) and posterolateral (PL) bundles during the stance phase of gait. We hypothesized that during the stance phase of treadmill gait, the AM and PL bundles have distinct functional behavior.

METHODS:

Eight subjects (six men and two women) with no history of knee injury, surgery and systemic disease were recruited in a previous study under the IRB guidance [1]. Each patient signed an IRB approved consent form. Magnetic resonance images from these subjects were used to create 3-dimensional models of the knee. The attachments of the ACL were outlined on each model (Fig. 1A). Next, the dual fluoroscopic imaging system (DFIS) setup was used to determine knee kinematics during the stance phase of gait. The subjects performed the gait on the treadmill at a treadmill speed of 1.5 miles per hour (MPH) i.e. 0.67 m/s. Two thin pressure sensors were fixed to the bottom of each shoe, recording between the heel strike and toe-off of the stance phase during gait. The model and fluoroscopic images were used to reproduce the motion of the knee. The relative bundle elongation, sagittal plane elevation, coronal plane elevation, and transverse plane deviation of the two bundles of the ACL were measured (Fig. 1B). A two way repeated measures ANOVA was used to compare the AM and PL function. Differences were considered statistically significant when $P<0.05$.

RESULTS:

At heel strike, both AM and PL bundles had first peak elongation of 9% ± 7% and 9% ± 13% (Fig. 2). The AM and PL bundles had maximal elongation of approximately 12% ± 7% and 13% ± 15%, respectively, at 50% of the stance. There was no significant difference in the bundle elongation for each bundle between 40% and 60% of the stance phases ($P>0.05$). The PL bundle was more oblique in the sagittal and coronal plane elevations than the AM bundle throughout the stance ($P<0.05$), while the PL bundle had significantly more lateral transverse plane deviation than the AM bundle ($P<0.05$) (Fig. 3). With increasing knee flexion, the sagittal plane and coronal plane elevation of the two bundles decreased, whereas the deviation angle increased.

DISCUSSION:

The elongation of the two bundles during the stance phase decreased similarly with increasing flexion. However, we did not find the relative constant elongation pattern of the AM bundle throughout the stance which is different from what was found during single leg lunge by Jordan et al [2]. The in vivo function of the two bundles during gait was different from that during weightbearing knee flexion, indicating that the ACL function is activity-dependent or loading-dependent.