INTRODUCTION:
Progression of human tibiofemoral osteoarthritis (OA) has been quantified by measuring change in joint space width, and most studies of primary OA have used this outcome to study the latter stages of the disease. There is limited information available regarding joint space width (JSW) changes that occur during the onset and progression of post-traumatic OA (PTOA) that is often associated with injury to the anterior cruciate ligament (ACL) of the knee. Furthermore, there is a paucity of information regarding JSW changes that occur naturally in healthy individuals over time, making the interpretation of JSW changes following the onset and early progression of PTOA (when the subject is asymptomatic) challenging at best. The purpose of this descriptive investigation was to evaluate changes in tibiofemoral JSW following ACL injury and subsequent surgical reconstruction, compared to those observed in healthy, matched control subjects.

METHODS:
This investigation used a case-control study design approved by our institutional review board. Thirty-six ACL-injured (19 women, mean age = 25.23 yrs) and 24 healthy control subjects (13 women, mean age = 27.27 yrs) of similar age, race, BMI, and activity level were recruited and provided consent to participate. Entry criteria for injured subjects included: Age 14-55yrs; BMI = 18.5-30; Tegner score > 5; no previous joint surgeries or knee injections; no relevant knee pathologies other than the index injury; abnormal clinical laxity of MCL, LCL, PCL, or posterior lateral corner; no evidence of arthritis on baseline radiographs; normal anatomical alignment of lower limb; < 2/3 medial or lateral meniscectomy; < Gr IIIb articular cartilage lesions of tibiofemoral or patellofemoral joints (based on Int. Knee Documentation Committee (IKDC) grading criteria).

Entry criteria for control subjects were similar to injured participants with the following exceptions: no subjective report of knee pain or dysfunction (KOOS & IKDC); no abnormal clinical findings on clinical knee examination (IKDC); and no abnormal findings on baseline MRI. ACL-injured subjects underwent arthroscopic reconstruction within six months of their injury and participated in the same standardized rehabilitation program. Injured subjects were assessed at baseline (within 3 weeks prior to surgery) and 4 years-post reconstruction. Matched control subjects were recruited from the surrounding community and underwent baseline and 3-year follow-up assessments. Control subjects also underwent baseline and final follow-up 3T MRI assessments to elucidate existing or new pathologies incurred before or during the study period.

Bilateral anterior-posterior (AP) view x-rays were obtained using a semi-flexed, metatarsal phalangeal (MTP) view technique. Following completion of all visits, x-ray films were digitized and computer-assisted assessment of JSW performed using previously validated techniques with excellent accuracy (within 0.13mm). The same investigator acquired and analyzed all x-rays. Follow-up interval JSW’s were subtracted from baseline measures obtained on the same knee, thus providing change in JSW measurements. To establish the JSW range in which normal/healthy knees change over time, control subject values were averaged, and 95% confidence intervals (CI) determined for the medial and lateral compartments. An injured subject whose change in JSW measurement fell above or below the 95% CI observed in the control group was considered to have a statistically significant change in JSW from baseline. Data were analyzed using multilevel regression to test for statistically significant changes.

RESULTS:
Control and injured subject group mean change in JSW values, standard deviations, and 95% CI’s for medial and lateral compartments are presented in Table 1. JSW change values over time are presented in Fig.’s 1 & 2 for injured subjects, as well as the 95% CI for controls. In control subjects, no effect for time or leg was observed in the medial compartment (p = 0.13 and 0.22 respectively), or lateral compartment (p = 0.22 and 0.14 respectively). Analysis of medial compartment JSW revealed seven of the injured subjects underwent a significant increase over time, and 5 underwent a significant decrease in JSW over time (Figure 1). Lateral compartment JSW analyses revealed 6 subjects that underwent a significant increase, while 5 decreased over time (Figure 2). Two subjects displayed a combined increase of medial and lateral JSW (data points outlined in blue on Figures 1 & 2), and two subjects displayed a combined medial and lateral decrease of JSW (data points outlined in green on Figures 1 & 2). No subjects demonstrated one significantly increased, and one significantly decreased compartment (no “teetering” effect observed).

Table 1: Joint Space Width Delta Values (Baseline to Longest Follow-up)

<table>
<thead>
<tr>
<th></th>
<th>Medial JSW (mm)</th>
<th>Lateral JSW (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Diff</td>
<td>SD</td>
</tr>
<tr>
<td>Control</td>
<td>0.07</td>
<td>0.26</td>
</tr>
<tr>
<td>Group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injured</td>
<td>0.18</td>
<td>0.56</td>
</tr>
</tbody>
</table>

DISCUSSION:
An advance made with this matched case control study design was establishment of the limits of JSW changes in subjects with normal knees over time. We feel this is important when evaluating the onset and initial changes of PTOA in subjects that have suffered ACL injury and have not experienced symptoms of the disease.

Prior to the initiation of our study, we did not expect the number of injured subjects with “increased” JSW measurements. Recent investigations in animal models of PTOA have evaluated a “swelling” effect of articular cartilage that occurs during the earliest stages of the disease process. This may explain our observation of increased JSW’s. Future evaluation will determine relationships between patient, clinical, and biological outcomes and JSW change over time in this cohort.

REFERENCES:
1Dupuis, et al., 2003; Calvo, et al., 2001; Calvo, et al., 2004.

AKNOWLEDGEMENTS:
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