Retention or substitution of the PCL in primary TKA has been debated for years. There have been reports that PCL retention after TKA may give better proprioception of the knee but others have shown no difference between cruciate retaining and substituting designed TKA implants. Other microscopic investigations of the PCL in osteoarthritic knees have revealed degenerative myxoid changes and the presence of all types of mechanoreceptors [1,2]. In this study we look at the quantitative aspect of mechanoreceptors of PCLs after they have functioned in a cruciate retaining TKA and compared to PCLs retrieved in OA knees during a TKA. It was hypothesized that the PCLs in both groups would be equal in number as identified by using immunohistochemistry techniques indicating their continued function after surgery.

Methods
The local retrieval program at the Medical Education and Research Institute (Memphis, TN) has been setup through our laboratory and was utilized as the source the specimens in this case study. The first five cruciate retaining (CR) TKA specimens were identified and utilized for this study. The whole en bloc knee specimens were then harvested and the PCL extracted. After IRB approval five PCLs were collected from OA patients undergoing a TKA where a posterior stabilized implant was utilized. The PCLs were all placed in 10% formaldehyde and fixed at 4 degrees C for 24 hours. The specimens were then cut into small slices with the proximal and distal thirds of the PCL in the transverse plane and embedded in paraffin. The PCL specimens were then sectioned to a thickness of 8 microns and mounted on lysoine-coated microscope slides. Sections were incubated overnight at 4°C in a humid chamber with commercially available mouse monoclonal antibodies against neurofilament protein (NFP), and S-100 protein (Millipore, Billerica, MA). These were used to label the central axon, the periaxonic Schwann-related cells, and the perineural-related cells of the mechanoreceptors. The stock NFP was diluted at a ratio of 1:200 with blocking solution, and stock S-100 was diluted at a ratio of 1:500 with blocking solution. The antigen-antibody reaction was developed using a commercially available kit (Vectastain ABC) with DAB as the chromogen (Vector Labs, Burlingame, CA). This immunohistochemistry histologic investigative technique has been previously reported [3]. The presence and or absence of mechanoreceptor organs were then recorded at 40X magnification under light microscopy. A quantitative analysis of four fields was then undertaken for each TKA and OA PCL specimen and the number of stained elements recorded for comparison. These four fields correlated to an area of 120 square millimeters in the distal third of each PCL for analysis. Each of the four fields was analyzed for positive stained elements using Aperio Imagescope Software (Aperio Technologies Inc, Vista, CA). The strong positive elements as defined by comparison to a primary antibody reaction were then recorded to an area of 120 square millimeters in the distal third of each PCL for histology that is not comparable to normal knee PCL’s they have reported that these ligaments in OA contain mechanoreceptor organs [1,2]. This study is the first to show that when the PCL is retained that it can maintain its mechanoreceptors, as was shown using immunohistochemical staining techniques with S100 and NFP and compared to OA PCLs had similar areas of staining in the distal third of the ligament.

Whether the mechanoreceptors discovered in this series are functioning may be a difficult question to answer. Reports concerning differences between patients who obtain a CR versus a PS type of knee have been reported with no difference in gait analysis or positioning sense of the knee after surgery. The question still exists however, whether the PCL allows a better stability profile in flexion where the PCL has been reported to give the most support to coronal rotation and sagittal posterior directed forces after CR TKA. The fact that the PCL continues to retain these receptors would suggest that they are functioning since it has been shown that osteoarthritic knees have fewer mechanoreceptors compared to normal knees. Therefore, if the receptors continue to be present it may indicate that they are functioning in at least a similar manner as in the OA knee. This study was not conducted to answer the question of whether the PCL should be retained after surgery. The authors do conclude that the ligament may function at least as well in proprioception after CR TKA as it does in the osteoarthritic knee due to since a similar number of mechanoreceptors are present.

Significance: If mechanoreceptors continue to function after CR TKA then the ligament may continue to participate in proprioception of the knee after TKA.

References

Figure 1A: NF staining of a section from an OA knee.

Figure 2A: NF staining of a section from a CR TKA.

Figure 1B: S100 staining of the section from the OA Knee.

Figure 2B: S100 staining of the section from the CR TKA.