INTRODUCTION: Lateral ankle instability is a serious problem that causes pain and disability for many patients. In addition, many studies have found that lateral ankle instability leads to an increased risk of osteoarthritis in the tibiotalar joint. As a result, there have been many surgical procedures developed for this condition. Procedures attempting to recreate the anatomical orientation of the lateral ligaments, such as the Broström-Gould technique, have had excellent clinical results on various outcome scoring scales.

Multiple cadaveric studies and a few in vivo studies have examined the mechanics of the ankle joint in lateral ankle instability, finding significant differences in tibiotalar joint mechanics in patients with lateral ankle instability. An in vivo study has been performed on patients with this condition and found that the talus of laterally unstable ankles are significantly anteriorly translated, internally rotated, and superiorly translated compared to talus of contralateral normal ankles. This likely contributes to the symptoms of this condition as well as the increased incidence of osteoarthritis in these patients. However, the effects of surgical reconstruction on in vivo ankle joint mechanics have not been previously studied.

This study uses a combination of MRI and biplanar fluoroscopy to quantify the effects of Broström-Gould reconstruction on the in vivo kinematics of the tibiotalar joint. Patients with unilateral ankle instability were evaluated before and after surgery using the contralateral intact ankle as a control.

METHODS: Patients undergoing modified Broström-Gould repairs for unilateral lateral ankle instability were recruited with institutional review board approval, and informed consent was obtained for each patient. Patients had no other ankle pathology and a normal contralateral ankle.

Ankle joint kinematics as a function of load were studied with magnetic resonance imaging and orthogonal fluoroscopy. Static ankle kinematics were studied at varying amounts of load while the patient was standing on the unstable ankle alone. The loading was repeated using the contralateral normal ankle alone as a control. This procedure was repeated on the repaired and normal ankles postoperatively, at mean followup of 11 months (range 7-16 months).

The ankles were imaged using a 3-T magnet (Trio Tim, Siemens). MR images at 0.7 mm intervals were acquired using a double-echo steady state sequence (DESS, spatial resolution: 0.3x0.3x1mm, flip angle: 54°, TR: 17ms, TE: 6ms). The bony outlines of the tibia and talus were traced in each slice, and the tracings were stacked to form 3-dimensional mesh models of the bones (Figure 1). The orthogonal fluoroscope positions were recreated in a virtual environment, and the models were placed in the virtual environment to recreate the positions of the bones (Figure 1), allowing measurement of tibiotalar kinematics. Differences between the motion of the injured ankle were compared before and after surgery using the Wilcoxon Signed Rank Test.

RESULTS: Six patients fit the inclusion criteria and were studied preoperatively and postoperatively. Talus of repaired ankles were 0.7±0.2mm (mean ± SD) less anteriorly translated (Figure 2), 0.2±0.1mm less superiorly translated, and 2.5±0.9° (Figure 2) less internally rotated than preoperative ankles at 100% bodyweight load. As compared to contralateral normal ankles, talus of repaired ankles were on average 0.1±0.2mm posteriorly translated (Figure 2), 0.2±0.2mm anteriorly translated, and 1.6±2.1° (Figure 2) externally rotated.

The repaired ankles showed statistically significant improvements from the same ankles before surgery in all three directions of motion at 100% bodyweight load (p=0.03 in each direction). The differences between repaired ankles and normal ankles were not statistically significant in any of the directions of motion.

DISCUSSION: The results of this study suggest that in patients with lateral ankle instability, the modified Broström-Gould repair improves static standing kinematics of the tibiotalar joint back towards normal. This finding of biomechanical correction correlates well with the excellent clinical outcomes of this repair technique and supports use of this procedure in patients with lateral ankle instability.

The risk of osteoarthritis after surgical repair has not been widely studied. One previous study found that this significant risk of arthritis remains despite anatomic repair. The results of the current study do not show any statistically significant biomechanical differences in static ankle kinematics between repaired ankles and normal ankles. However, the magnitude of correction of internal rotation was only 2.5°. A previous in vivo study performed on patients with lateral ankle instability found a mean internal rotation difference of 5.7° between talus of unstable and contralateral normal ankles, somewhat greater than the correction we found by the procedure. As a result, there may be a residual internal rotation of the talus after repair. Future work studying a larger group of patients and examining dynamic ankle kinematics could help to expose any biomechanical differences that may remain between repaired ankles and normal ankles.