INTRODUCTION:
The current recommended fixation for an intercondylar distal femur fracture is two 6.5 mm cancellous screws. Recently there has been a trend towards using smaller sized implants for fracture fixation. For example, tibial plateau fractures that used to be stabilized with 4.5 mm plates and screws are now routinely stabilized with 3.5 mm systems (1). Because of the wide “footprint” of LISS plate, 3.5 mm cortical screws are initially placed around the periphery of the plate for compression and fixation of the femoral condyles when an intercondylar fracture is present prior to placement of the plate for fixation of the supracondylar part of the fracture (2). This raised the question whether 3.5 mm screws could be used for fixation of a lateral femoral condyle fracture, and if 2 or 4 screws were needed to obtain fixation comparable to two 6.5 mm screws. In this study we compare the stability of two large diameter (6.5 mm) screws to two or four small diameter screws for the fixation of a lateral femoral condyle fracture. The hypothesis of the study is that at least two 3.5 mm cortical screws are necessary to provide similar stability to that of two 6.5 mm cancellous screws.

METHODS:
Using femoral synthetic composite bones, a fracture model was created to simulate a lateral femoral condyle fracture (AO/OTA 33-B1). Fracture fixation was achieved using three different types of screw constructs: two 6.5 mm cancellous screws inserted using the lag technique (Figure 1A), two 3.5 mm cortical screws inserted using the lag technique (Figure 1B), and four 3.5 mm cortical screws, with two inserted using the lag technique and two as position screws (Figure 1C). After osteotomy and instrumentation, the proximal half of each femur was held in a custom-built polymethylmethacrylate (PMMA) mold. The position of each femur in the mold was such that the line of action for the load went through the center of the femoral head and the intercondylar notch, simulating the mechanical axis of the femur. The constructs were tested using an axial force applied to the lateral condyle fragment via a stainless steel rod (2.54 cm diameter) attached to the actuator of the Instron at a loading rate of 20 mm/min. Axial loading proceeded in displacement control mode after stabilizing the constructs with a preload of 10 N. Testing was stopped at 2 mm of fragmentation displacement, which was defined as the failure point for the constructs since this is the acceptable limit of a reduction for an intra-articular fracture. A load-displacement curve was plotted for each construct, and stiffness was calculated as the slope of the initial linear region of the curve.

A two-way analysis of variance was performed to determine statistically significant differences in the load to displace the fracture 1 mm and 2 mm, and stiffness between each group. In addition, a Fisher’s post-hoc test was performed to determine which treatment group(s) was responsible for the observed differences. The level of significance was defined as \( P \leq 0.05 \).

RESULTS:
The 6.5 mm screw construct required 56% more load to displace the fracture fragment 1 mm than the two 3.5 mm construct (\( P < 0.0001 \)), and 40% more load than the four 3.5 mm screw construct (\( P < 0.0001 \)). At 2 mm of fracture displacement, these differences increased to 62% (\( P < 0.0001 \)) and 48% (\( P < 0.0001 \)), respectively. In addition, compared to the two 3.5 mm group, the mean load to displace the fracture for the four 3.5 mm screw construct was 28% higher at 1 mm (\( P = 0.003 \)) and 27% higher at 2 mm (\( P = 0.03 \)). Furthermore, the mean stiffness for the 6.5 mm group was significantly higher than both the four 3.5 mm construct and the two 3.5 mm screw construct (Figure 2). The difference in stiffness between the two 3.5 mm groups was also significant.

DISCUSSION:
This study compared the biomechanical stability of three different screw constructs that could be used for the fixation of an intercondylar distal femur fracture. The rationale for this study was the use of small fragment screws to initially stabilize the intercondylar portion of a supracondylar-intercondylar femur fracture. The large footprint of the LISS plate has made the placement of large diameter screws for the fixation of the condylar fragments difficult, leading to the use of small diameter screws, placed around the rim of a distal femur in the region anterior and distal to the LISS plate. Our data showed that the mean load at failure and the stiffness were significantly higher for the 6.5 mm screw construct when compared to the 3.5 mm screw groups. Furthermore, the four 3.5 mm screw construct was more stable than the two 3.5 mm configuration, with significantly higher mean loads at 1 mm and 2 mm of fracture displacement. Therefore, stabilization of an intercondylar femur fracture with two 6.5 mm cancellous screws provides the most rigid and stable fixation. However, if small fragment screws are used a minimum of four 3.5 mm cortical screws should be inserted around the rim of the distal femur.

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