INTRODUCTION: The tibial tubercle osteotomy has traditionally been used for patellofemoral realignment procedures and is recently gaining popularity for exposure in revision total knee arthroplasty. Bicortical screws and cerclage wires are the most common techniques for step-cut osteotomy fixation [1-3]. Previous studies [4,5] have shown adequate fixation with both screws and cerclage wires, but they only examined static loads. The goal of this study was to compare these fixation techniques under cyclic loads and with varying angles of pull that would simulate clinical loads during the rehabilitation of patients after tibial tubercle osteotomy. Our null hypothesis was that there would be no difference in failure rates between the two fixation techniques.

METHODS: Forty frozen lower extremities (range 48-82) were disarticulated at the knee with the patella-patellar tendon complex intact. Specimens were divided into two groups of twenty. Prior to testing, bone mineral density was determined using a DEXA scan (Hologic 4500A, Hologic Inc., Waltham MA). The tibia was then transected at the mid-diaphyseal level and skeletonized with preservation of the patella-patellar tendon complex.

A step-cut was performed with an osteotome just proximal to the insertion of the patellar tendon on the tubercle. The osteotomized fragment measured 10.3-12.5cm in length and 1.3-1.9cm in height at the tubercle. In the first group of specimens, osteotomy fixation consisted of two 4.5 mm bicortical screws (Synthes, Paoli, PA) placed approximately 2cm and 6cm distal to the tubercle. In the second group of specimens, fixation consisted of four 18-gauge cerclage wires (Ethicon, Somerville, NJ) placed just below the tubercle and then 2, 4 and 6cm distal.

Testing was performed using a servo-hydraulic Instron 1321 (Instron, Canton, MA). Testing consisted of dynamic cyclic loading, followed by static loading to failure. Dynamic cyclic loading to 400N at a rate of 200N/sec was imparted until the fragment displaced 1cm from its initial configuration or 500 cycles were completed. Static loading to failure was conducted at 25mm/min until a peak load or 1cm of displacement occurred. Displacement was measured by a linear variable differential transformer (LVDT, Transmek, Inc, Ellington, CT) attached to the fragment.

Specimens grouped into screws and wires were tested with the patellar tendon at 0 degrees [4] and at 25 degrees of angulation relative to the tibial axis. All osteotomized fragments were measured for length, height, step-cut depth and surface area upon completion of testing. Data was analyzed via a two-way ANOVA followed by Tukey-Kramer pairwise comparisons.

RESULTS: Constructs tended to require a load threshold before fragment movement was recorded (Fig.1). The fragments then displaced along the osteotomy plane until abrupt failure. There was no significant difference (p>0.30) in the final displacement at failure (Table1). Screw fixation at 25 degrees was significantly stronger than wire fixation, regardless of the loading direction (Fig.2). Screw fixation at 25 degrees of angulation was 1.3 times stronger than screw fixation at 0 degrees of angulation, yet this difference was not significant (p>0.30, Fig.2). Similarly, screw fixation at 0 degrees of angulation was 1.3 times stronger than wires at 0 degrees and 1.6 times stronger than wires at 25 degrees, but this difference was not significant (p>0.20, Fig.2).

The variables of surface area, step-cut depth, osteotomy height, osteotomy length, and bone mineral density were the same within the group tested at 0 degrees and the group tested at 25 degrees.

DISCUSSION: This data shows that cerclage wire fixation of a tibial tubercle will provide adequate fixation for normal rehab conditions at different knee positions. Abnormal conditions, such as very heavy patients or marked contraction of the extensor mechanism, may place excessive loads on the tubercle and may prohibit the procedure. Cerclage wire fixation is appropriate when screws cannot be placed due to intramedullary tibial stems, or concerns of placing drill holes in the tubercle.

REFERENCES: