INTRODUCTION: The extended trochanteric osteotomy (ETO) is an effective method for exposing a well-fixed femoral stem during revision total hip arthroplasty. However, solid fixation of the osteotomy fragment is essential to provide appropriate tension of the abductor tendons. In larger series, nonunion is reported between 0-4%. This complication significantly increases the risk of post-op hip dislocation. Despite the introduction of claw-plates and various cerclage techniques, all current methods have disadvantages and none have fully prevented proximal fragment migration. We hypothesize that a hybrid cerclage/locking plate technique will prevent proximal migration of the osteotomy fragment significantly better than an all-cerclage fixation technique.

MATERIALS AND METHODS: Following a priori power analysis, four matched-pairs of fresh-frozen cadaveric femurs underwent DEXA scanning and were dissected maintaining the insertion of the gluteus medius and minimus tendons. Each femur was cut to 30 cm from the tip of the greater trochanter and prepared for prosthesis implantation. As the femoral neck cut was performed, great care was taken to avoid notching the greater trochanter in any way. An ETO measuring 15 cm from the tip of the greater trochanter was then performed as described by Younger, et al. In one specimen of each matched-pair, the osteotomy fragment was secured with three 1.7 mm CoCr cables tensioned to 50 kg each. The cables were located 3 cm, 6 cm, and 9 cm from the distal edge of the osteotomy fragment, and the proximal cable was further secured by passing it through a hole drilled transversely through the lesser trochanter. In the other specimen, the fragment was secured with two proximal cables and a narrow 4-hole limited contact combi-plate (Synthes, Paoli, PA) with two 10 mm self-tapping unicortical locking screws on either side of the distal osteotomy cut. The undersurface of each osteotomy fragment was coated with silicone gel to prevent cement bonding to the fragment, and a 190 mm Endurance® (Depuy, Warsaw, IN) stem was cemented into place. The femurs were potted and placed into a novel apparatus (see illustration) that utilized a lever arm to tension the glutei tendons while loading the femur through the implant. The femoral head was located at the fulcrum of the lever arm, while the loading device (Instron, Norwood, MA) and glutei tendon attachments were positioned on opposite sides at a distance ratio of 3:1 respectively. This ratio approximates the typical anatomic relationship of the hip joint center and glutei origin to the center of gravity. Subsequently, a (4)x kg load applied to the lever arm tensioned the glutei tendons to (3)x kg and resulted in the application of a (4x) kg load to the implant. The addition of a pulley system to the glutei tensioning cables allowed for simulated stair-climbing by tensioning the tendons at +45° in the sagittal plane. The lever arm was loaded by the Instron, and the glutei tendons were tensioned both vertically and at +45° according to the following schedule: vertical tension 10 kg x 20 cycles, 20 kg x 20 cycles, 30 kg x 100 cycles; 45° tension 10 kg x 20 cycles, 20 kg x 20 cycles, 30 kg x 20 cycles; vertical tension 40 kg x 20 cycles, 50 kg x 20 cycles, 60 kg x 100 cycles; 45° tension 30 kg x 100 cycles. Migration of the osteotomy fragment was measured both vertically and horizontally using linear variable displacement transducers. Statistical significance was evaluated using a paired student’s t-test.

RESULTS: DEXA scans revealed T-scores >1.0 for all samples. Total vertical migration averaged 0.22±0.08 mm for the plated fragments and 4.67±1.15 mm for the all-cerclage constructs (p=0.02, 92% power). Total horizontal migration, measured proximally on the fragment, averaged 2.21±0.67 mm for the plated fragments and 4.87±5.04 mm for the all-cerclage constructs (p=0.45). Regardless of the type of fixation, all samples sustained a fracture of the greater trochanter during testing. Three matched pairs sustained a fracture when the glutei were tensioned at 45° under loads greater than 20 kg. The other matched pair sustained trochanteric fractures when the glutei were tensioned vertically under loads greater than 50 kg. The fracture line was consistently located proximal to the superior cerclage cable, and in each instance, visual inspection failed to identify any cortical defects that could contribute to failure.

CONCLUSION: Under controlled conditions, the hybrid locking plate/cerclage constructs performed significantly better than the all-cerclage constructs in preventing proximal fragment migration. Further, horizontal migration was also diminished for the plated constructs, although this result was not significant. Trochanteric fractures are a relatively rare post-operative complication of the ETO, and the consistency of fractures in our study may be related to the use of cadaveric bone which has no feedback mechanism such as pain to warn of imminent bony failure. Regardless, this data suggests a new and effective application of locking plate technology to the field of revision hip arthroplasty, and serves as a foundation for further in vivo studies.

REFERENCES

ACKNOWLEDGMENTS
This work was supported by unrestricted grants from Depuy and AO North America.

53rd Annual Meeting of the Orthopaedic Research Society
Poster No: 1731