Minimum Tensioning of Cerclage Cables to Achieve Pre-Fracture Stability after Intra-operative Periprosthetic Proximal Femoral Fractures: A Cadaveric Model

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INTRODUCTION

Intra-operative periprosthetic femur fractures during total hip arthroplasty (THA) are common due to the increase in cementless/press-fit implants and revision THA. When periprosthetic proximal femur fractures occur, cerclage wires or cables are typically applied to the proximal femur to stabilize the femoral component and prevent longitudinal propagation of the fracture, and the clinical results have been favorable. Although proximal femur cerclage wire fixation in THA has proven to be biomechanically effective, some authors have expressed concerns regarding the potential deleterious effect excessive cerclage wire tension may have on femoral blood supply. The objective of this study is to determine the minimum cerclage wire tension required to restore the stability of a press-fit femoral stem following a longitudinal periprosthetic femur fracture.

METHODS

Seven proximal femoral cadaver specimens were obtained and cleared of all soft tissue. Using the implantation technique outlined in the Zimmer technique guide, appropriately sized Zimmer M/L Taper Hip Prosthesis femoral stems were implanted in each specimen. Satisfactory clinical pressfit was achieved in each specimen prior to testing. An MTS Model 858 MiniBionix II testing machine was used to determine the initial torsional stability of the femur/implant construct. The construct was loaded to 100 N compression and then torqued cyclically to ± 5 N·m at a rate of .25 Hz. Using a reciprocating saw, a longitudinal osteotomy was then created in the medial cortex of the proximal femoral metaphysis beginning at the level of the femoral neck osteotomy medially and extended down to the tip of the femoral stem to simulate an intra-operative periprosthetic fracture and torsional stability was tested again. A single circumferential Zimmer cerclage cable was placed just above the lesser trochanter and tensioned and tested at increasing intervals, ranging from 0 N, 25 N, 50 N, and 100 N, as measured on the Zimmer cerclage cable tensioning device. These applied tensioning loads were also measured through a custom ring transducer with strain gauges to determine load accuracy. The implant's torsional stability was re-tested and documented at each tension level . Statistical analysis by paired t-test was performed to determine significant differences between pre-crack stiffness and stiffnesses at each level of cable tension.

METHODS

Figure 1 – Cable applied above the lesser trochanter with tension measuring transducer to monitor cable tension.

RESULTS

The mean torsional stiffness of the intact femur was 8.85 N·m/°. This decreased to 4.56 N·m/° after the longitudinal osteotomy was introduced and prior to cerclage cable placement. Once the cerclage cable was applied above the lesser trochanter, the mean torsional stiffness was 5.90 N·m/° at 100 N of tension and 5.35 N·m/° at 25 N of tension ($p = 0.039$). The mean torsional stiffness at 50 N was 5.68 N·m/° but this did not reach statistical significance compared to stiffness at 100 N ($p = 0.128$). Cabling above the lesser trochanter (5.90 N·m/°) was significantly stiffer than cabling below the lesser trochanter (5.08 N·m/°) at 100 N ($p = 0.007$).

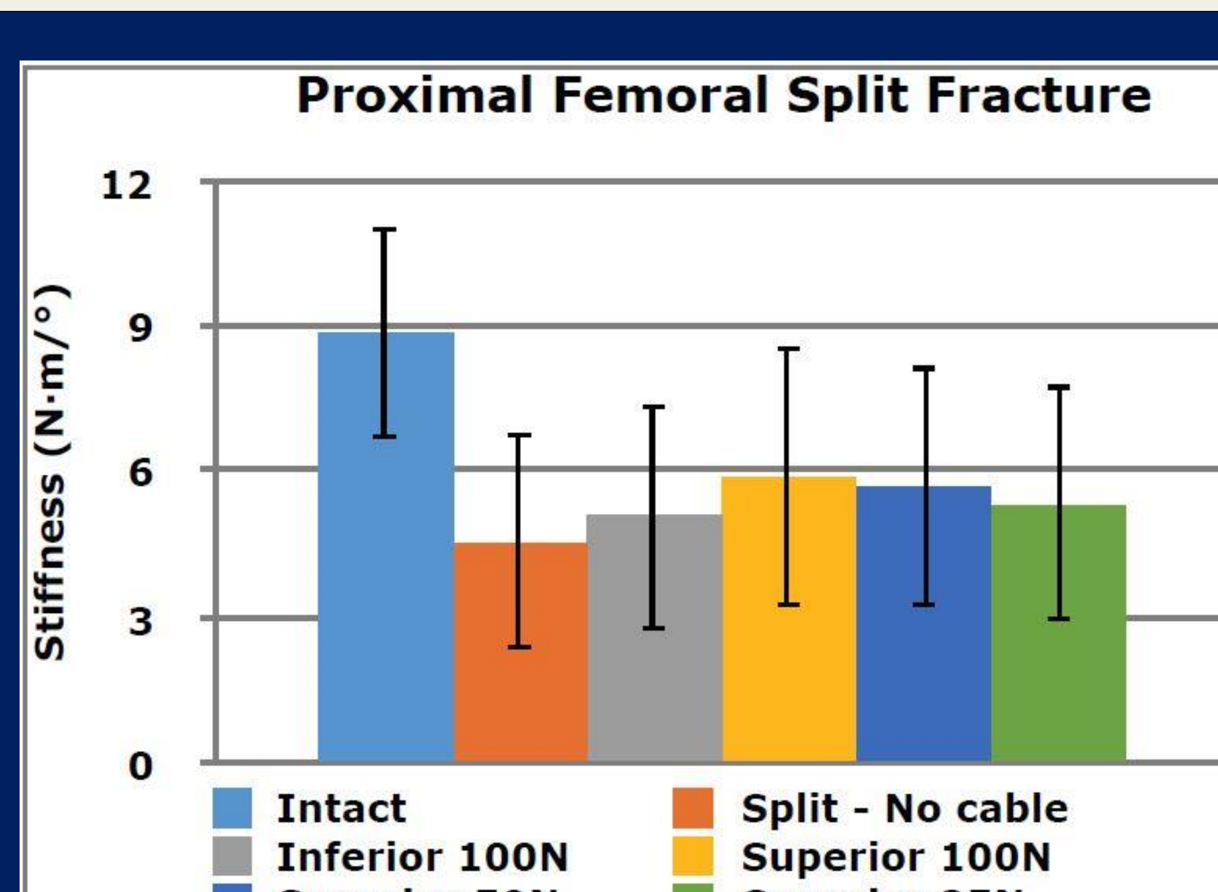

Figure 2 – Recovery of prefracture stiffness for each parameter

DISCUSSION

A single cerclage cable placed above the lesser trochanter can significantly improve torsional stability following intra-operative periprosthetic femur fracture during THA. The torsional stability restoration achieved at all tensioning levels was greater than that achieved with a maximally tensioned cerclage cable placed below the lesser trochanter. However, full pre-fracture stability could not be achieved using a single cable in any of the specimens, even at the maximal cerclage cable tension permitted by the Zimmer tensioning device.

SIGNIFICANCE

Although cerclage cables were capable of significantly improving the torsion stability of femoral press fit implants following a longitudinal periprosthetic fracture in this model, a single cable could not restore pre-fracture implant stability at the maximum tension generated by currently available tensioning devices.

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