Effectiveness of Prophylactic Cerclage Fixation for Prevention of Femoral Fracture Propagation

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INTRODUCTION:

Prophylactic cerclage cables have been widely advocated for preventing the propagation of fractures during total hip arthroplasty and postoperative activities. However, the placement of these cables in clinical practice varies, with recommendations spanning 0-20mm below the fracture site. Despite the clinical relevance, there is a lack of definitive biomechanical data guiding the optimal location for prophylactic cable placement. Therefore, this study was carried out to address two questions:

1) What is the effective placement range of cerclage cables to prevent fracture propagation?

2) Does cable tension change during loading, and what implications does this have on the stability of the cerclage technique?

METHODS:

Femoral shafts from six fresh-frozen cadavers were used. Each specimen underwent a series of five axial loading tests, with a cobalt-chromium prophylactic cable placed at different distances (i.e., 5mm, 10mm, 15mm, 20mm, and a cableless control) from an induced fracture. The cerclage cable was equipped with a compressive load cell to ensure consistent initial cable tension across all tests and to measure the changes in cable tension during subsequent loading.

To prepare the specimens for testing, the femoral canal was reamed, followed by the insertion of a 4° taper using an MTS machine at a rate of 10mm/min (Figure 1). The tests were terminated upon crack propagation. The fracture was stained with blue ink to facilitate visualization. The ultimate force and changes in cable tension were then compared among different groups using a repeated-measures ANOVA, followed by post hoc analysis using Fisher's protected least significant difference (PLSD) test.

RESULTS:

There were significant variations in the effectiveness of cerclage cable placement at different distances from the initial fracture. In comparison to the cableless control group, the 5mm group requires a significantly higher ultimate force (normalized: 331.6 ± 58.2 N/mm vs. 154.6 ± 28.7 N/mm) to propagate the fracture ($p=0.004$), corresponding to 3.3 times the body weight of an average person (Figure 2). A significant difference was also seen between the 10mm group and the control ($p=0.004$). However, when the cable was placed at 15mm and 20mm, the ultimate force was not significantly different from the control group ($p=0.385$ and 0.426).

The tension in the cerclage cable exhibited distinct patterns in different groups. With the cable at 5-10mm, the cable tension first remained relatively stable and then increased rapidly in the later stage (Figure 3). Conversely, when the cable was placed at 15-20mm below the fracture, the tension in the cable decreased an average of 3% throughout the test.

DISCUSSION AND CONCLUSION:

The results of this biomechanical study underscore the critical importance of precise cable placement. When the prophylactic cable was positioned within the 5-10mm range, the cable effectively resisted fracture propagation and experienced increased tension as the loading progressed. However, cables placed in the 15-20mm range exhibited limited effectiveness. These findings emphasize the significance of accurate cable placement for achieving optimal biomechanical outcomes and fracture prevention in clinical practice.

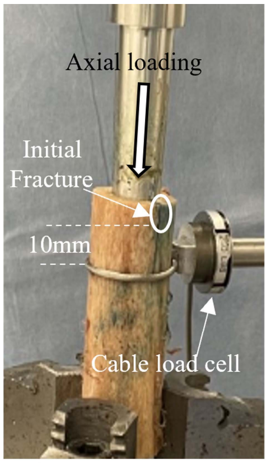

Figure 1. Setup of the fracture propagation tests

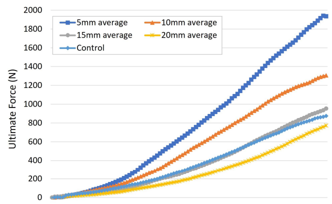
Figure 2. Variation of the axial force during loading with different cable placement

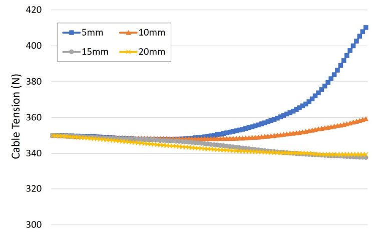
Figure 3. Variation of the tension of the cerclage cable during loading