GREATER TROCHANTER REATTACHEMENT: EXPERIMENTAL EVALUATION OF CABLE TENSION AND DISPLACEMENT DURING WALKING

[1,2] Kajsa Duke, [1]G Yves. Laflamme, [2]Vladimir Brailovski, [1,2]Yan Bourgeois, [1]Charles Toueg, [1]Annie Levasseur and [1, 2]Yvan Petit
[1]Sacre Coeur Hospital, Montreal, Canada,
[2]Ecole de technologie supérieure, Montréal, Canada; email: Yvan.Petit@etsmtl.ca

INTRODUCTION

During hip revision surgeries an osteotomy of the greater trochanter (GT) is often performed. Biomechanical analysis of GT reattachement began in the late 1970's when only wires were used [1]. More recently, cables and cable plate systems are being employed. Hersh et al [2] compared the stiffness of wire, cable and a short Dall Miles Two Cable Grip system (Howmedica, Rutherford, NJ). The cable grip system was found to be the stronger and more rigid of the three [2]. Even with recent improvements, a relatively high failure rate is still reported [3]. More modern cable grip type systems that extend down the lateral diaphysis of the femur have yet to be investigated. Variability in cable tension is also not well understood. The objective of this study is to evaluate the change in cable tension and displacement of the GT during loading similar to walking.

METHODS

A 4th generation Sawbones composite femur (Pacific Research Laboratories Inc. Vashon, WA) was osteotomised and implanted with a femoral stem and the GT was then reattached with a 4 cable system (Cable-Ready®, Zimmer, Warsaw, IN). The cable tension was monitored with a through hole compression load cell (Omega, Stamford, CT) and were tightened starting with the upper (most proximal) cable and subsequently tightened down the shaft. The first through fourth cables were then retightened as recommended by the manufacturer. Cable tension was set to either 178, 356 or 534 N (356 N or 80 lb is recommended by the manufacturer.)

A custom made frame (Figure 1) applied quasi static load on the head of the femoral stem implant (2340 N) and abductor pull (667 N) on the GT in

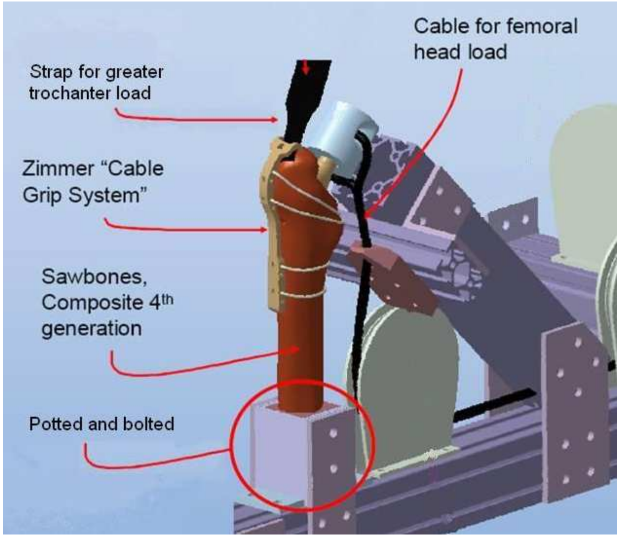

Figure 1: Schematic of loading frame

order to simulate walking. This loading was applied three times (steps) to evaluate the effect of repeated loads. The entire experiment was then repeated three times, in random order, for each cable tension configuration to assess the reproducibility of measurements.

Femur and GT displacement was measured with an Optotrack system (Northern Digital inc., Canada). A custom calibration procedure was used to animate a 3-D CAD femur model and measure relative gap and shear displacement of the GT.

RESULTS AND DISCUSSION

Cable tightening was analyzed determine any drop in cable tension as subsequent cables were tightened. The first cable dropped an average of 45%, the second 13% and no significant loss was observed in the third cable. All cables were retightened to the desired tension within an error of 9.8 N. Because a large drop in cable tension was observed, as seen in Figure 2, it was important to properly retighten the cables before locking the set screws as suggested by the manufacturer.

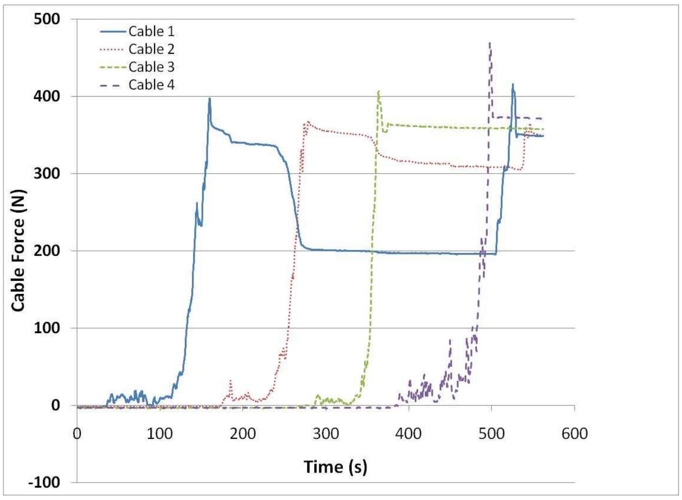

Figure 2: Cable tension during subsequent cable tightening

Cable tension was continuously monitored during loading to analyze any potential cable loosening. All cables loosen after testing with the exception of the first and fourth cable when tensioned to 178 N. With the manufacturer's recommended initial tension, the cables lost on average 23 N (7%) of tension. The second cable observed the greatest loss (60 N or 17%). This suggests that the cables slack considerably during the first few steps. However, this test was unable to show the long term effect of cyclic loads or bone remodeling around the cables.

GT displacement, relative to the femur, was monitored during loading. The gap measured was 0.39±0.14, 0.46±0.02 and 0.42±0.08 mm for 178, 356 or 534 N initial cable tightening respectively. The shear, or sliding, of the GT was more variable and was greatest at 0.89±0.3 mm when tension was only 178 N. The shear was only 0.24±0.06 and 0.26±0.11mm for the 356 N and 534 N initial cable tensions respectively.

CONCLUSIONS

A drop in cable tension was observed when tightening subsequent cables. Therefore, retightneing of the cables, as reccomended by the manufacturer, is very important. Loss in cable tension is measured after the simulation of only three steps. The effect of cyclic loading will be analyzed in future studies.

More variability in the displacement and greater shear was observed when the cables were only tensioned at 178 N (50% of the manufacturer recommended tension). Reducing the tension is not recommended. However, there appears to be no difference between the shear and gap when cables are tensioned at 356 N or 534 N. This suggests avoiding excessive tightening of the cables as it may increase stress in the bone.

REFERENCES

1. Markolf KL, et al. *Clin Ortho Rel Res*, **141**:111-21, 1979
2. Hersh CK, et al., *Clin Ortho Rel Res*, **329**:317-25, 1996
3. Barrack RL & Butler RA, *Clin Ortho Rel Res*, **441**:237-42, 2005

ACKNOWLEDGEMENTS

Funded by NSERC

Thank-you to Yannick Baril and Michel Drouin