Cable Tension for the Cerclage Cable Fixation of Periprosthetic Femoral Fractures

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Introduction

The amount of tension which surgeons apply to a two-side Dall-Miles cable during the fixation of periprosthetic fracture has not been reported. In most fixation surgeries of periprosthetic fracture, the amount of the tension is applied by the surgeons’ experience. When setting a loading condition to do biomechanical tests or finite element analysis of the cable fixation system, real amount of cable tension is a critical boundary condition for getting practical reference data. Current study is the first report that reveals the real cable tension data which was intraoperatively measured.

Methods

In vivo data of tightening torque was measured intraoperatively during Dall-Miles cable fixation surgeries for periprosthetic fracture of the femur. And the numerical relationship between torque and cable tension was assessed through mechanical tests. Using the torque vs. cable tension relationship, intraoperatively measured tightening torque was converted into a cable tension.

Intraoperative measurement of tightening torque

In vivo data of the maximal torque which was applied by an experienced surgeon was measured using a torquemeter. Total 11 cases of periprosthetic femoral fractures from 11 patients were participated with their agreement. A two-side Dall-Miles cable tightener (Stryker Co., USA) was used. To measure the torque of Dall-Miles tightener applied by a surgeon, a torquemeter (Torque driver 80FTD2-N-S, TOHNICHI, JAPAN) was connected to the Dall-Miles tightener through a square groove. The groove was machined with 1cm x 1cm x 1cm in dimension on the proximal end of the rotational shaft of the Dall-Miles tightener. Three trial data collections for each measurement were performed. The amount of tightening torque was determined as the maximal torque applied by the tightener during the cable fixation.

Laboratory measurement of torque and tension

To reveal the relationship between the torque of Dall-Miles cable tensioner and the tension of the cable, mechanical tests were done. A two-side Dall-Miles cable tensioner were mounted to INSTRON (INSTRON, Norwood, MA, USA) using a customized fixation jig. One cable of 2 mm in diameter was connected to the upper head of INSTRON, and another to the lower head. To secure a fair initial loading condition of both upper and lower cables, the fixation of the Dall-Miles cable tensioner and cables to INSTRON was designed to have some laxity. A preload was slowly applied to the cables up to 10 N so that the initially loose interaction among a tightener, two cables, and two loading heads of INSTRON became tight. Once the preloading finished, tightening torque and cable tension were simultaneously measured. The tightening torque was increased in increment of 1 N-m; accordingly, at each torque the tension hung to Dall-Miles cable was measured by reading loadcell data of INSTRON.

Results

Intraoperative tightening torque

Intraoperatively measured maximal torque applied to the Dall-Miles cable tensioner was 5.7±0.5 N-m.

Numerical expression of torque-tension relationship

Based on the data of tightening torque and cable tension measured from mechanical tests, the relationship between the torque (T) and tension (P) of Dall-Miles cable fixation system was numerically expressed. Total range of measured tightening torques and cable tensions was linearized. The linear expression was “T=106.8 × P” as sown in Fig. 2.

Discussion

This study revealed that 606.6±58 N of cable tension has been applied when an experienced surgeon does cable fixation of periprosthetic fracture. Even though the amount of the tension may be slightly different in each patient, authors believe that the torque-tension relationship will provide a key biomechanical clue for biomechanics scientists, and the amount of intraoperative cable tension measured at the time of Dall-Miles cable fixation for periprosthetic fracture will provide an important surgical key reference for the surgeons who use the cable fixation system.

REFERENCES