THE ACCURACY OF FINE WIRE TENSIONERS

INTRODUCTION

Transfixion wire tension appears to be an important factor in the overall stiffness of ring and hybrid external fixation (1, 2, 3). The tension achieved on a transfixion wire is based on the accuracy of the tensioner 1, 3). There are limited data available on the accuracy of commercially available tensioners. The purpose of our study was to compare the accuracy of five commercially available fine wire tensioners used in hybrid and ring external fixation.

MATERIALS AND METHODS

A laboratory investigation was performed to evaluate the null hypothesis that there are no differences between wire tension provided by five commonly available wire tensioners and corresponding nominal values (the manufacturer’s tension markings on the tensioners). The testing was performed using a servo-hydraulic test frame (MTS Bionix 858, Minneapolis, MN, USA). A 1.8 mm smooth transfixion wire (Smith and Nephew, Memphis, TN) was attached to a ring with an outer diameter of 20 cm, an inner diameter of 16 cm, and thickness of 2 cm (Fig. 1). A force transducer (load cell) device (Force Transducer, model 661.19 E-01, 5000 N capacity, MTS System Corp., Minneapolis, MN, USA) connected to the ring was used to measure wire tension (Fig. 1). One end of the wire was connected to the force transducer (Fig. 1). The other end was tensioned using commercial tensioners: the Ilizarov brand new tensioner (Smith and Nephew, Memphis, TN) (Fig. 1), the Ilizarov used, the EBI DynaFix tensioner (EBI Medical Instruments, Parsippany, NJ, Synthes hybrid tensioner new and used (Synthes USA, Paoli, PA), Hoffman II hybrid tensioner (Howmedica Stryker, Rutherford, NJ, and Ace-Fischer external fixator tensioner (DePuyACE Medical Company, El Segundo, CA). The load cell device was connected to the MTS, which measured the applied tension. Each tensioner was brand new and either provided by the manufacturer as a “loaner” or was recently purchased. Each tensioner was used according to the manufacturer’s instructions. The middle of the dot or line marking (half covered and half visible) was used as the endpoint of tensioning. Seven repetitions of each test were performed for each tensioner at each tension value marked by the manufacturer. We used a new wire for each test and for each repetition. The testing was done by an experienced orthopaedic surgeon. The second part of our study subjectively assessed the overall ease of manual usage of each tensioner based on the presence or absence of five parameters that are important in surgery: physical effort needed during tensioning, time spent to tension the wire, visibility of markings, tensioner size (hard to hold in the hand, easy to hold in the hand), and adjustability to ring. Based on these parameters, the tensioners were subjectively rated to characterize easy of usage. The real wire tension data of each tensioner provided by the MTS were compared to nominal values (manufacturer tension markings on each tensioner). The percent error of each value for each tensioner was calculated by dividing the real tension data of each tensioner provided by the MTS by the nominal values (tension markings).

RESULTS

The results of the tensioners testing are summarized. The error of the Smith and Nephew tensioner ranged from -8.6% at 50 kg, to -13.9% at 130 kg. The EBI tensioner was the most accurate with a percent error between 0.09% at 70 kg and -0.17% at 130 kg. The Howmedica tensioner had a percent error of -12.48% at 50 kg and -10.86% at 100 kg. The Synthes tensioner had an error of -0.2% at 50 kg, -8.81% at 100 kg and 24.28% at 130 kg. The most inaccurate tensioner was the DePuyACE tensioner, which had an error of -36.76% at 50 kg, -32.11% at 75 kg, -30.92% at 100 kg, and -34.13% at 125 kg. There were no considerable differences between new (unused) and used Ilizarov tensioners, nor between new (unused) and used Synthes tensioners. Comparing the ease of usage, the EBI tensioner, which was the most accurate, was the most difficult to use (needed a hard physical effort and a long time to tension, markings were difficult to visualize, and was hard to hold). The Howmedica tensioner, which was in the middle of the group for accuracy and has only two markings, was the most comfortable to use (tensioning was easy and quick, markings easy to visualize, and the tensioner was easy to hold and adjust to the ring). The Smith and Nephew tensioner had less visible markings. The DePuyACE tensioner was difficult to adjust to the ring because of the necessity of the adaptors and was hard to hold. The Synthes tensioner was difficult and time-consuming to tension, and its markings were difficult to visualize.

DISCUSSION

Garcia-Cimbrelo et al. (2) analyzed 100 cases treated by the Ilizarov method and concluded that manually tensioned wires caused frequent complications (24.5%), whereas wire tensioned by the dynamometric tensioners caused complications in only 7.8% of the cases. These results emphasize the importance of knowing the wire tension during external fixation.

The study demonstrated that most commercially available fine wire tensioners (Smith and Nephew, Howmedica, DePuyACE, and Synthes) are inaccurate. Most of the tensioners that we tested undertensioned compared to their calibration markings. Although the EBI tensioner was an exception and was fairly accurate (-0.17 to +0.09 % error), it was rated the lowest for ease of use. Our results are consistent with those reported by Watson et al. (3) who studied the accuracy of the Ilizarov tensioner. They reported significantly better results (4% error) when the tensioner markings were completely obscured (that is, tensioned past the marking) than when they were completely visible (17% error). Davidson et al. (1) testing the accuracy of Ilizarov tensioner, found that when the marker dots were half covered the under-tensioning was 5.8%-8.9%. Based on our results, when a surgeon uses an Ilizarov tensioner, he/she should keep in mind that by “tensioning” to the 110 kg marking achieved may be as low as 96 kg, and by “tensioning” to the 130 kg marking the tension may be as low as 112 kg. When using a Synthes tensioner, tensioning to the 100 kg marking may represent tension as low as 91 kg. The 130 kg marking should probably be avoided because of the risk of overtensioning which can lead to wire breakage, slippage, plastic deformation, and excessive construct rigidity. When using a Howmedica tensioner, the 100 kg marking may represent tension as low as 89 kg. When using the DePuyACE tensioner, the 75 kg marking may represent tension as low as 51 kg. The 100 kg marking may represent magnitudes as low as 51 kg, and the 125 kg marking may represent tension as low as 82 kg. Only the EBI tensioner’s markings correspond to the actual tension achieved by the tensioner. Future efforts should focus on the development of wire tensioners, which combine accuracy and ease of usage. We recommend that when tensioning fine wires, surgeons use their discretion regarding the tension achieved, and consider tensioning beyond the marking of the tension desired in order to avoid undertensioning.

REFERENCES