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TENSILE STRENGTH AT FAILURE OF A SURGEON'S KNOT OR A FLAT SQUARE KNOT

Hypothesis / aims of study

The square knot is a type of flat reef knot with a single overhand knot with a reversed overhand knot on top.[1, 2] The surgeon's knot, by contrast, has an extra twist in the first throw, forming a double overhand knot (Figure 1). The purpose of this study was to test the integrity of knots tied using a surgeon's knot and a flat square throw using four different suture materials.

Study design, materials and methods

The two types of knot configurations were tied with chromic catgut, polyglactin 910, silk or polydioxanone. Knots were tied using United States Pharmacopeia size 0-0. The knots were tied randomly on a jig by the same surgeon. We compared the individual knot strength when subjected to tensile forces via tensiometer with the point of knot failure, which was defined as untying and/or breaking of the knot (Figure 2).

Results

Four types of suture were divided into two groups based on first throw configuration for a total of 119 knots. We found that a surgeon's knot failed at a mean of 79.7 Newtons (SD 26.3N), and a flat square knot failed at 82.9N (SD 45.7N). An independent samples t-test showed that this was not a statistically significant difference. Material was a non-significant covariate when included in an ANOVA study design, thus the analysis was simplified to just a comparison of surgeon's vs. non-surgeon's knots. A Chi-square test was used to determine whether there was a difference in likelihood of coming untied between surgeon's knots (29%) and non-surgeon's knots (38%). We also noted no statistically significant effect between the two knot types.

Interpretation of results

Using comparable suture sizes and two different knot constructions, we demonstrate that a surgeon's knot has no greater tension at failure and is as likely to come untied as a square knot. As with all in vitro research, this study has limitations. When the surgeon's knot is tied robotically, it may have better security because the grip of the robotic arms is stronger than that of a surgeon.

We applied an elongation rate of 5 millimeters per minute and monitored tensile forces. Physiological rates of loading during resting, reflex motions (e.g., coughing), voluntary motions (e.g., Valsalva), activities (e.g., exercise), or extreme/explosive activities (e.g., motor vehicle collision) may exert more force over a shorter time period and at different rates. The goal to obtain knot security remains constant, despite the lack of standardization between surgeons for knot configurations.

Concluding message

A flat square throw and surgeon's knots did not differ in tension at failure, or likelihood of untying.

Figure #1: Square knot above and Surgeon's knot below.

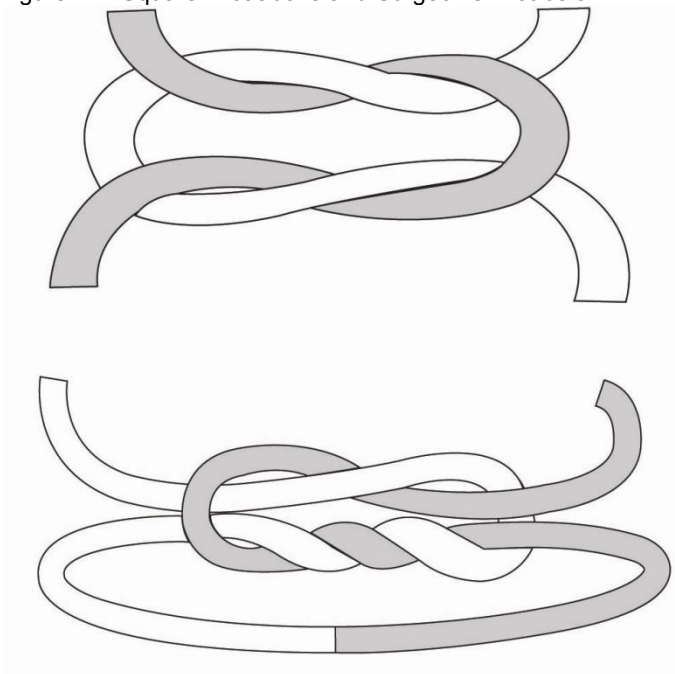
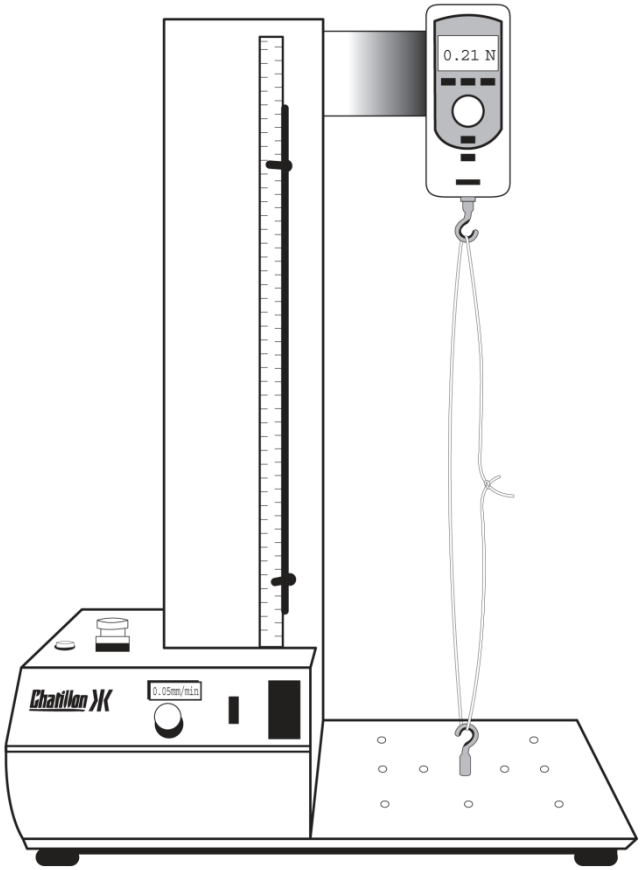


Figure #2: Tensiometer with knot attached.



References
1. Dunn DL. Wound Closure Manual. Ethicon, Inc.; 2007.
2. Graumont R. Encyclopedia of Knots and Fancy Rope Work. Fourth Edition ed: Cornell Maritime Press; 1952.

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What were the subjects in the study?	**NONE**