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Research Article

The Strength of Epitendinous Tendon Repairs and when a Core Suture is Needed

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Abstract

Tendon lacerations can be treated either surgically or non-surgically. Most scientists agree that over 60% of the tendon must be lacerated before a surgical repair is required. However, the formation of a 2-millimeter gap in a tendon from a laceration cause adhesions and triggering, permanently minimizing the mechanical ability of the tendon. This research tested the strength of flexor tendon Epitendinous repairs to determine the point at which tendons should be surgically repaired to prevent further injury and if core sutures are needed for repairs.

Human cadaveric tendons were cut at different percentages, and up to 40 pounds of force were exerted upon them. The tendons were evaluated in three groups - repaired using a simple suture, a Silfverskiold suture, and no suture.

For all of the tendons, the loads required to form a 2-millimeter gap and to rupture the tendon or the suture decreased as the laceration increased. All of the tendons formed 2-millimeter gaps. The tendons with no repair ruptured with lacerations of 70% and 90%. The tendons were repaired using a simple technique ruptured with lacerations of 50%, and above. Using a Silfverskiold repair, the tendons ruptured with all lacerations.

The data shows evidence that tendons can form 2-millimeter gaps with lacerations of only 30%, with or without a repair, and they can rupture with a repair at a laceration of 50%, proving that surgical repairs with core sutures are needed at 50%, and Epitendinous repairs are needed at 30%.

Keywords: Tendon laceration; Epitendinous repair; Core suture; Tendon repair; 2-millimeter gap

Introduction

Tendons are pieces of strong, inelastic tissue that are attached to and transfer load between muscles and bones. Wheeless [1] explained that when they are lacerated, they are healed either through physical therapy or surgery. Modern surgical tendon repairs involve the use of sutures to stitch tendon ends together. A thick core suture that holds the tendon ends together provides strength and a superficial thin suture that flattens the tendon circumferentially provides smooth surfaces. Some common Epitendinous tendon repair techniques include simple continuous and silver skiold.

Tendon lacerations often form gaps as the tear widens, which can fill with adhesions. Wheeless [1] held that once the width of this gap becomes greater than 2 millimeters, the tendon is at critical risk of losing its mechanical performance abilities. Griffin et al. [2] reported that most scientists agree that over 60% of the tendon must be lacerated before a surgical repair is required. According to Wheeless [1], the average flexor tendon needs about 5 pounds of force to remain active, but a repaired tendon requires about 10 pounds.

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The purpose of this research was to test the strength of flexor tendon repairs under different loads of force. Human cadaveric flexor tendons were used, and they had different laceration percentages. Loads of 0, 5, 10, 15, 20, 30, and 40 pounds of weight were applied to each tendon. Some of the tendons had Epitendinous repairs, while others did not, to demonstrate the need for either an Epitendinous and a core stitch for varying laceration percentages. Due to the previous literature about tendon lacerations, with the consideration of the weight a flexor tendon regularly carries, the hypothesis was that if the tendon laceration is less than fifty percent, no core suture would be required due to the lack of a 2 millimeter gap formation under a five pound force.

Materials and Methods

The experiment was conducted in the University of Louisville Department of Anatomy Fresh Tissue Dissection lab. 57 flexor tendons from six human cadaveric arms were used in this research. Standard surgical instruments were used to harvest the tendons and perform the repairs. Braided Dacron rope, a stable table, a millimeter ruler, and a Rapala digital scale were used to apply and measure load on the tendons (Figures 1and 2).

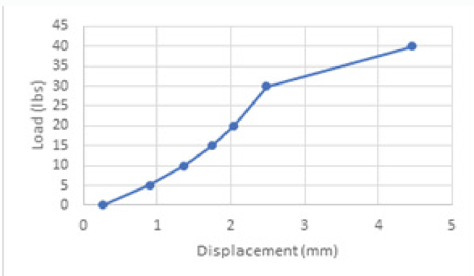

Figure 1: 30% Laceration- No suture.

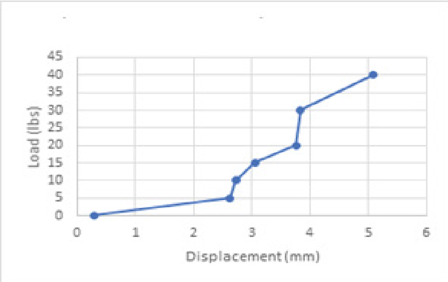

Figure 2: 50% Laceration- No suture.

A flexor tendon repair is needed when the tendon is lacerated. Tendons are mended with a thick core stitch and a thin superficial (Epitendinous) suture. A core suture provides strength for the repair, and the Epitendinous suture is used for tidying up the surface of the tendon. The standard suture used for Epitendinous stitches is 6-0 nylon. In this experiment, only an Epitendinous suture was used to find the point at which a core suture is needed.

The experiment involved loading tendons with different laceration percentages (30%, 50%, 70%, and 90%) to observe the formation of a 2-millimeter gap and the rupturing of the tendon. This was accomplished by loading each tendon repair with 0, 5, 10, 15, 20, 30, and 40 pounds of weight. The lacerated tendons were either repaired with a simple continuous (Group A) or Silfverskiold technique (Group B) using 6-0 nylon, or they were not repaired (Group C) (Figures 3 and 4).

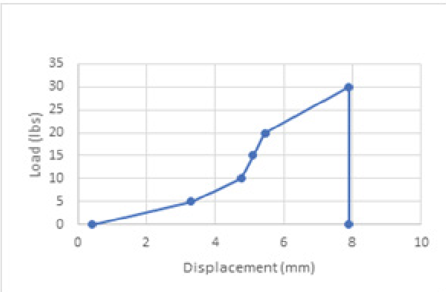

Figure 3: 70% Laceration- No suture.

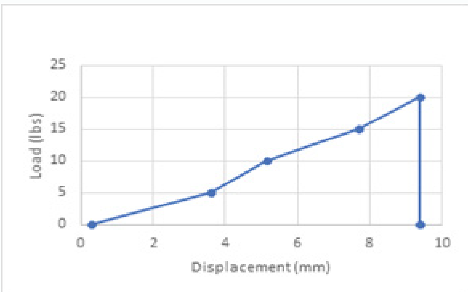

Figure 4: 90% Laceration- No suture.

The tendons were harvested from the hands of the cadavers, and each one was cut to measure 40 centimeters in length with a width of 5 centimeters. They were knotted and tied to the Dacron rope, which was attached to the table on one end and to the scale on the other. The tendons were cut to the appropriate percentage, and some of them were repaired with either simple continuous or Silfverskiold sutures, and some of them remained injured. The scientist applied the force by pulling on the scale, measuring the amount of load reached. Pictures of the laceration and the gap formation next to the ruler were taken once each specified load is reached. The images were later measured by using the ruler as a scale.

The independent variables for the experiment were the repair technique, the load, and the laceration percentage, and the dependent variable was the width of the gap formation and the point at which it forms. The control was the group of tendons that will not be repaired. The measuring tools, the size of the tendons, and the materials used were all kept constant (Figures 5-7).

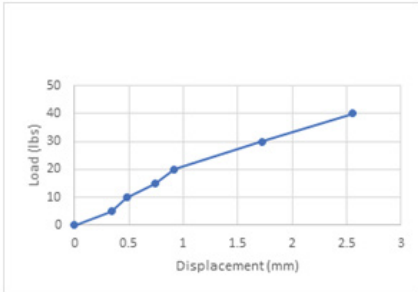

Figure 5: 30% Laceration- Simple suture.

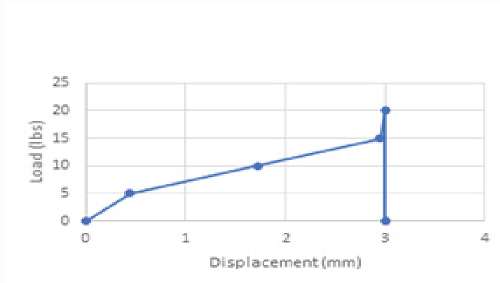

Figure 6: 50% Laceration- Simple suture.

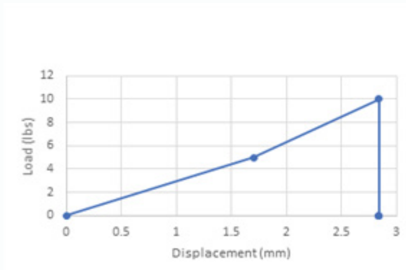

Figure 7: 70% Laceration- Simple suture.

Discussion

The tendons with no sutures formed a 2-millimeter gap at an average load of 24.1, 5.2, 2.9, and 0.8 pounds for the 30%, 50%, 70%, and 90% lacerations respectively. With a simple repair, the 2-millimeter gap formed at an average load of 33.1, 11.8, 5.3, and 2.5 pounds for the increasing percentages respectively. The tendons repaired with a Silfverskiold technique formed the gap at an average load of 26.4, 17.5, 16.1, and 6.2 pounds for the 30%, 50%, 70%, and 90% lacerations respectively (Figures 8-10).

The tendons with no sutures ruptured at an average load of 25 and 21.7 pounds for the 70% and 90% lacerations respectively. The

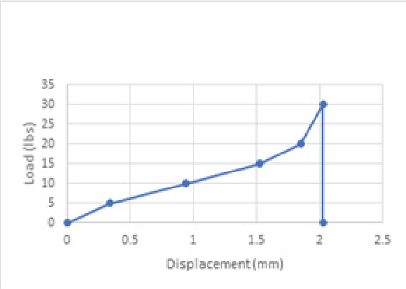

Figure 8: 90% Laceration- Simple suture.

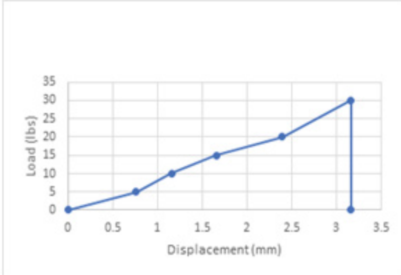

Figure 11: 70% Laceration- Silfverskiold suture.

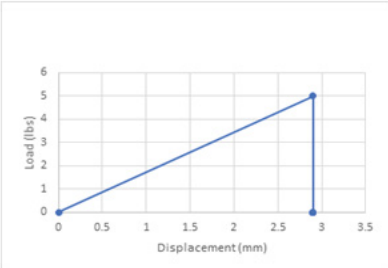

Figure 9: 30% Laceration- Silver skiold suture.

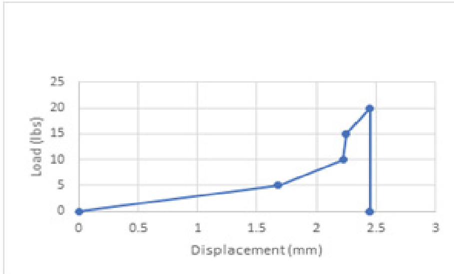

Figure 12: 90% Laceration- Silfverskiold suture.

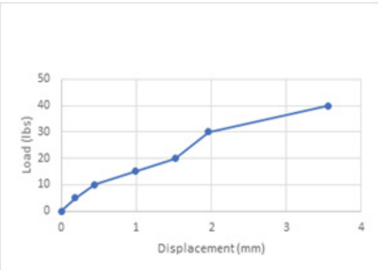

Figure 10: 50% Laceration- Silfverskiold suture.

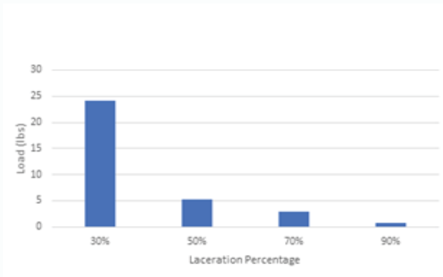

Figure 13: 2 mm Gap formation by laceration percentage- No suture.

tendons repaired using a simple technique ruptured at an average load of 23, 15, and 9 pounds for the 50%, 70%, and 90% lacerations respectively. With a Silfverskiold repair, the tendons ruptured at an average load of 38, 35, 29, and 21 pounds for the 30%, 50%, 70%, and 90% lacerations respectively.

The study found evidence that supports the hypothesis. The average displacement for every tendon laceration fifty percent and above was greater than two millimeters after being loaded with at most forty pounds. As the laceration percentage increased, the two-millimeter gap was reached with fewer loads. This can be seen in the increasingly steep slopes between the graphs of increasing laceration percentages. As the load on the tendon increased, the displacement increased as well, which can be seen in the positive slopes of each graph (Figures 11-13).

The tendons were found to rupture, or completely rip, during almost every repair. As shown in the graphs for the simple and silver skiold sutures, all tendons with lacerations above thirty percent ruptured, on average, under the force of twenty-five pounds.

The findings are similar to that of the study Biomechanical Studies of Four Circumferential Flexor Tendon Suture Techniques by Donna et al. [3]. The study found that a simple suture repair for a one-hundred percent laceration formed a two-millimeter gap under the load of approximately 5.13 pounds. This study found that a simple suture repair for a ninety percent laceration formed a two-millimeter gap under the load of 5.3 pounds.

The trends of the results can be explained by the procedures. As the laceration percentage was increased, a larger amount of the tendon was cut, allowing a larger gap to form with less force. As a larger gap formed more quickly, it ruptured with less force.

To improve the study, the methodology can be adjusted by strictly controlling the age and condition of the tendon outside of the body to ensure that their quality will be the same during testing. This research can be continued by studying more laceration percentages, such as every ten percent rather than every twenty (Figures 14 and 15).

Conclusion

In conclusion, tendon lacerations should be surgically repaired if they are greater than 30% even if there is no triggering, and a core suture should be used if the laceration is above 50%.

References

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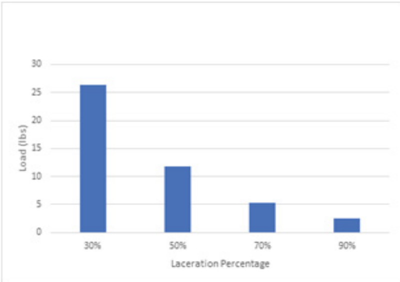

Figure 14: 2 mm Gap formation by laceration percentage- simple suture.

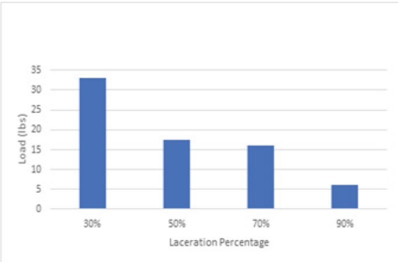

Figure 15: 2 mm Gap formation by laceration percentage- silver skiold suture.

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