POSTER 53

Tensile Strength of a Novel Superficial Suture Pattern Compared to Traditional Suture Patterns in a Cadaveric Human Skin Model

Francisco Rodriguez Fontan, MD[1]; Nicole Look, MD[1]; Todd H. Baldini, MS[1]; Bennie Lindeque, MD PhD[1]
francisco.rodriguezfontan@cuanschutz.edu

[1] *Department of Orthopaedics, University of Colorado Anschutz Medical Campus, Aurora, CO*

BACKGROUND*:* Impaired wound healing with subsequent wound dehiscence and/or surgical site infection contributes to morbidity, mortality, and increased costs for patients and health care systems. Surgical wounds need to withstand tension forces to heal properly. The suture material and technique utilized to maintain the skin edges in proximity contribute to successful primary wound healing. No prior studies have evaluated the tensile strength of different stitch skin closing patterns on human cadaveric skin. *Purpose: This study evaluates the tensile strength of four stitch patterns: simple (S), horizontal mattress (HM), vertical mattress (VM) and the novel Lindeque locking (LL).*
METHODS*:* Human de-identified cadaveric skin flaps 6 cm wide, 10 cm long and 1-2cm thick were harvested from the thigh and legs. A full thickness 6 cm incision was made the width of the sample. Four skin closure technique stitch patterns using a non-absorbable Ethilon™ 3-0 nylon suture were done -S, HM, VM, LL -, totaling four groups with six samples each. We proposed a unique stitch pattern designated as the LL, which applies the properties of a horizontal mattress, through spread of each interrupted stitch, and a simple pattern, through strength across the wound while locking the horizontal mattress (**Figure 1**). To test the tensile strength of the patterns, these specimens were pulled apart with an Instron servo-hydraulic test system. The specimens were secured to the Instron with custom built serrated grips with the sutured skin edges oriented perpendicular to the direction the tensile force was applied (**Figure 1**). The specimens were loaded at a rate of 1 N/sec while recorded at 100 Hz. The primary outcome measures were: wound dehiscence, force required to separate the wound edges by 3mm; and ultimate load to failure, force required for suture rupture.[1] To determine when a 3 mm gap opened between the edges of the skin the test was video recorded with a Canon EOS Rebel SL1 digital camera at 30 frames/second with a mm scale in the field of view. The video recording was synchronized with the tensile force recording. Statistics included one-way ANOVA with post-hoc Tukey tests for the 3 mm failure and ultimate load to failure. All data was analyzed with JMP Version 15 statistical analysis software. A p-value less than 0.05 was considered significant.
RESULTS*:* The LL stitch had the greatest tensile strength for 3 mm failure (221.8 N) and for ultimate load to failure (225.9 N), and was significantly greater than HM ($p < 0.001$, $p < 0.001$) and VM ($p = 0.015$, $p = 0.005$) respectively (**Figure 2**). While there was no significant difference between LL vs S (mean 186.08 N, $p = 0.062$) for 3 mm failure, there was for ultimate load to failure (mean 191.47 N, $p = 0.033$). Among all tested technique patterns, the HM had significantly less strength for 3mm failure (93.9 N) and for ultimate load to failure (110.1 N).
CONCLUSION*:* There are no prior ex vivo studies of tensile strength on human skin related to the technique of suture closure. This study showed the novel LL stitch has significantly greater ultimate tensile strength than the other 3 stitch patterns tested and significantly greater load to 3 mm gap failure than HN and VM. HM had the lowest strength, and we predict that could be related to the position of the knot being parallel to the incision, while the other patterns the knot was perpendicular to the incision. In addition, we believe that the LL stitch pattern is combining a parallel and a perpendicular tensile force that might result in its higher tensile strength. This study only looked at tensile forces while *in vivo* suture patterns must withstand other types of forces and should be tested in future studies. This study was done on cadaver specimens and therefore, could not test the wound healing properties of the suture patterns. The LL pattern should be tested in a future *in vivo* study to assess its wound healing capacity.
SIGNIFICANCE/CLINICAL RELEVANCE*:* We proposed a novel surgical skin closing pattern designated as the LL, which withstands the highest tensile strength through the wound among other basic closing technique patterns. The LL stitch may have fewer wound complications related to tensile forces.[2]

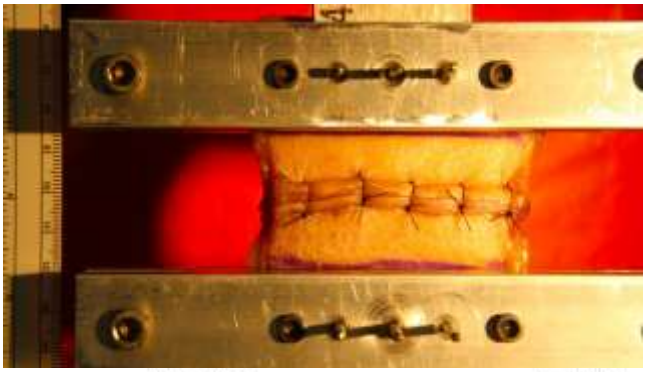

Figure 1. Lindeque locking stitch pattern on cadaveric skin sample being held by serrated grips on the Instrom servo-hydraulic system for tensile testing.

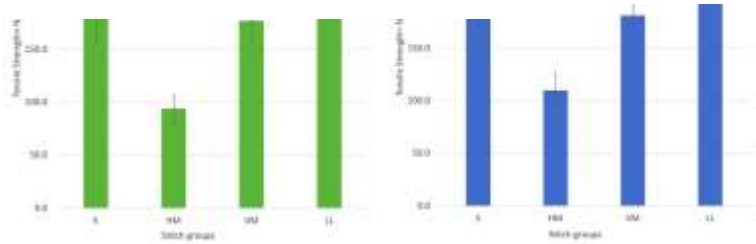

Figure 2. Load to 3 mm gap failure (left) and ultimate load to failure (right) Note: *, significant difference within groups; S, simple; HM, horizontal mattress; VM, vertical mattress; LL, Lindeque locking

Figure 2

References

1. Cengiz, Y., Blomquist, P., & Israelsson, L. A. (2001). Small tissue bites and wound strength: An experimental study. *Archives of Surgery*, *136*(3), 272–275. https://doi.org/10.1001/archsurg.136.3.272
2. Ogawa, R. (2011). Mechanobiology of scarring. *Wound Repair and Regeneration*, *19*(SUPPL. 1), s2–s9. https://doi.org/10.1111/j.1524-475X.2011.00707.x