

Suture interval spacing in meniscal repair influences meniscal stability: a biomechanical study

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INTRODUCTION: The probability of meniscal healing after meniscal repair is influenced by the resistance against gap formations during repetitive loading. This study aimed to examine how varying meniscal suture interval spacings affect the biomechanical properties in vertical meniscal repairs. It was hypothesized that there is a critical meniscal suture spacing interval limit beyond which the gap formation during cycling loading increases while the stiffness of the construct decreases.

METHODS: In 50 bovine menisci, complete vertical meniscal tears were created. All lesions were repaired using two 2-0 braided sutures (Ultrabraid, Smith&Nephew) with vertical sutures in an inside-out technique. Five different suture spacings (3, 5, 7, 9, and 11mm) with ten samples each were tested. Each sample underwent 1000 loading cycles between 5-20 N (combined suture load) at a 75 mm/min crosshead speed. The tear opening gap between the two meniscal sutures was measured using a Digital Image Correlation system (DIC) with two high-speed cameras after 1000 cycles (Fig. 1). Gap formation, cyclic stiffness, and load to produce a 1mm gap were measured.

RESULTS: Meniscus repairs with suture distances of 3mm, 5mm, and 7mm demonstrated significantly smaller gap formation—on average, 36% less—compared to those with 9mm and 11mm. There were no significant differences in gap formation among the suture distances of 3mm, 5mm, and 7mm (Fig 2). Construct stiffness was significantly higher with suture interval spacings of 7mm and below, in contrast to 9mm and above (all $p < .05$). No significant difference in construct stiffness was observed among the 3mm, 5mm, and 7mm suture intervals (Fig 3). There was a trend indicating that higher loads were required to produce a 1mm gap in suture distances of 7mm and below, compared to 9mm and above (Fig 4). Suture breakage occurred in 76% of cases (38/50), suture cut-through in 22% (11/50), and a combination of both in 2% (1/50). Failure mode did not correlate with suture distance.

DISCUSSION AND CONCLUSION: Meniscal repair with a suture interval spacing of 7mm and below demonstrates statistically significant lower gap formation and higher construct stiffness during cyclic loading than interval spacings greater than 7mm. Larger gapping may impede meniscus healing after meniscus repair. Based on this biomechanical data, a 7mm or less suture interval spacing is recommended for meniscal repair.

