DO CONTINUOUS EPITENDINOUS SUTURES IMPROVE GLIDING PROPERTIES AND FAILURE STRENGTH OF ZONE II FLEXOR DIGITORUM PROFUNDUS REPAIRS? REVISITING THE WORK OF WADE ET AL (1986)

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SUMMARY
In contrast to previous research, continuous circumferential or epitendinous sutures did not significantly improve the ultimate tensile strength of zone II Flexor Digitorum Profundus (FDP) tendon repairs when compared to use of four–strand core sutures alone. Incorporation of continuous peripheral sutures did, however, improve the low–load behaviour of the repair, minimising the force required to produce a 3 mm gap and enhancing the gliding properties of tendon by reducing the peak force differential. While the findings demonstrate the clinical importance of peripheral tendon repair, they also highlight for the first time, that to achieve comparable results, potential alternative circumferential repair methods need not necessarily impart additional repair strength but must negate the detrimental effects of gap formation.

INTRODUCTION
Flexor tendon repair, particularly in zone II or "no man's land" is still a surgical challenge. Typically, clinical repair techniques employ continuous circumferential sutures in addition to core repair, often citing the landmark paper of Wade et al [1] in which continuous peripheral sutures were noted to substantially improve the tensile strength (88%) and 2mm gap resistance (284%) of FDP repairs compared to repair using core sutures alone. However, in their earlier work, the beneficial effects of peripheral sutures on the tensile properties of repairs were not as obvious [2] and few published studies to date have simultaneously evaluated the tensile strength and gliding properties of core suture repairs with and without incorporation of peripheral sutures. This study is the first to evaluate the tensile strength and internal work of flexion, a measure of gliding resistance [3], of zone II FDP tendon lacerations repaired using four–strand core sutures with and without continuous circumferential suture repair.

METHODS
Forty–eight fresh porcine FDP tendons were sharply cut in zone II and surgically repaired within the flexor sheath using a Pennington Modification of a four–strand Kessler repair with the core suture arranged in a locking configuration. The locking loops were approximately 10 mm from the laceration, while epitendinous throws were in the order of 2 mm from the lacerated tendon, with approximately 1mm between each pair of stitches. In all cases, 3–0 ticron was used for the core suture and 5–0 prolene was employed for continuous epitendinous repair (Figure 1). All repairs were performed by the same investigator (EZ) and were kept moist throughout preparation and mechanical testing to prevent desiccation.

Following repair, the distal insertion of the FDP tendon was sharply divided and a small custom–made, lightweight, force transducer (aluminum ring configuration with full Wheatstone bridge) inserted at the tendon–bone interface using a bone plate and flexible steel cable. The proximal phalanx was then mounted within a test frame and the proximal end of the tendon secured to a 100 N load cell of a uniaxial materials testing machine. Initial pretension was applied to the tendon by a 100 g weight connected to the distal transducer, which also ensured full extension of the digit. The tendon was then pulled proximally over a 30 mm excursion at a rate of 2 mm.s⁻¹ and the force between the proximal and distal ends of the tendon recorded. Given that the applied loads were small (<10 N), it was assumed that deformation of the repair was minimal. Thus the peak force differential and the internal work of flexion (differential–force–tendon–excursion integral) were calculated as measures of gliding resistance (Figure 2).

Repaired tendons were then dissected free from the Flexor Digitorum Superficialis tendon and flexor sheath for tensile testing. The proximal and distal ends of the repaired tendon were secured within a set of mechanical wedge–action grips and mounted within the uniaxial materials testing machine with the longitudinal fibres of the tendon aligned with the axis of loading. A 2 N preload was applied to the repair while planar circular markers, 5mm in diameter, were fixed 10 mm...
Figure 2: Typical proximal (solid) and distal (dashed) tendon force during tests of the internal work of flexion of repairs.

RESULTS AND DISCUSSION

Table 1 summarizes the tensile and gliding properties of repaired tendons. The findings are limited to immediate post-surgical properties of the repair and may not exactly replicate in vivo conditions in humans. While temperature also likely influences suture properties, peak loads observed during tensile testing in the current study are comparable to those reported elsewhere for human FDP tendon repairs [2]. Similarly, peak loads during work of flexion testing were comparable to those reported for intact human FDP tendon during passive finger motion (9 N) [5]. Thus, the porcine model appears to emulate the human FDP–pulley system both anatomically [6] and functionally.

CONCLUSIONS

In contrast to previous research [1], the ultimate tensile strength and internal work of flexion of four-strand core suture repairs was not improved by the addition of a continuous circumferential repair. However, inclusion of the peripheral repair minimized the force required to produce a biologically–critical 3mm gap and reduce the peak force differential during tendon gliding. Continuous circumferential repair, therefore, is clinically beneficial. The findings also highlight that to achieve comparable results, alternative circumferential repair methods need not necessarily incur additional strength to the repair if they overcome the adverse mechanical and biological effects of gap formation.

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REFERENCES