INTRODUCTION:
The biomechanics of hand zone 2 flexor tendon repair techniques has been widely studied. The dynamic creep of the various suture materials that can be used for the core component of tendon repairs has not been addressed. Determining the extent of dynamic creep of such suture material can give insight into potential flexor tendon repair site gap formation, with less creep having a positive benefit. This study determined the dynamic creep of various suture materials using a cyclical testing protocol that simulates 30 days of post-operative active mobilisation.

METHODS:
Four-strand loops, 20mm in length, were created using Supramid, Prolene, Ticron, Ethibond, and Mersilene. Sixteen loops were made for each suture material, and were then divided into two groups of eight. All loops were suspended between two metal rods mounted on a materials testing machine (MTS 858 Mini Bionix, MTS Systems Corp., Eden Prairie, MN) with a preloaded of 3.5N.

To determine the amount of dynamic creep, one group of eight from each of the suture materials was cyclically loaded between 3.5N and 35N at 10 cycles per minute for 3000 cycles. The displacement-versus-time curves were used to establish the dynamic creep.

The second group of suture loops were loaded to failure using a crosshead speed of 20mm/minute. Load versus displacement curves were used to determine the ultimate load to failure. All testing was conducted in phosphate buffered saline at 37°C. All data was analysed using ANOVA on SPSS software.

RESULTS:
During cyclical testing, all Supramid samples failed after a mean of only 15 cycles (range 2-43). Only one Prolene sample survived, with failure occurring after a mean of 1182 cycles (range 574–2660), and a mean creep of 3.80mm (SD=0.51). In contrast, all specimens in the other groups survived the 3000 cycles, with a dynamic creep of 0.44mm (SD=0.19), 0.32mm (SD=0.17), and 0.28mm (SD=0.07) for Ticron, Ethibond and Mersilene respectively. There was no statistically significant difference between these three groups (p<0.05).

Using our static testing protocol, the loads to failure were 40.3N (SD = 2.4), 55.4N (SD = 2.5), 65.4N (SD = 3.9), 64.4N (SD = 2.1) and 73.1N (SD = 3.0) for Supramid, Prolene, Ticron, Ethibond and Mersilene respectively. Mersilene was statistically the best performer, with no statistically significant difference between Ticron and Ethibond (p<0.05).

DISCUSSION:
The repair of complete transections of flexor tendons in zone 2 requires both a core and a peripheral suture. The realisation that early mobilisation protocols improved the outcomes of such injuries has resulted in numerous techniques for both components being proposed. With respect to the core suture, a common theme among the proposed techniques is that the strength of the repairs is directly related to the number of strands crossing the repair site. Specifically, four-strand repairs are twice as strong as two-strands and six-strand repairs are nearly three times as strong. Eight-strand repairs have also been described. However, six- and eight-strand repairs are associated with increased bulk, complexity and tendon handling, and therefore have not been popularised. Four-strand techniques are therefore considered ideal. Repair site gap formation is an important issue in flexor tendon repairs, as studies have shown that it can be associated with poor clinical outcomes. Although biomechanical studies in flexor tendon repairs have addressed tendon-suture constructs, the contribution that different suture materials make to such potential gap formation had previously not been addressed.

The testing protocol we chose was based on the four-strands that comprise the core components of the tendon repair. The 20mm is related to the 10mm bite required on each side of the point of tendon division. The 35N is the worst-case scenario for the amount of force that might be expected to act on the four-strands that comprise the core component of the repair. Studies have shown that the maximum force acting along the FDP is 29N, and with the post-operative oedema, and up to 50% tendon weakening that occurs within 1 week after the repair, a repair that needs to sustain 70N force has been suggested. However, the peripheral suture can contribute up to 50% of the overall biomechanical integrity, and therefore 35N is the possible force on the core sutures. Ten cycles per minute for 3000 cycles was chosen because in a post-operative active mobilisation protocol, a patient can be expected to flex 10 times per minute, one minute per hour for ten hours a day. After 30 days, this would amount to 3000 cycles. At 30 days, sufficient healing would have occurred to take the load of the suture material.

This study has demonstrated significant differences in the biomechanical properties of various suture materials used for flexor tendon repairs. Supramid performed extremely poorly during both static and cyclical testing, suggesting that it would not be ideal if used in a four-strand repair in a patient undergoing a post-operative mobilisation protocol. Prolene performed somewhat better, but still developed a significant amount of creep with a high failure rate. All the polyester fibre based sutures performed extremely well, with Mersilene proving to be the best overall.

Regardless of your chosen suture technique for flexor tendon repairs, this study suggests that the suture material itself does play a vital role in the eventual outcome. These results should be kept in mind when deciding on the suture material for your repairs.