

Biomechanical Properties of Different Open and Arthroscopic Fixation Techniques for PCL Avulsion Fractures

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Summary:

After investigating structural properties of different fixation techniques for PCL avulsion fractures in a porcine knee model we found comparable biomechanics properties in arthroscopic techniques in comparison to open screw fixation

Abstract:

There are many reports about different minimal invasive techniques for refixation of a bony avulsion fracture of the PCL in the current literature. But there is no information about the structural properties of these different techniques.

The aim of this study was to analyze the structural properties of different fixation techniques for PCL avulsion fracture in single cycle and cyclic tests in a porcine knee model and to compare these with the golden standard of open screw fixation.

We hypothesized that arthroscopical fixation techniques show comparable structural properties in comparison to the open direct screw fixation.

In 40 porcine knees a standardized bony avulsion of the PCL has been produced. The bony avulsions have been fixed by the following techniques: 1. Direct anterograde screw fixation (AS) (3.5mm KFI with washer) 2. Retrograde screw fixation (RS) (cannulated 3,5 mm screw) 3. Endobuttonfixation (EB) (4.5 mm tunnel, Fibre Wire 2.0, two FlippTack (Karl Storz) 4. direct suture cerclage with 2.0 Fibre Wire (FWC) Following preconditioning, the constructs were cyclically loaded 500 times between 10 and 100 N measuring the maximum elongation. After cyclic testing, the constructs have been loaded to failure measuring stiffness, yield load and maximum load. For statistical analysis a Kruskal-Wallis test test has been used. The significance was set at $p < 0.05$.

After 500 cycles the following maximum elongation has been measured: AS: 2.17(+/-0.74) mm; RS: 1.94 (+/-0.59); EB: 1.25 (+/-0.27) FWC: 2.21(+/-0.66). The Endobutton fixation resulted in significant lower elongation than anterograde screw and cerclage (< 0.05).

The following results have been collected during load to failure testing:

Stiffness: AS: 65.6(+/-12.74); RS: 64.6(+/-14.1); EB: 58(+/-4.71); FWC: 51.2(6.11)

Yield Load: AS: 720.39(+/-139.0); RS: 668.58(147.59); EB: 596.25(+/-72.52); FWC: 493.55(+/-88.86).

Maximum Load: AS: 817.5(145.9); RS: 731.3(147.1); EB: 702.1 (81.9); FWC: 631.22(101.22).

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The cerclage techniques showed significantly lower stiffness and yield load than anterograde and retrograde screw fixation and significantly lower maximum load than anterograde screw fixation technique ($p < 0.05$). All other results have not been significantly different. ($p > 0.05$)

The results of the present study support partly our initial hypothesis. Except the cerclage technique all other minimal invasive fixation techniques showed comparable structural properties in comparison to the direct screw fixation technique.

Therefore these minimal fixation techniques seem to be a safe and biomechanical stable option for refixation of bony PCL avulsion fractures with less approach morbidity.