ABSTRACT INTRODUCTION:
The aim of the study was to evaluate the histology and the ultra-structure of the patellar tendon 10 years after reharvesting its central third. Moreover, this study serves as a model for tendon response in general after repeated surgical trauma.

METHODS:
Twelve consecutive patients (4 female, 8 male), who underwent Anterior Cruciate Ligament (ACL) revision surgery using reharvested ipsilateral patellar tendon autograft, were included in the study. Percutaneous biopsies were obtained from the central and lateral parts of the patellar tendon under ultrasonographic guidance median 116 months (102-127) after the index procedure. Ten open biopsies from asymptomatic patellar tendons obtained at ACL reconstruction served as controls. The histology and the presence of glucosaminoglycans (GAGs) were assessed in the light microscope. The specimens were fixed in 10% neutral-buffered formalin, embedded in paraffin and sectioned at 4-5µm. The sections were stained with haematoxylin and eosin (HE) to evaluate fibre structure, cellularity and vascularity, and Alcian Blue (pH 2.5)/Periodic Acid-Schiff (AB/PAS) for detection of GAG-rich areas (acrilinpholic non-collagenous extra-cellular matrix). The biopsies were evaluated using a semi-quantitative (non-parametric) grading system for the tendon alterations. Grading was based on a four-point scoring system. Fibre structure, cellularity, vascularity and level of GAGs were graded after examining the whole section. The number of cells was estimated in a high-power field representative of the section.[2] One biopsy from each patient was evaluated from the central and lateral part of the tendon respectively. The ultra structure was assessed using the transmission electron microscope (TEM) and the fibrils were classified into five size classes. Ultra-thin sections (approximately 40-50 nm) were cut and contrasted with uranyl acetate followed by lead citrate and examined in a Tecnai 10 microscope at 80 kV. From transverse oriented specimens, two randomly selected areas were taken and the fibril diameter was measured on printed copies (101 000x) by using a Zeiss TGG-3 particle-size analyser, grouped in 5 size classes (0-30 nm, 31-60 nm, 61-90 nm, 91-120 nm and >120 nm) and presented as the relative distribution.[6] A minimum of 100 fibrils were analysed in each specimen.

RESULTS SECTION:
The histological evaluation revealed a deteriorated fibre structure, increased cellularity and increased vascularity in both the central and peripheral parts of the patellar tendon compared with controls (p≤0.003). No difference in the amount of GAGs was seen between the central and lateral parts of the tendon compared with controls. The ultra-structural evaluation revealed a significant difference in the distribution of the fibril size classes between the three groups (p<0.0001). The control specimens displayed the most heterogeneous pattern with all five fibril size classes present. In biopsies from the central and lateral parts of the tendon there were significantly more fibrils in the small size classes compared with the control specimens.

DISCUSSION:
The principal findings of the present study were that, 10 years after reharvesting the central part of the patellar tendon, the patellar tendon still displayed significant histological abnormalities in terms of deterioration in fibre structure and an increase in cellularity and vascularity as well as significant ultra-structural abnormalities in terms of abnormal fibril size class distribution. The strength of the study is its median follow-up period of 10 years, the evaluation of both the histological and the ultra-structural appearance, and that it was performed on humans. There are similarities between the findings in our study and the results from histological studies of symptomatic tendinopathies describing changes in fibre structure, variations in cellularity and increased vascularity. However, the non-inflammatory reactive process visible in tendinopathies includes an increased amount of GAGs, a finding we could not verify in our study. [1, 3] The central and the lateral parts of the reharvested patellar tendon were primarily composed of smaller collagen fibrils. This could be a result of formation of new collagen or one might also speculate that it could be the result of a brake down of large fibrils. The displacement towards collagen fibrils with smaller diameters in the lateral part of the patellar tendon could be a result of increased load in this area, which could be caused by inferior loading capacity in the central part. The finding that primarily small fibril sizes have been found in rats after mechanical stress shielding of the patellar tendon supports this theory.[4, 5] The present study can also be regarded as a model of what happens to a tendon when it is subjected to repeated surgical trauma. Ten years after repeated surgery, histological and ultra-structural changes are still present. It is our opinion that these results can be generalised, and it could most likely be stated that the repair tissue never regenerates to a normal tendon.

We conclude that repeated surgical trauma to the central third of the patellar tendon does not only affect this part of the tendon, but appears to induce permanent histological and ultra-structural changes in the whole tendon.

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REFERENCES: