SHORT REPORT

Ultrastructural study of the extra-articular Leeds-Keio ligament prosthesis

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Background: There have been several histological studies of the Leeds-Keio ligament in anterior cruciate ligament reconstruction, but there have been few of the Leeds-Keio ligament in the extra-articular portion.
Aims/Methods: To report the histological and ultrastructural findings of two cases of medial patellofemoral ligament reconstruction using the Leeds-Keio ligament, removed 6.1 years and 8.7 years after implantation.
Results: In both cases, the tissue over the Leeds-Keio ligament was a ligament-like tissue. Electron microscopy showed that the diameter of the collagen fibrils in the tissue over the Leeds-Keio ligament was unimodal in the case investigated 6.1 years after implantation but bimodal in the case investigated after 8.7 years.
Conclusions: The tissue over the Leeds-Keio ligament may continue to grow with prolonged periods of mechanical stress.

The Leeds-Keio (LK) ligament (Neoligaments, Leeds, UK), which is made of polyester as an open weave mesh-like structure, was developed as an alternative anterior cruciate ligament.[1] Several histological studies of reconstructed anterior cruciate ligament LK ligaments have shown that the fibroelastic response to the LK ligament usually lacks axial orientation inside or immediately adjacent to the artificial ligament.[2 3] We histologically examined the extra-articular reconstructed medial patellofemoral ligament (MPFL) using the LK ligament and a medial retinaculum slip coverage[4] in 15 specimens, one to nine years after transplantation, and showed that the tissue over the artificial ligament was mature only in specimens taken more than five years after surgery. In addition, we found that it was extremely important to investigate the reconstructed MPFL using the electron microscope.

This report presents the histological and ultrastructural findings of two Leeds-Keio MPFL grafts gathered 6.1 years and 8.7 years after implantation.

CASE REPORT

Two female patients aged 14 and 26 years underwent extra-articular MPFL reconstruction using the tape-type LK ligament and medial retinaculum slip coverage for recurrent patellar dislocation.[5] The LK ligament was placed through the patellar tunnel and the two bundles were fixed to the anatomical MPFL femoral attachment using double stapling. Then the medial retinaculum slip (10 mm wide and 6–8 cm long with the patellar side intact) was covered over the LK ligament. Biopsies of the reconstructed MPFL were performed at the time of staple removal (with consent), 6.1 years and 8.7 years after surgery, respectively. The small biopsies—1.5 mm wide, 6 mm long, and 4 mm deep—were performed parallel to the longitudinal axis at the middle of the ligament and only the tissue over the LK ligament was selected for specimens. For light microscopy, the specimens were stained with haematoxylin and eosin and elastica von Gieson. For electron microscopic examination, a transmission electron microscope (JEM-1010, Nihon Densi, Tokyo, Japan) microscope was used.

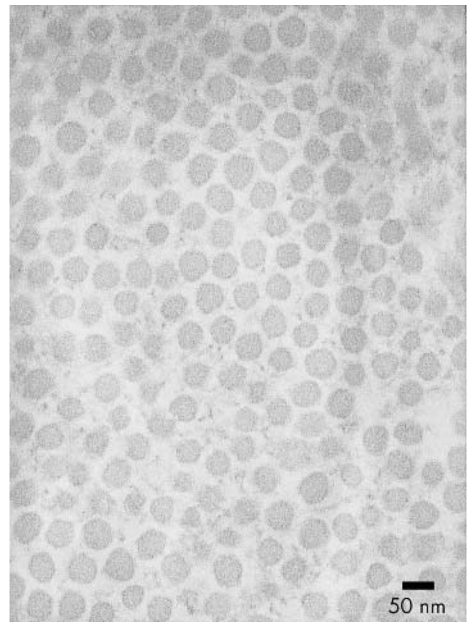

Figure 1 Case 1: 6.1 years after implantation (original magnification, ×100 000). A unimodal distribution with small fibrils approximately 30–45 nm in diameter was seen.

Pathology

In both cases, sufficient connective tissue macroscopically ensheathed the whole prosthetic ligament, and the LK polyester fibres could not be seen from the surface. In both cases, light microscopy showed that the tissue over the LK ligament was made up of longitudinally aligned collagen fibre bundles with spindle shaped nuclei, hypovascularity, and crimp patterns. In the elastica von Gieson stained specimens, small numbers of elastic fibres were seen in the tissue over the LK ligament.

In both cases, transmission electron microscopy showed that the collagen fibrils in the tissue over the LK ligament were regularly orientated in the transversely sectioned area. However, collagen fibril diameter distribution was different in two cases. In case 1 (6.1 years after implantation), the collagen fibrils were uniform and approximately 30–45 nm in diameter (fig 1), whereas in case 2 (8.7 years after

Abbreviations: LK, Leeds-Keio; MPFL, medial patellofemoral ligament

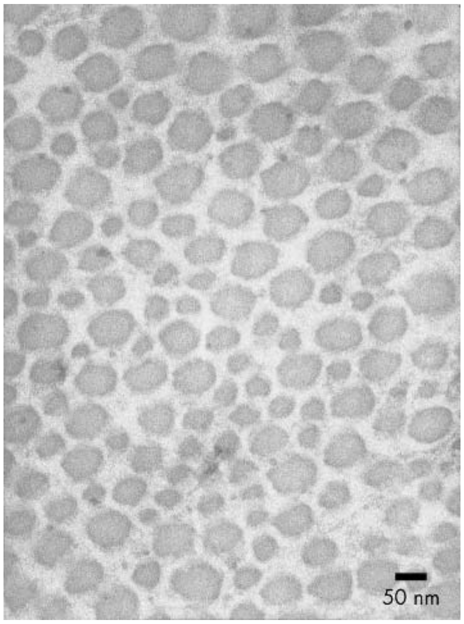

Figure 2 Case 2: 8.7 years after implantation (original magnification, ×100 000). Collagen fibrils had a bimodal distribution, with small fibrils approximately 25–40 nm in diameter and larger fibrils, approximately 50–70 nm in diameter.

implantation), the collagen fibrils were bimodal, and were approximately 25–40 nm in diameter and 50–70 nm in diameter (fig 2).

DISCUSSION

Many investigators have reported that reconstructed cruciate ligament grafts using autogenous tendons or allografts are histologically and biochemically similar to the normal anterior cruciate ligament one year after surgery.[6–8] It is well known that the diameter of collagen fibrils in normal tendons or ligaments had a more or less pronounced bimodal distribution.[9] However, many electron microscopic studies have shown that cruciate ligament autografts or allografts have a unimodal distribution, with small diameter collagen fibrils, and are different from normal tendons or ligaments, which have a bimodal distribution, even two years after surgery.[8 10] Therefore, there has been no evidence of the re-establishment of a bimodal distribution of collagen fibrils in the reconstructed autografts or allografts.

> "Although the diameter of the larger collagen fibrils was not as large as that of large collagen fibrils in normal tendons and ligaments, this bimodal distribution of collagen fibrils is similar to that seen in the normal tendon and ligament"

In our previous study, we showed that the tissue over the LK ligament seemed to be mature in specimens more than five years after implantation. In addition, we described the importance of the increased numbers of elastic fibres and that of the prolonged environment of mechanical stress in the development from a fibrotic tissue to a ligament-like tissue. In our present study, both patients, who had undergone surgery more than five years previously, also had matured connective tissue over the LK ligament on light microscopy. However, the two cases had different electron microscopic characteristics. In case 1 (6.1 years after implantation), collagen fibrils had a unimodal distribution, with small diameter fibrils of 30–45 nm. In case 2 (8.7 years after implantation), the collagen fibrils had a bimodal distribution, with smaller fibres of approximately 25–40 nm diameter and larger fibres, approximately 50–70 nm in diameter. Although the diameter of the larger collagen fibrils (50–70 nm) was not as large as that of large collagen fibrils in normal tendons and ligaments, this bimodal distribution of collagen fibrils is similar to that seen in the normal tendon and ligament. It is probable that the tissue over the LK ligament continues to grow with prolonged periods of mechanical stress.

Take home messages

- We investigated the histological and ultrastructural findings of two cases of medial patellofemoral ligament reconstruction using the Leeds-Keio (LK) ligament removed 6.1 years and 8.7 years after implantation
- In both cases, the tissue over the LK ligament was a ligament-like tissue, but electron microscopy showed that the diameter of collagen fibrils in the tissue over the LK ligament was unimodal 6.1 years after implantation and bimodal after 8.7 years
- The tissue over the LK ligament may continue to grow with prolonged periods of mechanical stress

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