Thirty cruciate ligaments were retrieved from either cadavers or limbs which had been amputated. Each specimen was sectioned and stained to demonstrate the presence of collagen, nerves and vessels.

All 30 specimens contained an interconnecting band of collagen fibres between the anterior and posterior cruciate ligaments. Vascular structures were present in all specimens and nerve fibres were identified in 26 (86%). We have called this structure the ‘intercruciate band’. The anterior and posterior cruciate ligaments should no longer be thought of in isolation, but together as a ‘cruciate complex’.

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We have observed a band of tissue, not previously described, which links the anterior to the posterior cruciate ligament in the human knee and which contains collagen fibres, vessels and nerves. The presence of the band provides further evidence that the cruciate ligaments have a proprioceptive as well as a mechanical function in stability of the knee.

Materials

We collected specimens of human cruciate ligaments from cadavers and from limbs after above-knee amputation in patients with peripheral vascular disease. Examination of the cadavers showed no deformity or scars suggestive of previous intra-articular injury to either knee. The patients for above-knee amputation had no clinical history of trauma or degenerative joint disease.

There were 21 cadavers available for dissection but because of dehydration only 26 of a possible 42 knees were found to be suitably preserved. A further four specimens were obtained from limbs after above-knee amputation. Of the 30 specimens collected, 16 were from right knees and 14 from left, with 19 from women and 11 from men.

After exposure of the knee the cruciate ligaments were detached from their tibial and femoral insertions, while preserving the tissue between the anterior and posterior ligaments. Inspection of the knees showed no significant degenerative changes. Although amputation had been carried out for peripheral vascular disease, on inspection none of these specimens appeared to be atrophic.

They were immediately preserved in formaldehyde, processed and then embedded in paraffin wax. Histological slides were prepared from multiple transverse slices 2 to 6 µm thick. Haematoxylin and eosin, Masson’s trichrome and gold and silver stains were used to identify collagen and vascular and neurological structures, respectively.

Results

Morphological study. In all specimens the anterior ligament was oval and flatter in outline than the broader posterior ligament. Running between the ligaments in all specimens was a band of tissue covered in synovial membrane continuous with that covering the cruciate ligaments (Fig. 1). The interconnecting tissue, when viewed from above, described a ‘lazy-S’ shape (Fig. 2) with a twist, reflecting its origins along the borders of the anterior and posterior cruciate ligaments.

Histological examination. In all specimens, synovium enveloped the anterior and posterior ligaments and all interconnecting tissue. The anterior and posterior ligaments were both seen in cross-section. The interconnecting band consisted of collagen fibres in continuity with fibres from both the anterior and posterior ligaments. In contrast with the cruciate ligaments, which were cut transversely, the fibres within the interconnecting band were cut longitudinally, or obliquely, which suggests a gentle spiral from anterior to posterior (Fig. 3).

Abundant arteries and veins of varying diameter were
present within the tissue connecting the anterior to posterior ligaments at all levels and in all sections. Neurological tissue was always seen close to these vascular elements (Fig. 4). Nerve bundles, with numerous Schwann-cell nuclei, were within the interconnecting tissue (Fig. 5). Neurological material was present in 26 of the 30 specimens examined histologically. Occasional free nerve endings, the simplest form of mechanoreceptor, were seen in eight specimens. The specimens in which no nerve tissue was identified were the four least well-preserved cadaver specimens from which it was most difficult to produce stained histological slides. Neurovascular bundles were present in equal amounts in the periphery and the centre of the interconnecting band and cruciate ligaments.

Discussion

Textbooks of anatomy are quite clear in describing the anterior and posterior cruciate ligaments as separate structures divided by a fold of synovium and, when present, the anterior meniscofemoral ligament. Our study distinguishes a band of collagen fibres within the synovial envelope which connects the anterior to the posterior ligament. From the cadaver and amputation specimens studied, we have been able to describe the gross morphology of this
Proprioception has been shown to be of importance in the rehabilitation of cruciate-deficient knees and is a major factor in the outcome of reconstruction of the anterior cruciate ligament. The role of ligaments in protective neuromuscular reflex arcs is not a new concept. As long ago as 1944, Palmar stated that “the function of certain ligaments is not only to restrict movement, but to initiate muscular co-operation”. Direct evidence of the proprioceptive function of the anterior cruciate ligament was provided more recently by Pitman et al who measured somatosensory evoked potentials in the human cerebral cortex on stimulation of the anterior cruciate ligament at arthroscopy. The presence of the intercruciate band containing neurological material adds further weight to the importance of considering the cruciate ligaments as having a proprioceptive as well as a structural role. It is improbable that the intercruciate band, itself, has any inherent proprioceptive or mechanical function. Instead, it should be thought of as a neurological conduit linking the cruciate ligaments.

The presence of the intercruciate band with a nerve supply also fits the concept of the four-bar cruciate linkage system, which seeks to explain the interaction of the anterior and posterior cruciate ligaments during flexion and extension of the knee. The anterior and posterior cruciate ligaments should no longer be regarded in isolation but, along with the intercruciate band, as an intra-articular ligament complex, the ‘cruciate complex’.

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