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Removal or retention—will we ever know? The posterior cruciate ligament in total knee replacement

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Guest editorial

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For more than 2 decades the question regarding retention or removal of the posterior cruciate ligament during total knee arthroplasty has appeared at congresses, instructional courses and in orthopedic journals. One reason for this intense debate is that the scientific evidence behind choice of surgical technique—and its consequences—is limited, as reported in a meta-analysis by Jacobs et al. (2005) in this issue of Acta Orthopaedica (pages 757-768).

Little is known about the detailed weight-bearing kinematics of the knee after posterior cruciate ligament rupture in the natural knee also. Even though this topic has been studied using both MRI and radiostereometry, these studies were not dynamic and the existence of any associated injuries was not completely known (Jonsson and Kärrholm 1999, Logan et al. 2004). According to Logan et al. (2004), the medial femoral condyle will more or less always adopt an anteriorly displaced position, whereas the motion and position of the lateral condyle and rotations of the knee seem to be unaffected.

Our limited knowledge about the importance of the PCL for normal knee kinematics and function may explain the lack of consensus regarding the optimum treatment of the PCL in total knee arthroplasty. This may have been the reason for the divergent designs of the early TKRs, either intended to spare both the anterior and the posterior cruciate ligament (e.g. the Geomedic), or as for the cruciate removing designs such as the Freeman-Samuelsson and the Total Condylar prosthesis, to substitute for these ligaments by increased inherent stability (Freeman and Railton 1988). Later on, posterior cruciate substitution with a central tibial post and a corresponding box on the femoral component was introduced, often as a design option to an existing standard prosthesis.

During the late 1970s, these more constrained designs became popular. They were the obvious choice in severely deformed knees, not least when the anterior cruciate was eroded or absent. They made ligament balancing easier and had some tolerance to variations in the positioning.

Cruciate retaining bicondylar designs were sensitive to malpositioning. If inserted incorrectly, full range of motion was impossible, and the interfaces became subjected to high loads—resulting in loosening. The success of unicondylar prostheses probably contributed to the almost complete disappearance of ACL-sparing total condylar designs, and the debate was focused on the degree of optimum constraint of a total knee replacement and the optimum treatment of the PCL.

Those in favor of retention have based their opinion on analyses of unconstrained designs showing more normal gait pattern, concerns about absent "femoral roll-back" during flexion after PCL removal, increased stresses on the implant-bone and/or implant-cement interfaces after resection, increased medial loading and higher joint reaction forces after resection, and more rare complications such as increased risk of anterior/posterior component dislocation.

Those in favor of resection have found that PCL resection with use of substituting designs results in increased range of motion. The surgical procedure, and ligament balancing especially, are claimed to become easier. According to Matsuda et al. (1997), knee extension will improve using a posterior-stabilized design compared to a design with deeply-dished polyethylene and anterior buildup of the tibial articular surface. This later variation of the

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joint area may, on the other hand, be associated with lower contact stresses due to improved load distribution between the components. It is intended to substitute for the stabilizing effect of the PCL by its high congruency and the anterior buildup.

A number of studies have, however, come to the conclusion that the clinical results of TKR are not, or are only to a negligible extent, influenced by the presence or absence of the PCL. Conflicting opinions and results are more frequently reported when parameters other than the clinical results are studied. Li et al. (1995) concluded that retention of the PCL resulted in improved proprioception, whereas Lattanzio et al. (1998) did not find any such association. Most studies were actually not designed to study the key question about resection or retention using one and the same implant design, but have adapted to the more common clinical situation and have compared one cruciate-sparing design with a removing or substituting implant design. Such studies have shown more posterior displacement of the tibio-femoral contact area or the femoral condyles with increasing flexion of the PCL-substituting design, as recently demonstrated by Victor et al. (2005).

Uvehammer et al. (2000a, b) performed dynamic radiostereometric studies at up to 50 degrees of flexion of one and the same implant design, with and without retention of the PCL. Compared to the normal knee, the femoral condyles were displaced more anteriorly in both groups and by about the same amount. Knees with retained PCL showed a small tibial angulation into valgus with increasing flexion, whereas those with resected PCL showed minimum rotation into varus. There were no obvious clinical differences between the groups. The value of this information is limited, however, because the studies were not primarily designed to address the question about PCL resection.

It is disappointing that so little knowledge can be extracted from preclinical and clinical studies concerning the optimum treatment of the PCL during arthroplasty surgery. Manufacturers design implants to be either cruciate-sparing or cruciate-removing. Even if these designs have been tested in different laboratory settings, the clinical evidence behind these changes of the joint area is often limited or absent. According to Jacobs et al. (2005), the only evidence-based observation available is that PS designs result in 8º more knee flexion than designs allowing PCL retention. However, it is uncertain whether this observation can be generalized, and whether it is of clinical relevance. Posterior cruciate-retaining designs and PS components show wide design variations with different shapes of the joint area, and the central post. Today, movable platforms have become increasingly popular, but their effects on the kinematics of the knee are only vaguely known (Stiehl et al. 1999, 2001, Haas et al. 2000, Walker et al. 2002, Saari et al. 2003), and there is little if any evidence-based information on the role of the PCL in these cases.

The status of the PCL at surgery is a confounder, which must be controlled in a randomized study. Osteoarthrosis of the knee is a progressive disease, which changes the kinematics of the knee. Dynamic radiostereometric studies have shown that these changes differ between cases with medial and lateral osteoarthrosis (Saari et al. 2005). With progression of the disease, the stiffness of the ligaments and the relative tibiofemoral position will change due to contractures and loss of cartilage and, with time, also loss of bone. In knees with advanced osteoarthrosis, resection of the PCL is no longer an option, but it is necessary to achieve alignment. Another confounder in any study of PCL retention is that a complete retention of the PCL is seldom possible. Usually, the anterior fibers inserting on the tibial plateau will be more or less damaged when the tibia is cut.

The debate about the PCL will certainly continue. Our limited knowledge in this field is embarrassing for the profession, not least because TKR is one of the most cost-effective procedures available. Since almost 40 years of research has not provided more evidence for or against retention and resection, it is tempting to conclude that any difference between these options must be small and of limited clinical relevance.

On the other hand, it would be much more appropriate to face the challenge. Today, we have developed sophisticated instruments to optimize surgical interventions, to study knee kinematics and kinetics, neuromuscular function, gait, and not least, knee function, and quality of life experienced by the patient. The challenge is to design prospective and randomized trials with sufficient numbers of cases. Since many previous studies have indi-

cated no or minimum differences, correct calculation of study power will be imperative. If possible, recordings of the treatment of the PCL should also be reported to national registers.

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