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Does Contemporary Bicruciate Retaining Total Knee Arthroplasty Restore the Native Knee Kinematics? A Systematic Review of In-vitro Cadaveric Investigations.

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1 Background

Total knee arthroplasty (TKA) is a widely performed surgery on patients with severe knee arthritis. However, over 20% patients remain unsatisfied following the surgery [1]. Abnormal knee kinematics has been assumed a major factor that could affect muscle functions and proprioception. The bicruciate retaining (BCR) TKA (Fig. 1) preserves the anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL) and provides a tempting option to restore native kinematics after the surgery. Many studies have tested the kinematic features of BCR TKAs using in-vitro cadaveric specimens. This study aims to systematically review the in-vitro cadaveric studies on BCR TKA kinematics.

Fig. 1. Bicruciate Retaining Total Knee Replacement (Vanguard XP system, Zimmer Biomet). The anterior and posterior cruciate ligaments are preserved (colored in green).

2 Methods

A keywords-based literature search was performed in the MEDLINE and Web of Science database in February of 2019. Inclusion criteria were studies reporting at least one kinematic parameter (e.g., internal knee rotation, femoral rollback, etc.) during a dynamic knee motion with varying knee flexions (e.g., knee flexion) for at least one BCR TKA system. Studies with only one static parameter (e.g., anteroposterior laxity at full extension) were not included. Non-English articles, published before 2010 and non-journal articles (e.g., abstracts, systematic reviews, case reports, editorial, letters and comments) were also excluded.

3 Results

A total number of 127 entries (excluding duplicates) were obtained based on the keywords enhanced database query on MEDLINE and Web of Science since 2010. After implementing the exclusion criteria, five in-vitro studies that tested the Vanguard XP system (Zimmer Biomet) using cadaveric knee specimens were selected for analysis [2-6]. All five studies reported the tibiofemoral internal rotation during passive flexion (Fig. 2a) and the differences from the native knee (Fig. 2b). Four studies reported the anteroposterior tibiofemoral contact (dynamic translations [3-5] or static locations [2]) and only two studies reported the valgus rotations [3, 5]. In terms of knee loading, all five in-vitro studies included data measured from passive knee flexion under non-weight bearing, and two studies also collected knee kinematics data under quadriceps and hamstring loading conditions [3, 5]. On average, large differences in the internal tibial rotation during passive flexion between the BCR TKA and native knee was observed during extension (5 degrees) and terminal passive flexion (4 degrees), as shown in Fig. 2b.

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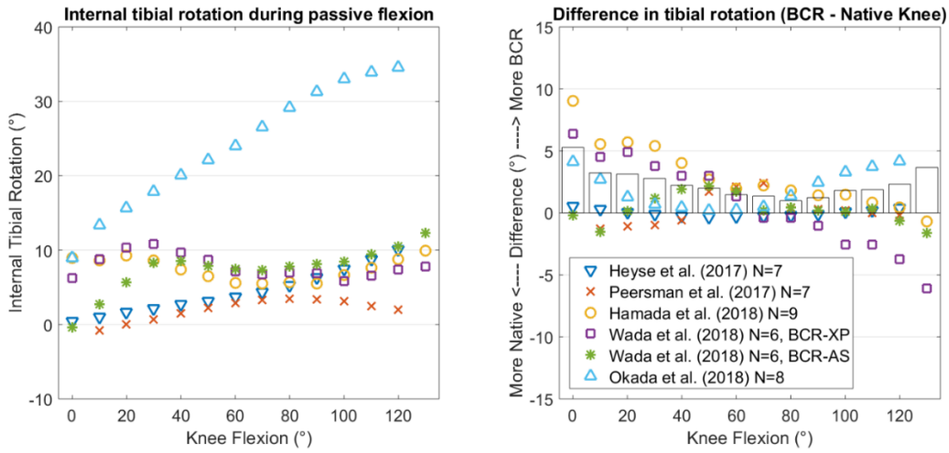

Fig. 2. Summary of (a) the internal tibial rotation during passive flexion in BCR TKAs and (b) the difference in the internal tibial rotation between BCR and native knees (bar plots indicate the mean square error).

4 Discussion

There is a limited number of in-vitro cadaveric studies investigating the BCR TKA kinematics and the reported data varied greatly in terms of kinematic metric and experimental condition. The BCR TKA does not restore the native knee kinematics, with largest errors observed at extension and deep flexion.

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