Rotatory Knee Laxity

Mattias Ahldén, MD[a,*], Kristian Samuelsson, MD, PhD[a],
Freddie H. Fu, MD[b], Volker Musahl, MD[b], Jón Karlsson, MD, PhD[a]

KEYWORDS

• Anatomic • Anterior cruciate ligament • Reconstruction • Pivot shift • Rotatory laxity

KEY POINTS

- The interest in rotatory knee laxity has increased with the implementation of anatomic anterior cruciate ligament reconstruction.
- The pivot shift test represents a link between static testing with 1° of freedom and dynamic testing during functional activity such as running.
- The difficulties are how to standardize the performance of the pivot shift test and how to extract measurable and relevant kinematic data. With new technical developments, newer standards are emerging.

INTRODUCTION

Manual clinical examination and the assessment of laxity in the injured knee is one of the foundations for evaluation of the injured knee. It is a key point for enhancement of the optimal treatment selection and clinical follow-up. Most research reports rely on manual clinical examination of laxity as an outcome measure, especially the well-known Lachman test. The Lachman test is considered to be a sensitive manual examination and an important part of the knee investigation when an anterior cruciate ligament (ACL) injury is assessed.[1] Instrumented measurements, such as KT-1000 arthrometer (MEDmetric Corp, San Diego, California), are commonly used to standardize and quantify measurements of anterior-posterior (A-P) knee laxity. However, several studies report that the A-P laxity does not correlate with functional outcome or osteoarthritis, whereas the pivot shift test does.[2,3] The pivot shift test represents dynamic rotatory laxity and entails a complicated motion, which is generally described

The authors did not receive any outside funding or grants directly related to the research presented in this article. The Department of Orthopaedic Surgery from the University of Pittsburgh receives funding from Smith and Nephew to support research related to reconstruction of the ACL. The authors state that this article is an original work submitted only to this journal. All authors contributed to the preparation of this work.

[a] Department of Orthopaedics, Sahlgrenska Academy, University of Gothenburg, Sahlgrenska University Hospital/Mölndal, Mölndal 431 80, Sweden; [b] Department of Orthopaedic Surgery, University of Pittsburgh, 3471 Fifth Avenue, Pittsburgh, PA 15213, USA
* Corresponding author.
E-mail address: mattias.e.ahlden@vgregion.se

Clin Sports Med 32 (2013) 37–46
http://dx.doi.org/10.1016/j.csm.2012.08.005 **sportsmed.theclinics.com**
0278-5919/13/$ – see front matter

as a two-component rotation around the axis of knee flexion and the axis of tibial rotation.[4] However, these rotatory axes are not consistent across patients and subsequently there are interindividual differences.[5] Moreover, the pivot shift represents motion in the extremes of the rotatory laxity envelope and simulates the patient's give-way situation.[6] Rotatory laxity and kinematics during functional activity such as running can be examined using dynamic radiostereometry (RSA) or dynamic stereo radiographs (DSX).[7–9] The pivot shift test can be regarded as a link between static laxity testing in 1° of freedom and functional dynamic laxity testing in multiple degrees of freedom. The importance of these different expressions of rotatory laxity, and how they relate to each other, is still not fully understood. DSX is not applicable for office use or in clinical follow-up; the pivot shift test is most likely the most valuable tool in terms of dynamic rotatory laxity evaluation today. Nevertheless, the pivot shift test as an outcome measure needs further improvement and testing in terms of validation and reliability. Important factors to consider when using the pivot shift test are (1) quantification, (2) its subjective nature, and (3) interpretation.[10–12]

In recent years, the interest in evaluating rotatory laxity has markedly increased in parallel with the development and implementation of anatomic ACL reconstruction and double-bundle techniques to improve the outcome of ACL reconstruction. Studies have shown that normal knee kinematics are not restored after traditional nonanatomic ACL reconstruction.[7] The goal of anatomic ACL reconstruction is, therefore, to reproduce the native anatomy of the ACL to improve kinematics and, thereby, long-term prognosis. It seems that anatomic reconstructive techniques better resist rotatory loads than traditional transtibial nonanatomic ACL reconstruction and might, at least theoretically, produce improved long-term outcome.[13–16]

Despite reports on the impact of laxity and the development of osteoarthritis,[17,18] it is still not clear which factors influence the restoration of laxity in the injured knee.[19] Moreover, most studies on rotatory laxity have been conducted on cadavers and little is known about the rotatory laxity in vivo.

The increase in knowledge regarding rotatory laxity has also put emphasis on the development of valid and reliable methods to quantify rotatory laxity and the pivot shift test.

PRIMARY AND SECONDARY RESTRAINTS TO ROTATORY KNEE LAXITY

The contribution of different factors in controlling rotatory laxity in the knee is still poorly understood. The envelope of laxity was described and validated by Bull and colleagues[5] and describes primary restraints (ACL) and secondary restraints (collateral ligaments, menisci, and joint capsule). Thus, the pivot shift grade is not only dependent on the integrity of the ACL. Musahl and colleagues[20] have shown that in a case of grade 1 pivot shift, the ACL injury was more often isolated compared with grade 2 pivot shift. The investigators also reported that the lateral meniscus was more important than the medial meniscus in controlling the pivot shift.

The anterolateral capsule and iliotibial band displays a similar role in controlling rotatory laxity.[21] The anterolateral capsular injury can also be represented by a Segond fracture, a bony avulsion of the insertion site of the anterolateral capsule on the proximal anterolateral tibia. On the other hand, Matsumoto[22] reported a lower pivot shift grade when sectioning the anterolateral secondary restraints. Researchers suggested that sectioning of the iliotibial band produced a less prominent reduction phase of the pivot shift.[23] Furthermore, associated injuries to the medial collateral ligament could reduce the pivot shift, probably because of inability to maintain a distinct pivoting point in the medial compartment.[23]