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CORR Insights®: Can Femoral Rotation Be Localized and Quantified Using Standard CT Measures?

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Where Are We Now?

The introduction and wide availability of CT enables us to directly measure femoral anteversion and tibial torsion. However, there is ongoing controversy regarding what to measure, where to measure, and even why to measure.

The terminology regarding the torsional profile of the femur can be confusing – some authors tend to use femoral torsion and anteversion interchangeably, while others refer to femoral torsion as being localized in

the femoral shaft and femoral anteversion as a result of the anatomy of the proximal femur.

The authors must be congratulated for attempting to introduce clarity into the confusing terminology in regards to torsion of the femur [6]. They differentiate between femoral version and femoral torsion and suggest using “version” for rotation localized proximal to the lesser trochanter and “torsion” for rotation localized distal to the lesser trochanter. Additionally, they provide the tools to differentiate between the two

and report the accuracy of the two methods that allow for this differentiation. The intra- and inter-rater reliability were surprisingly high for all of all three methods used. Differentiation between femoral anteversion and torsion was possible using the Kim and volumetric method in all cases.

Many articles focus on the accuracy and reliability of CT measurements; these show that the localization and level of the CT cuts on the distal and especially on the proximal femur appear to influence the accuracy of the measurements made [7, 8, 11]. Proximal femoral anatomy introduces bias when taking measurements from a simple transverse plane cut. Therefore, techniques have been proposed to incline the plane and to reconstruct the intertrochanteric and neck region using three-dimensional CT [7, 11].

In contrast to previous reports [7, 11], the accuracy of all three techniques, including the traditional single neck axis cut, was equally high with a deviation from the true torsion of only 1 ± 4 degrees.

This CORR Insights® is a commentary on the article “Can Femoral Rotation Be Localized and Quantified Using Standard CT Measures?” by Georgiadis and colleagues available at: DOI: 10.1007/s11999-014-4000-4.

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Previously published studies [1, 9] have questioned the influence of the bony anatomical torsional deformity on the resulting gait pattern. In patients with cerebral palsy, Aktas and colleagues [1] found a significant dynamic component during gait, as well as a low correlation between gait analysis data and the anatomic deformity. Even in otherwise healthy patients, femoral torsion correlated weakly with the resulting gait pattern as dynamics of gait introduce compensatory mechanisms [9].

The bigger question is why we need to measure torsional deformities. While a correction of gross functionally impairing torsional deformities seems warranted, we still know little of the correlation of femoral torsion with hip or knee pathology. In their long-term study, Tönnis and Heinecke [14] showed that a decreased femoral anteversion or retroversion was associated with early osteoarthritis and an especially low McKibbin instability index. The additive effects of femoral anteversion and acetabular anteversion were also found to be an important predisposing factor [14].

With increasing interest in hip reconstruction, hip arthroscopy, and pelvic osteotomies, femoral anteversion has come under new scrutiny. Speakers at conferences state that there is less anterior coverage in the presence of increased femoral anteversion. Additionally, increased femoral

anteversion angles have been associated with bigger labral tears observed at hip arthroscopy [4, 15].

As these controversies and unanswered questions show, it is important to more accurately describe transverse plane deformities of the hip and lower extremity.

Where Do We Need To Go?

What sets the present study aside from previous work is the differentiation between a deformity level localized proximal or distal to the lesser trochanter and the suggestion to consider this during treatment. To my knowledge, little is known about the different effects of a correction proximal or distal to the lesser trochanter. Traditionally, in pediatric patients, blade plates or angle-stable plate-screw systems are used with the osteotomy level usually in the intertrochanteric region. In adolescents and young adults, intramedullary nailing is increasingly used for pure derotation of the proximal femur with the osteotomy level mostly below the lesser trochanter. Although one might assume that an intertrochanteric osteotomy has more impact on the length of the involved muscles attaching at the lesser trochanter, a study looking at a three-dimensional computer simulation of derotational osteotomies suggested

differences were present only when a large degree of intertrochanteric derotation was performed [10]. Of course, it would be interesting to know if derotation above or below the lesser trochanter has a different effect on the relation or additive effect of femoral anteversion and acetabular anteversion. Would an intertrochanteric derotation be more effective in changing the relation of the femoral neck anteversion angle in relation to the acetabular version? Would the subtrochanteric osteotomy more directly influence the knee position (hip rotation from gait analysis) during gait?

How Do We Get There?

New techniques to evaluate torsional profile are evolving. Although MRI is beneficial for the pediatric patient population because it does not contain radiation, discrepancies in the absolute anteversion number between the MRI and CT techniques have been suggested [2, 13], highlighting the need for adjusted reference values.

Recently, results from torsional profile measurements using low-dose stereoradiography with 3D reconstruction have been reported. The results suggest high accuracy and similar values as obtained from CT with the benefit of reduced radiation [3, 5]. In fact, even pelvic parameters

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can be assessed [12]. Could this new technology enable us to look at the relation and the additive effect between femoral anteversion and acetabular version during stance? Or even better, during walking on a treadmill? Would this allow us to evaluate the true femoral acetabular relationship during motion and give us new insights into hip function and pathology? Could the newfound understanding of femoral version versus femoral torsion be included into this equation and point us towards the optimal localization for surgical intervention? Maybe, but until then, we should appreciate that the study by Georgiadis and colleagues [9] brings us one step closer to answering these questions.

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