A New Physical Examination Technique for Evaluating Valgus Knee Deformity: Swing Test

Yi-Xin Zhou, De-Jin Yang, Hong-Yi Shao
Department of Adult Joint Reconstructive Surgery, Beijing Jishuitan Hospital, 4th Medical College of Peking University, Jishuitan Orthopaedic College of Tsinghua University, Beijing 100035, China

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INTRODUCTION
Restoring mechanical alignment and soft tissue balance in total knee arthroplasty (TKA) for valgus knees depend on the origin of deformity and soft tissue status.[1-3]

Valgus deformity can exist during knee flexion besides extension, which could lead to patellofemoral joint instability and soft tissue imbalance in the flexion gap, and thus complicate the surgical procedures. Valgus deformity during knee flexion can be measured by radiographic analysis using long-film radiograph and computed tomography (CT) scans.[4] It usually results from a bone defect in the posterior part of the lateral femoral condyle (measured on CT scan) or valgus deformity in the tibia (measured on long-film radiograph). However, it is difficult to inspect this deformity during the physical examination.

We recently use a new physical examination technique, the swing test, to detect valgus deformity during knee flexion. We conducted this diagnostic study to compare the results of swing test to those of radiographic analysis and reported the sensitivity, the specificity, and the accuracy of swing test.

METHODS
This was a prospective diagnostic study based on consecutive cases. All cases were recruited from January 2011 to December 2013. We had obtained an approval for this study from the Institutional Review Board of Beijing Jishuitan Hospital.

We consecutively enrolled 54 patients (6 men and 48 women) with 54 valgus knees who had been admitted to our hospital for surgical treatment (either osteotomy or TKA) from the year 2011 to 2013. The average age was 60.6 years (range: 18–77 years). The definition we used for a valgus knee was the same as that previously reported, that is, knee with a femorotibial angle ≥10° is defined as valgus knee.[4] All patients had a range of motion of >90° and had undergone CT scanning of the affected knee.

Every knee was evaluated using both the swing test and traditional radiographic analysis (regarded as the “gold standard”) by two surgeons independently. Then, we compared the results of these two methods and calculated the sensitivity, specificity, and accuracy of the swing test.

Swing test
During the swing test, we let the patient sit on a firm and rigid examination board, with the board edge right under their knees. The examiner stood facing the patient, palpated the greater trochanter of the femur, and asked she/he to repeatedly extend and flex the affected knee slowly[Figure 1a]. If the greater trochanter moved up and down when the knee extended and flexed, we recorded a positive finding, indicating that there was a valgus deformity during knee flexion. In this instance, the valgus position of the calf was diminished by hip external rotation, which was induced by the force of gravity acting on the calf. If the greater trochanter remained static, we recorded a negative finding, indicating that no detectable valgus deformity presented during knee flexion.
TKA for a valgus arthritic knee encompasses a broad discussion. No case with false-positive results was detected. In eight cases with false-negative results, all knees had a valgus deformity <5° during flexion (average: 4.1°; range: 3.5–4.9°). In a radiographic analysis, valgus deformity during knee flexion existed in 85% cases, with a range from 3.0° to 15.1°. The sensitivity, specificity, and accuracy of the swing test were 82.6%, 100%, and 85.2% of those of radiographic analysis, respectively.

Valgus deformity in tibia exists throughout the full range of motion, which contributes to the valgus deformity during knee flexion. Moreover, an enlarged PCA is a sign of a bone defect in the posterior part of the lateral femoral condyle, which contributes to valgus deformity during only knee flexion but not an extension. The valgus deformity in the tibia and that resulting from a bone defect in the posterior part of the lateral femoral condyle contribute to the whole valgus deformity during knee flexion. Thus, we can calculate the whole valgus angle during flexion. We defined a normal aMPTA as 87° and a normal PCA as 3°. Moreover, we defined a whole valgus deformity <3° as a negative finding, while a whole valgus deformity ≥3° as a positive finding.

Results

In a radiographic analysis, valgus deformity during knee flexion existed in 85% cases, with a range from 3.0° to 15.1°. The sensitivity, specificity, and accuracy of the swing test were 82.6%, 100%, and 85.2% of those of radiographic analysis, respectively.

In eight cases with false-negative results, all knees had a valgus deformity <5° during flexion (average: 4.1°; range: 3.5–4.9°). No case with false-positive results was detected.

Discussion

TKA for a valgus arthritic knee encompasses a broad spectrum of complexities. During knee flexion, if valgus deformity exists it affects the algorithmic and individualized procedure to correct it and restores soft tissue balance in TKA. According to the results of the radiographic analysis in this study, deformity during knee flexion is common in valgus knees (in 85% cases).

The swing test is a simple physical examination technique to detect whether valgus deformity exists when the knee flexes. Compared to radiographic analysis based on long film and CT scans, this test has a considerably high sensitivity and perfect specificity.

The swing test is useful for categorizing valgus knees according to classification systems based on origins of deformity and thus for individualizing surgical treatment for the patients.

If the swing test is positive, the valgus deformity probably exists in the tibia or results from a bone defect of the posterolateral femoral condyle, which can be easily differentiated further by a malalignment test performed on the long-film radiograph. In the first scenario, if the alignment of the tibia is normal, a bone defect or dysplasia probably exists in the posterior aspect of the lateral femoral condyle, which usually coexists with a bone defect or dysplasia in the distal aspect. In these cases, the lateral collateral ligaments (LCL) are usually in contracture because the distance between the two ends of the ligament is decreased when the knee extends and flexes. Moreover, as a result, more difficult soft tissue balancing with extensive release or even using a constrained prosthesis is inevitable. In the second scenario, if the deformity results from a bone defect of the lateral tibial plateau, the surgeon will encounter difficulties similar to those in the first scenario. In the third scenario, if an extra-articular valgus deformity exists in the tibia, an additional extra-articular correction osteotomy may be needed besides a traditional TKA, no matter whether it is performed in one stage or two stages. This means a positive result of the swing test indicates increased complexity and difficulty in TKA.

If the swing test is negative, there will be no deformity or just a slight deformity (<5°) in the posterior aspect of the femoral condyle and the tibia. In this scenario, most cases have a supracondylar femoral valgus deformity or just a bone deform or dysplasia only involving the distal aspect but not the posterior aspect of the lateral femoral condyle. For these cases, soft tissue balancing will be less difficult. In addition, valgus knees with negative results in the swing test are usually easier to perform surgery on. If the major deformity originates from the supracondylar area, a supracondylar osteotomy can change a valgus knee into a well-aligned knee, or a lateral condyle sliding osteotomy with a traditional TKA will be enough to balance the knee and constrained TKA can be avoided. If there is a bone defect only in the distal aspect of the lateral femoral condyle, the length of LCL is usually normal because of the maintenance of the posterior height of the lateral condyle. A traditional bone cutting and nonconstrained implant with/without complementary metal augmentation will be enough.
There are some limitations of our study. First, it can be difficult to palpate the greater trochanter in obese patients, for whom we suggest an additional palpation simultaneously performed on the femoral condyle to help detect external rotation of the hip. Second, the sample size is relatively small in this study. Further study is needed to validate this new technique. In addition, we suggest swing test should be combined with the radiographic evaluation in practice. For those knees with a limited range of motion, swing test could not be performed, so the deformity should only be evaluated in prudent radiographic analysis. Furthermore, we used traditional radiographic analysis as a gold standard, but the inaccuracy of radiographic measurement might affect the results of the sensitivity and specificity.

In conclusion, valgus deformity during knee flexion commonly exists in valgus knees. Swing test is useful for detecting this kind of deformity. It is simple to use and cause no damage to the patient. In addition, compared to radiographic analysis, it has high sensitivity and specificity. A positive swing test is a predisposing factor for greater complexity and difficulty in TKAs.

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Conflicts of interest
There are no conflicts of interest.

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