Editorial on: is the use of spreaders an accurate method for ligament balancing?

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Total knee arthroplasty (TKA) has become successfully performed procedure for knee osteoarthritis. Accurate alignment of knee implants and soft tissue balance during TKA may induce reproduction of stable tibiofemoral and patellofemoral (PF) joints (1,2). Therefore, appropriate methods are necessary for assessment of soft tissue balance. Spreader and Spacer blocks are commonly used. However, they could not control joint distraction force precisely. Conversely, several tensors could adjust joint distraction force precisely as surgeons like. Some authors have reported the application of maximum manual joint distraction force for assessment of soft tissue balance with spreaders (3), but many authors have not described the applied joint distraction force with spreaders and actual joint distraction forces with spreaders are still unknown.

In this study, Marcio *et al.* analyzed 2 methods of manual spreader gap assessment, visual *vs.* blinded, compared with controlled tensioner. To my knowledge, this study is the first report to compare manual spreaders with tensioners for assessment of soft tissue balance. The authors hypothesized manual spreader does not estimate properly gap tension and ligament balance compared with controlled tensioner. In addition, the authors hypothesized visual spreader assessment is more accurate than blinded spreader assessment. The authors defined standard extension gap force and flexion gap force by tensioner as 100 Newtons (N) and 80 N respectively, although optimal join distraction force needs to be further discussed.

In this study, the authors reported that both lateral gap and medial gap in extension and flexion by manual spreader was greater than gaps by tensioner (100 N in extension and 80 N in flexion). In other words, manual force during gap assessment with the spreaders was higher than standard force with the tensioner (100 N in extension and 80 N in flexion). Caution should be needed because of overestimation of joint gaps when spreaders are used for soft tissue balance assessment. Furthermore, in my opinion, it is difficult to control joint distraction force precisely and reproducibly with spreaders. Therefore, manual spreader measurement may not be reliable. In this study, these measurements were carried out in 5 different procedures. In, fact, this result showed high range of manual force and high standard deviation for spreaders. And the authors described the comparison of distraction force performed manually between left and right hands were different for both extension and flexion and surgeons performed largest force in the knee lateral tibiofemoral joint. These results demonstrated the measurements with spreaders are not reproducible.

And the authors reported that the gaps between spreaders and the tensioner showed the higher difference in flexion and the lager difference in the lateral compartment. These results may depend on the reduction of capsular resistance in the flexion and the loose lateral soft tissue.

In addition, the authors reported the blinded measurement (BM) showed a slight higher manual force than the visual measurement (VM) with spreaders. Measurement by both VM and BM with spreaders were oversized gaps ($P<0.01$) compared with measurement by tensioner with the measures in flexion more markedly than

those of extension. All measurements by VM presented smaller gaps than BM when compared with the results of tensioner and controlled standard distraction force. The VM was similar to the tensioner method, with mean difference of asymmetry of 2.68 and 2.41 mm for extension and flexion compared with the tensioner. As the authors described, the results demonstrated the VM were more accurate than BM. However, there is a risk of subjective bias of examiners when the VM are used.

Many authors demonstrated the importance of soft tissue balance in TKA. Therefore this study is very interesting for orthopedic surgeons. However, there are some limitations. Spreaders are easy and convenient procedure for gap assessment. And the Force Controlled Ligament Tensioner (Smith & Nephew, Switzerland) is also excellent procedure, which can control force on the medial and lateral side separately. However, these procedures have to push soft tissue to the lateral side because of their configurations. In this study, gap measurement was carried out without eversion, but patella and extensor mechanism were displaced laterally and the PF joint was not reduced perfectly. In addition, these assessments have been performed under unphysiological tibiofemoral and PF joint conditions, and without the implants only at extension and 90 degrees of flexion. In several years, new tensors have been produced to overcome the problems. Matsumoto *et al.* reported the importance of PF joint reduction for assessment of soft tissue balance (4,5). Matsumoto *et al.* developed a new offset-tensor for TKA. The new tensor possesses three parts: upper seesaw plate, lower platform plate, and extraarticular main body. The extra-articular main body is connected to two plates by the offset connection arm through medial parapatellar arthrotomy, which always allows the PF joint reduction during the measurement. The upper plate has a post to fit the cam of the femoral trial implant of PS TKA. This post-cam part manages the tibiofemoral stability, reproducing the joint constraint and alignment after the prostheses are implanted. Joint distraction forces ranging from 20 lbs. (9.1 kg) to 60 lbs. (27.2 kg) can be controllable between the upper and lower plates. The offset-tensors enable soft tissue balance assessment under the all range of motion under physiological and reproducible tibiofemoral and PF joints with reduced PF joint and with femoral component. Thus, several types of tensors have different features and have to be used depending on the features.

The authors defined the standard distraction force as 100 N in extension and 80 N in flexion. However, in gap-balancing technique and soft-tissue balance assessment, the optimal joint distraction forces are different among surgeons and still controversial. Nagai *et al.* reported that larger joint distraction forces induced larger varus ligament balance and larger joint center gap because soft-tissue is stiffer in the lateral compartment than in the medial compartment, which could relate to determination of the rotation of the femoral posterior condyle resection for gap-balancing technique (6). They analyzed the joint center gap and varus ligament balance between 20, 40 and 60 lbs of joint distraction force. Larger distraction force showed significantly lager joint center gaps and more varus ligament balance. These findings indicate soft tissue balance depends on the strength of the joint distraction force. The optimal distraction force for soft tissue balance assessment needs to be discussed further with clinical results.

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