Editorial Commentary: Patient-Specific Instrumentation for Knee High Tibial Osteotomy Addresses the Bony but Not the Soft-Tissue Aspect of Deformity Correction

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Abstract: Both bony and soft-tissue components should be considered during preoperative planning and intraoperative performance of knee high tibial osteotomy to achieve accurate correction. 3D-printed patient-specific instrumentation may aid in addressing the bony component. Even with appropriate preoperative planning for bony and soft-tissue correction, appropriate adjustments must be made intraoperatively to achieve successful outcomes, and accurate correction is impossible unless the soft-tissue component is considered.

See related article on page 2741

In patients with symptomatic knee varus deformity, early osteoarthritis, and pain, medial opening-wedge high tibial osteotomy (OWHTO) is often indicated. In the deformity correction, we usually focus on the bony deformity and perform preoperative planning to accomplish target correction according to the deformity profile. However, due to soft-tissue changes around the deformity site, the concave medial soft tissue is usually contracted and the convex side usually becomes lax. This deformity is usually formed 3 dimensionally (3D), and this can explain why inaccurate correction sometimes occurs. Even with appropriate preoperative planning of both bony and soft-tissue components of the deformity, appropriate adjustment must be made intraoperatively to achieve successful outcome. Therefore, accurate preoperative planning and intraoperative adjustment are key factors in achieving satisfactory outcomes in around knee osteotomy.[1-3]

Various preoperative planning and intraoperative adjustment methods have been employed to restore the preplanned target point, especially in medial OWHTO. Examples of these methods are navigation systems, 3D-printing techniques, aligning with electrocautery cables, and fluoroscopy.[4-7] In addition, there have been some reports that emphasize the soft-tissue factor for the accurate correction. Kim et al.[8] proposed the intraoperative cable technique while applying valgus stress to the knee joint. Kim et al.[1] used preoperative varus—valgus stress radiographs to assess the soft-tissue component that can be reduced in the preoperative planning. This can be done because medial contracture is released in accordance with the lateral laxity.

Recently, the simulation of a real-sized model or cutting guide using 3D printing has been reported.[7,9] Patient-specific instrumentation (PSI) or guiding template reported promising outcome in accuracy, reducing operation time, hemorrhage, and radiation exposure. Future of 3D printing is expected to expand beyond the intraoperative application.

In the article on which I am writing an Editorial Commentary, "Improved Accuracy of Coronal Alignment Can Be Attained Using 3D-Printed Patient-Specific Instrumentation for Knee Osteotomies: A Systematic Review of Level III and IV Studies,"[7] authors Aman, Nicholas, DePhillipo, Peebles, Familiari, LaPrade, and Dekker evaluated the accuracy of coronal alignment using 3D-printed PSI for knee osteotomies by performing a systematic review of Level III and IV

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studies. They evaluated 14 studies (2 opening-wedge distal femoral osteotomy (DFO), 9 OWHTO, 1 closing-wedge DFO, 1 opening-wedge or closing-wedge high tibial osteotomy, 1 OWHTO and DFO). Low rate of outliers on the coronal plane, shorter operative times, and less exposure to intraoperative fluoroscopy were noted in this study. However, as reported in the limitations section, these findings may not be applied to other procedures, including osteotomies addressing posterior tibial slope. In addition, the authors did not address how accurate correction can be obtained without consideration of the soft tissue.

Both bony and soft-tissue components should be considered during the preoperative planning and intraoperative adjustment in the around knee osteotomy. 3D-printed PSI is solely dependent on the bony component. It is assumed that it also can properly work on the sagittal plane because 3D planning of the bony component may be possible. However, accurate correction would be impossible if the soft-tissue component is not considered. The effect of the soft-tissue component could be less important in the DFO because osteotomy is performed outside of the collateral ligament insertions. On the contrary, medial and lateral soft tissue should be considered to achieve accurate correction during high tibial osteotomy because the osteotomy is performed between proximal and distal insertions of the ligament at both medial and lateral side.

In conclusion, 3D printing is rapidly developing, and its application in orthopaedic surgery is exciting. However, one needs to understand what can be done and what can't be done with current PSI. Therefore, a supplement that overcomes its disadvantages should be developed and then, more evidence should be obtained to prove its superiority over conventional methods.

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