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EVIDENCE BASED REVIEW IN ORTHOPEDICS

Closing Verses Opening Wedge High Tibial Osteotomy: an Evidence-Based Review

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Introduction

Knee osteoarthritis is a common and disabling disorder made worse by lower extremity malalignment [3]. Medial knee arthrosis is the most common indication for high tibial osteotomy (HTO). Surgical techniques include closing wedge osteotomy, opening wedge osteotomy, dome osteotomy, progressive callus distraction, and chevron osteotomy [4, 7]. Opening and closing wedge osteotomies are the most common. While lateral closing wedge HTO was once considered standard of care, both techniques have advantages and disadvantages, and neither has proven clinical superiority [3]. Technique selection, therefore, is largely driven by surgeon preference.

Jackson [4] first described the closing wedge technique in the 1960s and demonstrated improvements in patient function and pain. This technique, however, is associated with fibular osteotomy or proximal tibiofibular joint release, possible peroneal nerve injury, longer rehabilitation, and a more challenging conversion to total knee arthroplasty [1, 6, 9]. Disadvantages of medial opening wedge osteotomy, on the other hand, include the possible need for bone graft, higher rates of nonunion, and the risk of collapse [9].

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Reviewed here, Duivenvoorden's article describes the mid-term follow-up on 92 patients randomized to high tibial opening wedge or closing wedge osteotomy for varus deformity and medial compartment OA. They investigated clinical and radiographic outcomes, in addition to survival rate, at a mean of 7 years postoperatively. The specific aims of this review are to (1) interpret this study's findings and (2) to evaluate the validity of the authors' conclusions and recommendations.

The Article

Comparison of Closing Wedge and Opening Wedge High Tibial Osteotomy for Medial Compartment Osteoarthritis of the Knee: A Randomized Controlled Trial with a Six-year Follow-up

Duivenvoorden T, Brouwer RW, Baan A, Bos PK, Reijman M, Bierma-Zeinstra SM, Verhaar JA. J Bone Joint Surg Am. 2014 Sep 3;96(17):1425–32.

In this prospective, randomized controlled trial comparing opening wedge to closing wedge osteotomy, the investigators sought to determine the radiographic and clinical mid-term outcomes, in addition to survival rate, as determined by conversion to total knee arthroplasty (TKA).

Between 2001 and 2004, 92 patients were enrolled and randomized to one of the two procedures performed by one of four surgeons. Inclusion criteria were medial joint pain, medial compartment OA (Ahlback score < III), and varus malalignment of 1 to 14°. Patients with symptomatic lateral compartment OA, rheumatoid arthritis, range of motion (ROM) < 100° or a flexion contracture >10°, ligamentous laxity, and those with prior ipsilateral knee surgery were excluded from the study. Two patients in the closing wedge group and nine patients in the opening wedge group were lost to follow-up.

Outcomes measured at 6 years postoperatively included maintenance of the achieved correction, progression of OA, knee pain and function, walking distance, complications,

and survival rate with conversion to TKA as the end point. There was no difference in correction achieved, progression of OA, knee pain or function, and walking distance between the two groups. Opening wedge osteotomy was associated with more complications—17 (48%) versus 3 (8%). Nearly half of the early complications in this group, however, were caused by harvesting bone at the iliac crest to perform the bone grafting. The only significant difference reported was the conversion to TKA: ten (22%) patients in the closing wedge group versus three (8%) in the opening wedge group (p=0.05).

Ultimately, the authors recommended opening wedge osteotomy without autologous bone graft in an effort to minimize the risk of complications and maximize its survival.

Commentary

The purpose of this review is to critically examine Duivenvoorden et al.'s randomized controlled trial comparing the radiographic and clinical mid-term results and survival rates of closing wedge and opening wedge osteotomies for varus knee deformity. Furthermore, we aim to evaluate the authors' support of the opening wedge osteotomy given the data presented.

A review of the published literature demonstrates that both HTO techniques have comparable clinical and radiographic outcomes [8]. Both also have their own sets of complications. Closing wedge osteotomy requires a fibular osteotomy or a proximal tibiofibular joint release and a potentially longer rehabilitation. Opening wedge osteotomy, on the other hand, is associated with a higher risk of tibial nonunion and may require bone grafting [9]. These same authors published their 1-year follow-up data results in JBJS Br. in 2006. They concluded that closing wedge osteotomy achieves a more accurate correction with less morbidity—a majority of the patients in the opening wedge group required removal of hardware—but both techniques reduced pain and improved knee function at 1 year [3].

This study exhibits a number of strengths. Prospective, randomized trials with surgical interventions are difficult to perform. The patients were well-randomized and had relatively good follow-up with a mean of 7.2 years. Despite these strengths the study has several limitations. First, when a worst-case scenario is assumed, in which patients lost to follow-up were considered to have converted to a TKA, the opening wedge survival rate changes from 3/36 (8%) to 12/45 (27%) and the comparison to closing wedge loses statistical significance. But because there were no significant differences in baseline characteristics of patients followed and patients lost to follow-up, the authors assumed that the lost patients did not significantly influence their results. This is not an unreasonable assumption.

Interestingly, five patients in the opening wedge group suffered recurrent varus alignment at 6 years. None of these patients met the surgical goal of 4° of valgus at 1 year postoperatively. This early failure was attributed to the inadequate stabilization provided by the Puddu plate. Other authors [2, 5] have advocated rigid locking plates for both osteotomy techniques. Because opening wedge osteotomies are believed to allow a more accurate correction compared to closing wedge osteotomy, a more rigid plate may allow for more predictable maintenance of this correction. Also, as noted above, opening wedge osteotomy was associated with a higher complication rate. Nearly half of these early complications were caused by harvesting bone at the iliac crest. As the authors point out, this complication could be minimized by using allograft for opening wedges less than 12.5 mm [10]. Other authors recommend allograft or bone substitute for all cases or only for larger opening wedges [2].

One other prospective randomized controlled trial comparing opening wedge versus closing wedge osteotomies exists [6]. The study performed by Magyar et al. evaluated 46 patients who underwent 50 HTOs. Their outcome measures included postoperative hip-knee angles, patient-reported pain levels, functional assessments, and complications. Comparing the two trials, Duivenvoorden et al.'s study was larger [N=92 vs. 50], reported a longer follow-up [6 vs. 2 years], utilized a power analysis, quantified loss to follow-up, and assessed survival rate as judged by conversion to TKA, a clinically significant endpoint. Both studies' interventions were performed by multiple surgeons. Both studies offered an assessment of clinical and radiological outcome scoring that allowed for a multidimensional and fair comparison of techniques. Magyar et al. concluded that there was no significant difference between opening wedge and closing wedge osteotomy, while Duivenvoorden et al. concluded that opening wedge osteotomy demonstrated better survival, but was associated with more complications.

In conclusion, this well-performed, well-designed RCT with mid-range follow-up further reinforces our current understanding that high tibial osteotomies can offer good clinical and radiographic results in a properly selected patient population. The authors conclude that opening wedge osteotomies demonstrate greater survivability and imply that the use of allograft could decrease the rate of complications related to autograft donor site morbidity. Furthermore, a more rigid construct may reduce the risk of correction loss in opening wedge osteotomies. The data alone, however, does not demonstrably support opening versus closing wedge osteotomy, and technique can be based on surgeon preference until further evidence is available.

Disclosures

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