

# Editorial Commentary: An Inverted V-Shaped High Tibial Osteotomy Combining a Lateral Closing Wedge and Medial Opening Wedge May Have Advantages



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**Abstract:** High tibial osteotomy (HTO) is enjoying somewhat of a resurgence as a treatment for medial compartment arthritis with a varus deformity. An inverted V-shaped high tibial osteotomy (IVHTO), which is essentially a combined lateral closing-wedge high tibial osteotomy (CWHTO) and medial opening-wedge high tibial osteotomy (OWHTO), has some theoretical benefits over more conventional techniques. This also has been termed a combined HTO or a hemi-wedge osteotomy. After valgus correction is performed, the osteotomy is fixed with the bone wedge resected from the lateral side being inserted into the medial side. There may be a clinical advantage of an IVHTO over a CWHTO, and retrospective evidence has shown some postoperative radiologic differences between the techniques, but there are some inconsistencies between the studies. Proponents have argued that an IVHTO can correct a severe varus deformity more easily than a CWHTO, and that an IVHTO will not change the posterior tibial slope, the patellar height, or the length of the lower limb because the hinge point is located at the centre of rotation of angulation of the lower limb deformity. However, there may be disadvantages of this technique, including the technical difficulty of performing a precise inverted V-shaped osteotomy and the need to perform a fibular osteotomy, with the associated risk of peroneal nerve injury. Prospective clinical and radiological studies are needed, particularly comparing an IVHTO with an OWHTO, to help decide where the hinge of an HTO should be placed: lateral, medial, or central. My view is that the argument for adopting the IVHTO technique over other techniques is not yet persuasive, particularly as the IVHTO is more technically demanding than an OWHTO, my current preferred technique.

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High tibial osteotomy (HTO) is enjoying somewhat of a resurgence as a treatment for medial compartment arthritis with a varus deformity. However, there remains some debate about the best surgical technique. A lateral closing-wedge high tibial osteotomy (CWHTO) technique was popularized by Coventry in the 1960s,<sup>1</sup> but more recently a medial opening-wedge high tibial osteotomy (OWHTO)<sup>2,3</sup> has become the preferred technique of many surgeons.

A less well-known technique is an inverted V-shaped high tibial osteotomy (IVHTO), which was proposed by Levy et al in 1973.<sup>4</sup> Essentially, this is a combined

lateral CWHTO and medial OWHTO. Rather than the hinge being medial, as with a lateral CWHTO technique, or lateral, as with a medial OWHTO technique, the hinge is central. After valgus correction is performed, the osteotomy is fixed with the bone wedge resected from the lateral side being inserted into the medial side.

Since the technique was first described, there have been only sporadic reports of studies involving an IVHTO, which has also been termed a combined HTO or a hemi-wedge osteotomy.<sup>5-9</sup> Proponents have argued that an IVHTO can correct a severe varus deformity more easily than a CWHTO, and that an IVHTO will not change the posterior tibial slope, the patellar height, or the length of the lower limb because the hinge point is located at the centre of rotation of angulation of the lower-limb deformity.<sup>7,9</sup>

In their retrospective study titled “Inverted V-Shaped High Tibial Osteotomy Decreases the Posterior Tibial Slope More but Shortens the Tibia Less Than Closed-Wedge High Tibial Osteotomy,” Hayashi, Tsukisaka,

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Okuhara, Tsuyuguchi, Goto, and Hashiguchi<sup>10</sup> compared the IVHTO and CWHTO techniques by measuring the postoperative changes in several radiologic indices measured on 3-dimensional computed tomography. They found that there was a significantly greater flattening of the posterior tibial slope in the IVHTO group (the mean posterior slope of the medial tibial plateau decreased from 12.8° to 5.3° in the IVHTO group and from 9.9° to 7.6° in the CWHTO group) and a significantly smaller decrease in tibial length in the IVHTO group (a mean shortening of 1.6 mm in the IVHTO group and 4.1 mm in the CWHTO group).

There are several limitations to note. First, the statistically significant differences may not have been clinically significant, and no clinical outcomes were reported. Second, the cohorts were small: 18 knees in the IVHTO group and 19 knees in the CWHTO group. Third, the mean planned correction angle was 12.5° for the IVHTO group and 10.5° for the CWHTO group, but the mean correction angle that was achieved was only 6.3° and 5.0° respectively. Finally, there were several sources of bias, including a performance bias (the 2 osteotomy techniques were performed by different surgeons), a selection bias (the difference in the planned correction angle between the 2 groups was statistically significant), and a transfer bias (nearly one-third of all the osteotomies were excluded due to the lack of a complete image data set and most of the exclusions were in the CWHTO group).

A few other studies have reported outcomes after an IVHTO. Aoki et al.<sup>5</sup> reported a retrospective comparison of 48 IVHTOs and 56 CWHTOs at a minimum follow-up of 10 years and they found that the Japanese Orthopaedic Association score was graded satisfactory more often after an IVHTO and delayed union occurred more often after a CWHTO. There was also a greater loss of correction in the CWHTO group, but this did not reach statistical significance. It may be pertinent to note that the osteotomies in both groups were fixed with a monolateral external fixator. El-Alfy<sup>8</sup> presented the outcomes of a hemi-wedge osteotomy performed on 28 knees with a varus or valgus deformity of at least 20°, reporting a failure of correction in 2 cases. Papp et al.<sup>6</sup> reported that the short-term results of a series of 103 combined HTOs were good or excellent in 89%. Subsequently, Papp et al.<sup>7</sup> published the results of a prospective radiologic study of 45 CWHTOs and 46 combined HTOs, which found that a combined HTO resulted in smaller changes in the posterior tibial slope and patellar height. The fact that a combined HTO resulted in less flattening of the posterior tibial slope than a CWHTO contrasts with the findings of Hayashi et al.<sup>10</sup>

Thus, there is some limited evidence to support the use of an IVHTO. Hayashi et al.<sup>10</sup> have argued that an

IVHTO may be a better technique than a CWHTO in cases of anterior cruciate ligament deficiency when a decrease in the posterior tibial slope is beneficial, although the findings of Papp et al.<sup>7</sup> contradict this view. It also has been suggested that the IVHTO technique may be a good option for larger corrections.<sup>9</sup> Typically, larger corrections are achieved using either a single osteotomy in the coronal plane, accepting some postoperative joint line obliquity, or a double-level osteotomy,<sup>11,12</sup> which is more complex. The benefits of an IVHTO over these 2 options have yet to be proved, and indeed the results presented by Hayashi et al.<sup>10</sup> show that the postoperative medial proximal tibial angle, a measure of joint line obliquity, was similar in their 2 groups: 94.5° ± 2.9° in the IVHTO group and 95.6° ± 2.7° in the CWHTO group.

The IVHTO technique has some potential disadvantages, including the technical difficulty of performing a precise inverted V-shaped osteotomy, and the need to perform a fibular osteotomy, with the associated risk of peroneal nerve injury.<sup>9</sup>

There are also many unanswered questions. How does an IVHTO compare with an OWHTO, both clinically and radiologically? How do the clinical outcomes of an IVHTO compare with other techniques in a prospective comparative study? What is the effect of an IVHTO on joint line obliquity in knees requiring a large correction and how does this compare with other techniques?

My view is that the argument for adopting the IVHTO technique over other techniques is not yet persuasive, particularly as the IVHTO is more technically demanding than an OWHTO, my current preferred technique.

We still await the answer to the question: does the outcome of an osteotomy hinge on where the hinge is? And, if so, which is best: a lateral hinge, a medial hinge, or a central hinge?

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