Tibial slope after Medial Opening-Wedge High Tibial Osteotomy: Is plate positioning the biggest issue?

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No funding

Authors have nothing to disclose

Abstract

Objetive: One major cause of Medial Opening-Wedge High Tibial Osteotomy (MOW-HTO) failure is inadvertent Posterior Tibial Slope (PTS) increase. To avoid this complication, posterior placement of the wedge plate is traditionally recommended. However, in the attempt of achieving such positioning, surgeon may encounter some undesired consequences, like medial collateral ligament disruption, instability or neurovascular injury. The purpose of this study is to evaluate the correlation between plate position in the sagittal plane and posterior tibial slope, in patients undergoing MOW-HTO.

Methods: Forty-three patients undergoing MOW-HTO were radiographically evaluated, before and after surgery, to determine posterior tibial slope changes and plate position.

Results: Mean Posterior Tibial Slope before surgery was 7.6 ± 3.0 degrees. After surgery, it increased to 10.3 ± 4.9 degrees ($p = 0.0005$) - this was not influenced by position or size of the plate. High values of posterior slope before surgery were correlated with greater increases after surgery.

Conclusion: Plate positioning and wedge size were not related to PTS change, but patients with high preoperative PTS values showed a significantly greater increase in postoperative PTS .

Level of evidence: Level 4 – case series.

Keywords: knee; osteoarthritis; osteotomy

1. Introduction

High tibial osteotomy (HTO) is a procedure for the correction of varus deformity in middle-aged patients with unicompartmental osteoarthritis that fell out of favor with orthopedic surgeons as knee arthroplasty became more commonplace (Gomoll, 2011). In the past 10 years, however, osteotomy has been rediscovered, and the Medial Opening-Wedge High Tibial Osteotomy (MOW-HTO) has become the most popular technique to correct varus lower limb deformity in young, active patients complaining of persistent knee pain in the medial compartment of the knee (Gomoll, 2011; Amendola et al, 2005). MOW-HTO has several advantages, including easy surgical exposure, preservation of bone stock and intra-operative adjustment (Amendola et al, 2005). However, a frequent cause of failure of this technique is an inadvertent increase of Posterior Tibial Slope (PTS) in the sagittal plane (Amendola et al, 2005, Hernigou et al, 1987). Inadvertent change of Tibial Slope is a frequent condition (Yanasse et al, 2009; El-Azab et al, 2008; Marti et al, 2004; Schaefer et al, 2008).

Among technical maneuvers to avoid an inadvertent increase in PTS during MOW-HTO, the most recommended is posterior plate positioning (Lee et al, 2010; Noyes et al, 2005; Rodner et al, 2006; Rubino et al, 2008). However, in order to achieve such positioning, surgeon may encounter some undesired consequences, like medial collateral ligament disruption, instability or neurovascular injury (Franco et al, 2005; Chae et al, 2011; Shenoy et al, 2009; Rose et al, 2007).

The purpose of this work is to evaluate the correlation between plate position in the sagittal plane and posterior tibial slope, in patients undergoing MOW-HTO.

2. Materials and Methods

Between 2007 and 2008, forty-six Medial Opening Wedge High Tibial Osteotomies (MOW-HTOs) were conducted as part of a randomized controlled trial (Zoezi et al, 2011). Subsequently, forty-three cases were selected, for pre and post-operative analysis of sagittal plain radiographs, to determine posterior tibial slope and plate position.

All osteotomies were performed according to a classical description of MOW-HTO (Franco et al, 2005). The lateral cortex of the tibia was left intact to enhance stability and to function as a hinge. After gradually opening of the gap to desired correction degree, a Puddu wedge plate was used to fix the osteotomy. The plate was positioned as far posterior as possible. In cases which the wedge was smaller than 10mm, the plate was positioned just anterior to the medial collateral ligament's (MCL) border. When larger corrections were performed (10 mm or more wedges), the MCL was partially detached from distal tibial insertion, accordingly to the described technique (Franco et al, 2005).

Measurement of the Posterior Tibial Slope measurement (PTS) was performed according to the "Posterior Tibial Cortical Method" in short plain radiography, as described by Brazier (Brazier et al, 1996). A brief description is presented in figure 1.

A simple and objective method, shown in figure 2, was developed to determine plate position in the tibia. The x-ray must be positioned in a true sagittal view to ensure reproducibility.

First, a line is drawn over the posterior tibial cortex. Next, the apex of the anterior tibial tubercle (ATT) is localized (point A). A line perpendicular to the posterior cortex is drawn and the intersection of lines is called point C. The position of the plate in line AC is defined as a ratio (BC x 100) divided by AC, where point B is the posterior side of the plate, excluding the wedge.

2.1 Statistical Analysis

Pre and postoperative PTS values were compared using a two-tailed Student t-test. A two-tailed Pearson correlation was used to determine the correlation between plate positioning and PTS values. Wedge sizes were compared using one-way ANOVA. Results were considered significant when the p-value was < 0.05. All statistical analyses were performed using the software Prism 3.02 (Graphpad Software Inc., San Diego, CA, USA).

3. Results

Plain radiographs of forty-three patients before and after surgery were analyzed.

Mean age of patients was 43 ± 8 (SD) years. The vast majority of patients (95%) were male.

All osteotomies were fixed with a Puddu stainless steel plate. Wedge size ranged from 7.5 mm to 15 mm (mean 10 mm ± 2 SD).

Before surgery, the mean Posterior Tibial Slope (PTS) was 7.6 ± 3.0 degrees. After surgery, there was a significant increase to 10.3 ± 4.9 degrees (p=0.00005) (figure 3).

Patients with high preoperative PTS values showed a significantly greater increase in postoperative PTS values (p=0.0065) compared to patients with low baseline PTS (Figure 4).

Plate position, at sagittal view x-rays, did not correlated to PTS changes (figure 5). Plates were in an average position of 61.15% of the AC line described above.

Wedge size of the plate, which represents the magnitude of correction, did not correlate with PTS changes (figure 6),

4. Discussion

Among strategies to prevent PTS increase, one of the most recommended is positioning wedge-plate as far posterior as possible (Lee et al, 2010; Noyes et al, 2005; Rodner et al, 2006; Rubino et al, 2008). In attempt to achieve a very posterior plate positioning, some surgeons end up causing some unnecessary injuries, such as a deliberate medial collateral ligament cut (Franco et al, 2005), or even a much more serious vascular injure (Shenoy et al, 2009). Despite the awareness of the posterior placement strategy, the choice of a point to divide the groups into anterior and posterior positioned plates is somewhat random (LaPrade et al, 2010).

Opening Wedge High Tibial Osteotomy has an important risk of increase tibial slope. In the present study, Posterior Tibial Slope (PTS) increased from 7.6 ± 3 degrees to 10.3 ± 4.9 degrees (p=0.00005). This result is in accordance with previous descriptions (Ozalay et al, 2008) that reported an increase from 9.0 ± 5.1 degrees to 11.7 ± 5.7 degrees. (p < 0.007). Kendoff et al. (Kendoff et al, 2008) reported an increase in tibial slope from 4.2 ± 5.9 degrees to 7.1 ± 3.7 degrees (P < 0.005).

Increasing the PTS is one of the main disadvantages of Medial Opening-Wedge technique, since Lateral Closing-Wedge tends to preserve or reduce tibial slope (El-Azab et al, 2008; Schaefer et al, 2008; Brouwer et al, 2005; Hohmann et al, 2006). Wang et al. (Wang et al, 2009) proposed that high tibial osteotomy affects PTS in the sagittal plane because of the triangular configuration of the proximal tibia. The posterior-lateral location of the cortical hinge will increase PTS after medial open wedge osteotomy, but lateral location of the cortical hinge will not affect PTS. To prevent unintentional increase of the PTS, care should be taken to locate the intact cortical hinge on the lateral, not the posterior-lateral side of the tibia. Matar et al. (Matar et al, 2009) proposed that a more oblique osteotomy in the frontal plane could avoid an inadvertent increase in PTS. The group with oblique osteotomy showed more normalized postoperative sagittal tibial slope and patellar height than a group with a horizontal osteotomy. Caution should be taken not to perform the osteotomy too distally, due to the risk of delayed union.

Rodner et al. (Rodner et al, 2006) performed a cadaveric study in which anterior plate application resulted in an increase in PTS by an average of 6.6 degrees ($P < .001$) compared with posterior plate placement. Rubino et al. (Rubino et al, 2008) described the results of eight cadaveric knees that underwent MOW-HTO with Puddu plates of each different size. Plates were analyzed based on position (anterior, central, and posterior) and on plate size used. Tibial slope was affected by plate position ($P < 0.05$) and size ($P < 0.001$). Smaller, posterior plates had less effect on tibial slope.

In our study, there was no difference between plate positioning and PTS increase. The average position of the plates was beyond 60% of the sagittal diameter of the tibia. We believe that as long as the plate is on the posterior half of the tibia, its positioning is not as important as other factors, such as position and integrity of the lateral cortex hinge, magnitude of correction and, most of all, previous PTS. Patients with high preoperative PTS values showed a significantly greater increase in postoperative PTS. Maybe patients with high PTS should have undergo to closing-wedge techniques. More studies are needed on that matter.

5. Conclusion

Plate positioning and wedge size were not related to PTS change, but atients with high preoperative PTS values showed a significantly greater increase in postoperative PTS .

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Figures

Figure1: Posterior Tibial Slope (PTS) measurement technique, in a short sagittal view plain radiograph. The PTS value is the angle between the line parallel to the medial tibial plateau and the line perpendicular to the posterior tibial cortex.

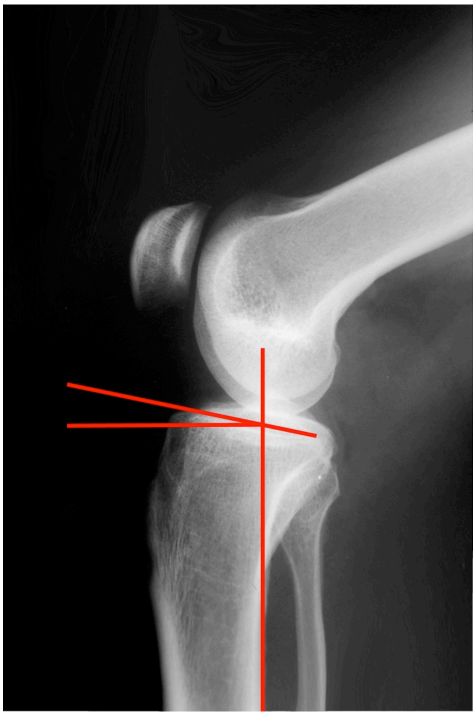


Figure 2: Sagittal plain radiograph showing the lines used to determine plate position in the proximal tibia.

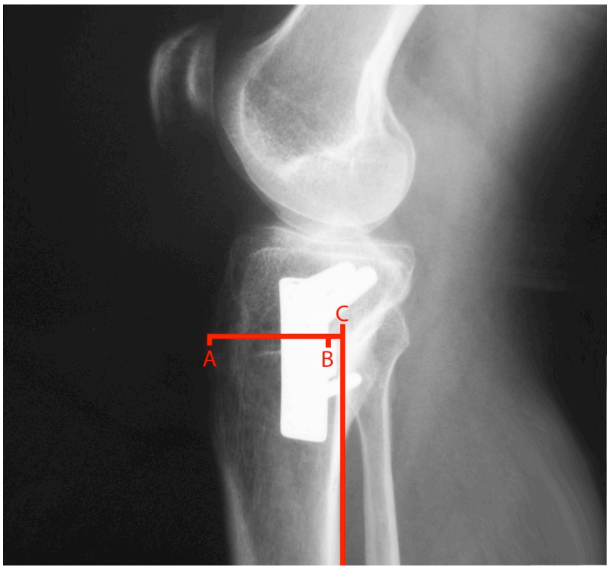
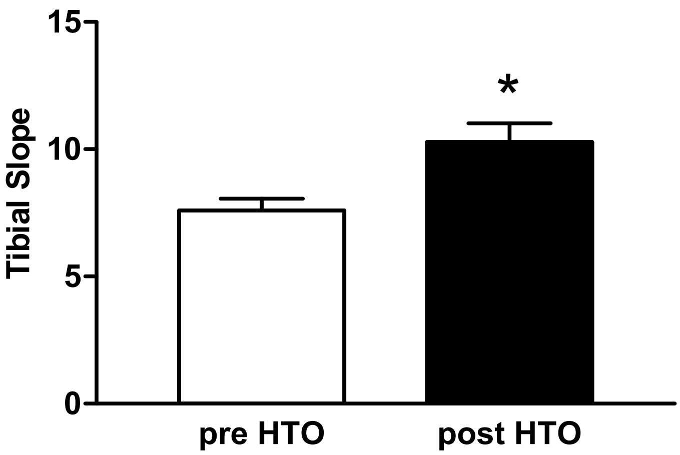


Figure 3: Comparison of mean Posteror Tibial Slope values before (pre-HTO) and after (post-HTO) surgery.



*** p= 0.0005**

Figure 4: Posteror Tibial Slope (PTS) values before and after surgery, analyzed by Pearson correlation test, showing that high pre-HTO PTS correlates with a greater increase in PTS post-operatively.

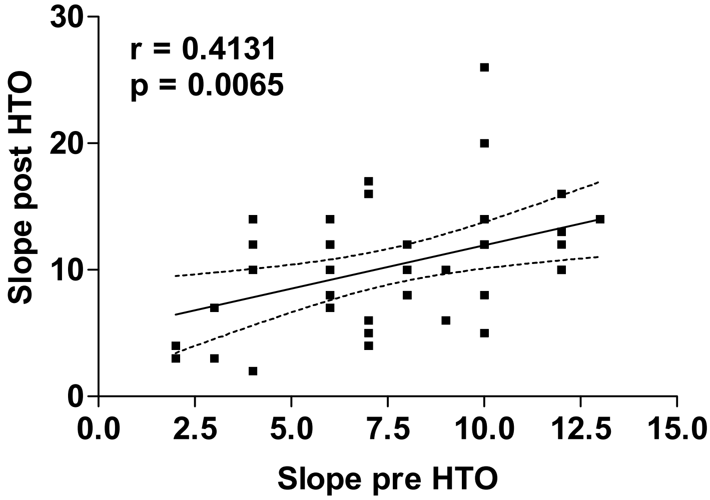
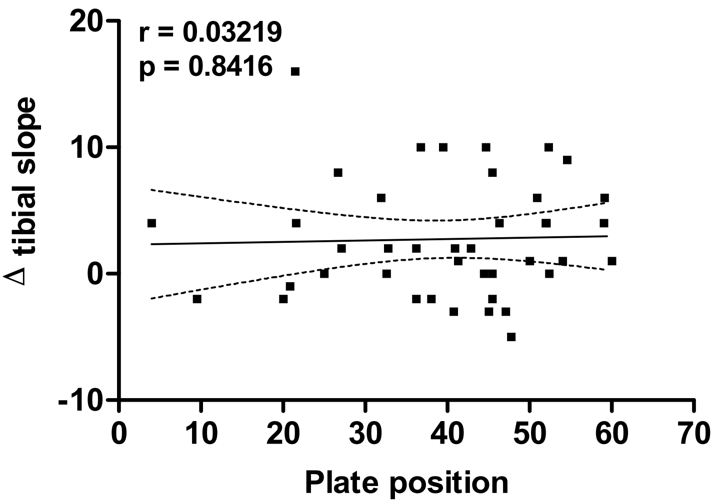


Figure 5: Pearson correlation based comparison of plate position on sagittal view plain radiographs and the variation of PTS after surgery.



WULFENIA JOURNAL KLAGENFURT, AUSTRIA ISSN:1561-882X
Vol 21, No. 6;Jun 2014

Figure 6: Comparison of wedge size (plate size) and variation of PTS values after surgery by ANOVA (p>0.05).