

# Comparison of the change in patellar height between opening and closed wedge high tibial osteotomy: measurement with a new method

Mitsuru Hanada · Masaaki Takahashi ·  
Hiroshi Koyama · Yukihiro Matsuyama

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## Abstract

**Purpose** The purposes of this study were to examine patellar height at preoperation and postoperation, and compare the change of patellar height between opening wedge high tibial osteotomy (HTO) and closed wedge HTO by using Insall-Salvati (IS) ratio and our original method.

**Methods** Twenty patients (26 knees) were included. There were 6 males (6 knees) and 14 females (20 knees). Sixteen knees underwent closed method and 10 knees underwent opening method. Patellar height was measured at preoperation, immediately after the operation (postoperation) and 1 year after the operation according to IS ratio and modified Blumensaat (MB) ratio. We defined MB ratio as the ratio of distance from Blumensaat line to the midpoint of patellofemoral joint of patella against the length of Blumensaat line.

**Results** In opening wedge HTO, though IS ratio significantly increased postoperatively compared with preoperative IS ratio, IS ratio at 1 year after operation was not significantly different from preoperative values. MB ratio at postoperation and that at 1 year after the operation significantly decreased compared with preoperative MB ratio. In closed wedge HTO, there was no difference between preoperative and postoperative values of both IS ratio and MB ratio.

**Conclusions** In the postoperative period after opening wedge HTO, IS ratio was significantly increased, whereas MB ratio was decreased. We recommend that patients with low preoperative MB ratio must be treated with closed wedge HTO.

**Keywords** Patellar height · High tibial osteotomy · Opening wedge · Closed wedge

## Introduction

High tibial osteotomy (HTO) is commonly performed for unicompartmental osteoarthritis of the knee. We have been well aware the patellar descent after opening wedge HTO and not aware after closed wedge HTO. There are some reports that patellar height is changed after HTO. However, these reports cannot be unconditionally compared, because the methods of evaluation are varied. Wright et al. [1] and Brouwer et al. [2] reported that Insall-Salvati (IS) ratio [3] decreased after opening wedge HTO. On the other hand, Chae et al. [4] reported IS ratio increased after opening wedge HTO. Though we assume that most important factor of patellar height is alignment against femur, IS ratio might show length of patellar tendon, not patellar height against femur. Otherwise, Blackburne-Peel (BP) ratio [5] is considered useful method of the evaluation of patellar height. However, the posterior slope of tibia is changed during opening and closed wedge HTO [6–9]. We considered that BP ratio was unsuitable for the evaluation of patellar height for HTO. Therefore, we contrived new method for the evaluation of patellar height. The purpose of this study was to examine patellar height on preoperative and postoperative radiograph, and compare the change of patellar height between opening wedge HTO and closed wedge HTO by using new method.

M. Hanada (✉) · H. Koyama · Y. Matsuyama  
Department of Orthopaedic Surgery, Hamamatsu University  
School of Medicine, 1-20-1 Handayama, Higashi-ku,  
Hamamatsu 431-3192, Japan  
e-mail: mitsuruhanada@gmail.com

M. Takahashi  
Joint Center, Jyuzen Hospital, Hamamatsu, Japan

## Patients and methods

From 2005 to 2009 year, the patients with medial uni-compartmental osteoarthritis who underwent closed wedge or opening wedge HTO were included in this study. Twenty patients (26 knees) were included, with an average age of 63.2 years (range: 30–78 years). There were 6 males (6 knees) and 14 females (20 knees). We underwent closed wedge HTO to all patients from September 2005 to December 2006, whereas after January 2007, we chose the operative method for every each patient. Patients who had a femorotibial angle of  $\geq 185^\circ$  were treated with closed wedge HTO and those with  $<185^\circ$  were treated with opening wedge HTO. We determined the correction angle, so that femorotibial angle on supine position would be made  $168^\circ$  in closed wedge HTO and weight-bearing axis on stand would be made 62.5 % from medial condyle of tibia in opening wedge HTO. Sixteen knees were underwent closed wedge HTO and 10 knees were opening wedge HTO. Standard lateral radiographs of the knee around  $30^\circ \pm 10^\circ$  of flexion were obtained preoperatively and postoperatively (just after the operation) and at 1 year after the operation. The patellar height was measured by IS ratio (Fig. 1) and modified Blumensaat (MB) ratio, which modified the method using Blumensaat line for the evaluation of patellar height against femur (Fig. 2). We defined the value of MB ratio as the ratio of distance from Blumensaat line to the middle at patellofemoral joint of the patella against the length of Blumensaat line.

Statistical comparison of preoperative IS and MB ratios between closed group and opening group was performed



**Fig. 1** Insall-Salvati (IS) ratio = II/I

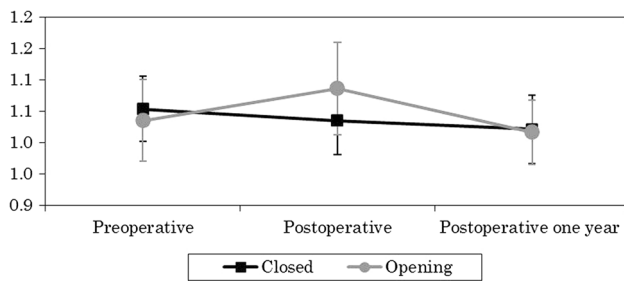


**Fig. 2** Modified Blumensaat (MB) ratio = II/I. We defined the value of MB ratio as the ratio of distance from *Blumensaat line* to the midpoint at patellofemoral joint of the patella against the length of *Blumensaat line*

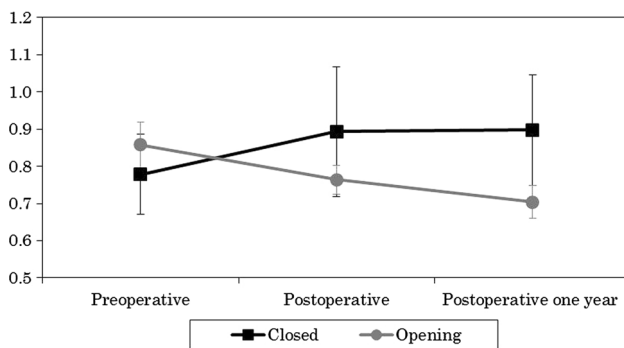
using Mann–Whitney *U* test. Statistical comparisons between the change of patellar height of closed group and opening group preoperatively, postoperatively, and at 1 year after the operation were performed using paired *t* test. A *P* value of 0.05 was considered to be statistically significant.

## Results

Figure 3 shows the result of the change of IS ratio from preoperation to 1 year after the operation, and Fig. 4 shows the result of the change of MB ratio. In closed wedge HTO group, the mean value of postoperative IS ratio (1.035) and the mean value of IS ratio at 1 year after the operation (1.021) did not significantly change compared with preoperative IS ratio (1.054). The mean value of postoperative MB ratio (0.893) and the mean value of MB ratio at 1 year after the operation (0.897) did not significantly change compared with preoperative MB ratio (0.778). In opening wedge HTO group, though the mean value of postoperative IS ratio (1.086) significantly increased compared with preoperative IS ratio (0.778) ( $P = 0.00624$ ), the mean value of IS ratio at 1 year after the operation (1.016) did not significantly differ from preoperative IS ratio. The mean postoperative MB ratio (0.763) significantly decreased compared with preoperative MB ratio (0.857) ( $P = 0.019$ ), and the mean value of MB ratio at 1 year after the operation (0.704) significantly decreased compared with preoperative MB ratio ( $P = 0.045$ ).



**Fig. 3** The mean values of IS ratio were evaluated in each group of *opening and closed* wedge HTO. In opening wedge HTO group, the mean postoperative IS ratio significantly increased compared with preoperative IS ratio



**Fig. 4** The mean values of MB ratio were evaluated in each group of *opening and closed* wedge HTO. In opening wedge HTO group, the mean postoperative MB ratio significantly decreased compared with preoperative MB ratio, and the mean MB ratio at 1 year after operation significantly decreased compared with preoperative MB ratio

## Discussion

In this study, IS ratio significantly postoperatively increased after opening wedge HTO, but did not significantly changed after closed wedge HTO. We assume that IS ratio increased to extend patellar tendon which bent preoperatively because of lowering tibial tuberosity distal after opening wedge HTO. However, patellar height does not mean length of patellar tendon but location of patella against femur or joint line. One of the points of problem about patellar alta or baja was alignment of patellofemoral joint for the patient with anterior knee pain after HTO and in operation of total knee replacement after HTO. BP ratio might show patellar height against joint line. However, Kaper et al. [10] reported BP ratio was influenced by tibial posterior slope and BP ratio could not be used to evaluate patella height during HTO. We previously observed tibial posterior slope was significantly changed during opening and closed wedge HTO. In addition, there are several reports about the change of tibial posterior slope during opening and closed wedge HTO [6–9]. Therefore, we used the original method for patellar height as MB ratio to evaluate patellar height against femur

because the change of patellar height should affect the condition of patellofemoral joint. MB ratio decreased after opening wedge HTO because patella was pulled to distal side by opening wedge. At 1 year after opening wedge HTO, there was no difference from preoperative IS ratio in opening group because patellar tendon sagged down similar to preoperation. Then, though it was considered that MB ratio decreased more than postoperative to sag down, there was no difference from postoperative MB ratio. During closed method, though the patellar tendon should sag down, condition of patellofemoral joint and length of patellar tendon were not influenced. We suggest that we must adequately give attention when patients with low preoperative MB ratio are undergone opening wedge HTO because MB ratio decreases for a year after opening wedge HTO and patella baja is present. Therefore, we recommend that patients with low preoperative MB ratio must be treated with closed wedge HTO.

## Conclusions

Patellar height was evaluated with Insall-Salvati method and modified Blumensaat method, and compared between opening wedge HTO and closed wedge HTO. Though Insall-Salvati ratio did not significantly change after opening wedge HTO postoperatively, modified Blumensaat ratio decreased after opening wedge HTO postoperatively and at 1 year after closed wedge HTO. We suggest that patients with low preoperative modified Blumensaat ratio must be treated with closed wedge HTO.

**Conflict of interest** None.

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