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## CASE REPORT

# Re-correction osteotomy with osteophyte graft for correction loss with non-union after high tibial osteotomy

Ryuichi Nakamura,<sup>1</sup> Hitoshi Nishimura,<sup>2</sup> Yasuo Katsuki<sup>3</sup><sup>1</sup>Department of Orthopaedic Surgery, Harue Hospital, Sakai, Japan<sup>2</sup>Department of Rehabilitation, Yawata Medical Center, Komatsu, Japan<sup>3</sup>Department of Orthopaedic Surgery, Yawata Medical Center, Komatsu, Japan**Correspondence to**

Dr Ryuichi Nakamura, ryu-nakamura@msj.biglobe.ne.jp

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**SUMMARY**

A 68-year-old man with right knee varus osteoarthritis was treated by lateral closed-wedge high tibial osteotomy. A correction loss with non-union occurred 6 months after surgery and a re-correction osteotomy was performed. Removing the proximal screws of the lateral plate, a medial opening-wedge re-osteotomy was performed. Arthroscopically harvested osteophytes were used to fill the gap after opening. An additional medial locking plate was installed on the medial side. Finally, the proximal lateral screws were reinserted and locked again. Mature trabecular continuity was obtained in the gap by 6 months, and there was no varus deformity 4 years after re-correction. Re-correction osteotomy could be a viable treatment when lateral compartment osteoarthritis has not progressed and good range of motion still exists. Osteophyte grafting may be an effective option not only to avoid iliac bone grafting but also to promote bone healing in re-osteotomy.

**BACKGROUND**

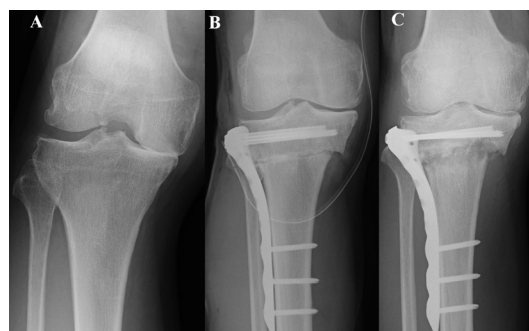
In recent years, medial open wedge high tibial osteotomy (OWHTO) for medial compartment osteoarthritis (OA) has become an increasingly frequent surgical technique, with the introduction of plates specifically designed for OWHTO.<sup>1</sup> Despite the simple surgical procedure, a high rate of intraoperative lateral hinge fracture in OWHTO has been reported when the opening distance is large.<sup>2-3</sup> Furthermore, delayed gap filling of the opening site is a possible complication in such cases.<sup>4,5</sup> Therefore,

to reduce the chance for these complications, we prefer a lateral closed wedge high tibial osteotomy (CWHTO) for severe varus knees.<sup>3</sup> However, correction loss and non-union are well-described bone-related complications after CWHTO.<sup>6</sup> Once correction loss occurs, it is usually treated by total knee arthroplasty (TKA)<sup>7</sup> if the osteotomised site already has united. Re-correction osteotomy could be a viable alternative for treating correction loss<sup>8,9</sup> especially when bone union of the osteotomised site is not achieved. Here, we report a case of correction loss with non-union after CWHTO treated by re-correction osteotomy using OWHTO.

Surgeries for non-union generally consist of reduction and fixation with a bone graft. Although the most common bone graft is harvested from the anterior iliac crest, a high rate of chronic pain at the donor site presents a considerable hindrance to harvesting iliac bone.<sup>10</sup> In this case, to avoid complications at the donor site, arthroscopically harvested osteophyte grafts, first reported by Akiyama *et al*,<sup>4</sup> were used.

**CASE PRESENTATION**

A 68-year-old man presented with right knee pain on the medial side over a period of 4 years. The preoperative Japanese Orthopaedic Association (JOA) score<sup>11</sup> was 75 points and the knee flexion range was 140°. As the patient engaged in the hard work of confectionery manufacture, and because the range of flexion was well preserved, we decided to perform a joint preserving surgery rather than a TKA according to our HTO indication.<sup>3</sup> CWHTO was chosen because a large correction angle was required due to the severe varus deformity.<sup>3</sup> A non-contact bridging plate for proximal tibia (Zimmer Inc, Winterthur, Switzerland) was used for the fixation. The JOA score improved to 90 points 3 months after the CWHTO surgery, and the knee flexion range was 150°. In spite of the good clinical result at the time, the osteolytic change described below developed and was identified on the radiographic examinations. Therefore, low-intensity pulsed ultrasound<sup>12</sup> using the Sonic Accelerated Fracture Healing System (SAFHS; Exogen, Piscataway, New Jersey, USA) was initiated to accelerate the fracture-healing process. A brace for knee OA was applied at the same time. However, 6 months post-CWHTO, the patient developed difficulty in walking to a degree nearly equivalent to



**Figure 1** Anteroposterior radiograph of the right knee. (A) The preoperative Rosenberg view<sup>13</sup> revealed the completely closed medial joint space. (B) A medial cortex fracture was seen just after the initial osteotomy. (C) An osteolytic change at 3 months after initial osteotomy.



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**Figure 2** Full-length anteroposterior weight-bearing radiographs of the right leg. (A) Preoperative severe varus deformity. (B) 1 month after initial osteotomy. (C) Correction loss 6 months after initial osteotomy. (D) 1 month after re-correction osteotomy. (E) 4 years after re-correction osteotomy.

his preoperative status due to a correction loss with non-union. He decided to receive a reoperation 9 months after the initial osteotomy.

### INVESTIGATIONS

For the initial CWHTO, in addition to monthly follow-up radiological evaluations of the knee, full-length anteroposterior (AP) weight-bearing radiographs of the leg were obtained preoperatively and at 1, 2, 3 and 6 months postoperatively. Similar radiological examinations were evaluated after the re-correction osteotomy, and an annual follow-up was scheduled until 4 years

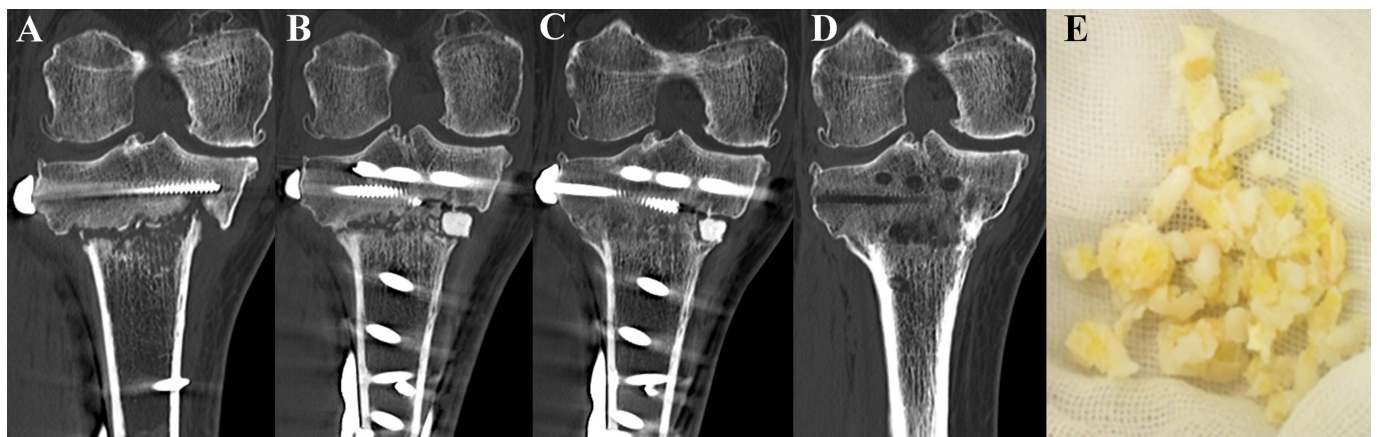
after surgery. CT scans were taken 6 months after the initial osteotomy and 6 months, 1 year and 2 years after re-correction osteotomy.

The preoperative Rosenberg view<sup>13</sup> revealed Kellgren-Lawrence grade IV medial compartment OA<sup>14</sup> (figure 1A) with preservation of the lateral compartment. Bilaterally the patient's knees were in severe varus and the full-length AP radiograph of the right leg revealed a femorotibial angle (FTA, lateral angle between the femoral shaft and the tibial shaft)<sup>15</sup> of 186° (figure 2A). On the AP view just after the initial CWHTO, the osteotomy lines were in contact with each other in spite of a medial cortex fracture with step-off (figure 1B). The osteolytic change at the osteotomised site appeared at 3 months and the screws bowed in connection with the medial tilt of the proximal fragment (figure 1C). Although the FTA was corrected from 186° to 173° on the full-length AP view at 1 month (figure 2B), a 6° correction loss with non-union was observed 6 months postoperatively (figure 2C).

After the re-correction osteotomy, the FTA was corrected from 179° to 170° (figure 2D) and there was no recurrence of the correction loss 4 years later (figure 2E). The coronal views of the multiplanar reconstruction CT 6 months after the initial osteotomy revealed a non-union surrounded by a sclerotic margin (figure 3A). Mature trabecular continuity was obtained by 6 months after filling the gap with osteophytes during the re-correction osteotomy (figure 3B). The gap completely healed by 1 year (figure 3C), and the bone substitute was almost absorbed 2 years later (figure 3D).

### TREATMENT

As the lateral compartment OA had not progressed and a good range of motion still existed, re-correction valgus osteotomy was planned. After removing the proximal screws of the lateral plate, an opening procedure from the medial side was performed. The size of the opening wedge was decided to place the weight-bearing axis on the lateral side of the knee, at 62% of the width of the tibial plateau.<sup>3</sup> As the osteotomised site was fused with fibrous tissue, re-osteotomy was necessary. The osteotomy was aimed to end at the starting point of the initial lateral CWHTO. Once the re-osteotomised site was open, the underlying sclerotic bone was completely resected and the arthroscopically harvested 6 mL of osteophytes from the knee (figure 3E) were used to fill the gap according to the procedure reported by Akiyama *et al.*<sup>4</sup> The osteophytes were cut into small pieces without decortication.



**Figure 3** The coronal views of the multiplanar reconstruction CT. (A) 6 months after initial osteotomy. (B) 6 months after re-correction osteotomy. (C) 1 year after re-correction osteotomy. (D) 2 years after re-correction osteotomy. (E) Arthroscopically removed osteophytes.

About 1 mL of bone substitute (Osferion 60, Olympus Terumo Biomaterials Corp, Tokyo, Japan) also was inserted as a postero-medial cortical support and a TomoFix Small (Synthes GmbH; Solothurn, Switzerland) was installed on the medial side. Finally, the proximal lateral screws were reinserted and locked again (figure 2D).

### OUTCOME AND FOLLOW-UP

Partial and full weight bearing was started at 1 and 3 weeks after surgery, respectively, according to our standard protocol for OWHTO.<sup>3</sup> The detailed healing process of the osteophytes grafting was described in the Investigations section. Both lateral and medial plates were removed 2 years after re-correction osteotomy. At 4-year follow-up, the JOA score had improved to 95 points with 150° of knee flexion. The detailed radiographic follow-up results were described in the Investigations section above.

### DISCUSSION

The correction loss with non-union in this case may be related to the medial cortex fracture. In the knees with severe varus, the medial cortex may be harder than the lateral cortex as most of the weight-bearing force is applied to the medial side of the knee. Therefore, as van Raaij *et al* described,<sup>16</sup> to preserve the medial cortex intact during CWHTO is far more difficult than to preserve the lateral cortex in OWHTO. In this case, the displacement of the disrupted medial hinge generated a step-off, which created proximal impaction of the distal portion of the osteotomised site. Furthermore, the bowing of the screws after osteolysis due to their cannulated structure and insufficient stability due to the distance between the proximal and distal screws could have increased the risk for re-varus deformity.

Once correction loss occurs, TKA is usually performed,<sup>7</sup> and there are few reports of re-correction osteotomy.<sup>8,9</sup> In our case, the osteotomised site had not fused when the decision was made to reoperate. Therefore, even if TKA conversion were selected, fixation for the non-union would be required. In addition to that, the correction loss arose within 1 year of the initial osteotomy, and thus, the lateral compartment was still intact and the range of motion was still preserved. Re-correction osteotomy can be considered for such cases.

The method for stabilising the disrupted medial cortex might be the key to successful re-correction osteotomy. In this case, the sinking of the medial side of the proximal fragment resulted in the progressive varus deformity. Therefore, raising the fragment by medial opening was an ideal procedure. The locking plate fixation on both sides with the support of a bone substitute may provide absolute angular stability after the opening.

In addition, arthroscopically harvested osteophytes were grafted to the re-osteotomised site. This technique for OWHTO was first reported by Akiyama *et al*.<sup>4</sup> The first advantage of this procedure is to avoid complications after iliac bone harvesting.<sup>10</sup> The second probable advantage may be the acceleration of the healing process. Akiyama *et al* mentioned that osteophytes are associated with active endochondral bone formation processes and expression of various growth factors.<sup>4</sup> Therefore, osteophyte grafting could be an additional option to promote healing of the osteotomised site in re-osteotomy. The sufficient gap healing after osteophyte grafting, despite the non-union with sclerotic change, supports the efficacy of the graft.

### Learning points

- ▶ Re-correction osteotomy for a correction loss with non-union after closed-wedge high tibial osteotomy was successfully performed without recurrence of varus.
- ▶ This procedure could be a viable alternative for total knee arthroplasty when lateral compartment osteoarthritis has not progressed and a good range of motion still exists.
- ▶ Osteophyte grafting may be an effective option to promote bone healing in re-osteotomy.

**Contributors** RN, wrote the paper and performed the surgery. HN, helped in postoperative rehabilitation. YK, helped in surgery.

**Competing interests** None declared.

**Patient consent** Obtained.

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