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Modified Mitchell Osteotomy for Juvenile Hallux Valgus: A Case Report

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Abstract

Juvenile hallux valgus is typically managed conservatively; however, surgery is indicated in symptomatic cases refractory to non-operative treatment. Herein, we report the case of a 17-year-old girl with juvenile hallux valgus who did not respond to orthotic management. After confirming physeal closure, a modified Mitchell osteotomy was performed. Postoperatively, the hallux valgus angle improved from 38° to 18°. Self-administered foot evaluation questionnaire scores revealed marked improvement, and the correction was maintained without major complications at 12 months postoperatively. The modified Mitchell osteotomy may be an effective treatment option for juvenile hallux valgus in skeletally mature adolescents.

Categories: Pediatric Surgery, Orthopedics
Keywords: first metatarsophalangeal joint deformity, foot deformity correction, hallux valgus surgery, juvenile hallux valgus, modified mitchell's osteotomy

Introduction

Juvenile hallux valgus is a deformity that develops during childhood or adolescence and is understood as a three-dimensional pathology involving the first metatarsal varus, sesamoid displacement, and pronation of the hallux. Its development is associated with genetic predisposition, ligamentous laxity, first-ray instability, and foot alignment abnormalities. Its prevalence is reported to be 2%-4% [1-3]. Conservative treatment is the first-line approach, and surgery is considered for symptomatic cases refractory to non-operative management [4]. Surgical procedures include distal or proximal osteotomy [5], the Lapidus procedure [6], and Akin osteotomy of the proximal phalanx [7]. Appropriate procedure selection should be based on skeletal maturity and the pattern of deformity. Minimally invasive surgeries have recently been reported, such as the distal linear metatarsal osteotomy (DLMO) procedure [8] and the simple, effective, rapid, and inexpensive (SERI) method [9,10]. Recurrence remains a major challenge in juvenile cases, and improvement in long-term outcomes requires three-dimensional assessment of the deformity and appropriate selection of surgical procedures [10]. The modified Mitchell osteotomy [11] is one of several joint-preserving distal first metatarsal osteotomies used to correct hallux valgus. It allows realignment of the first ray through lateral translation of the distal metatarsal fragment and is generally applied to selected patients with mild-to-moderate deformity. Although numerous procedures have been described for hallux valgus, the optimal approach in adolescent patients remains controversial because recurrence may be influenced by skeletal immaturity, residual growth, and deformity severity. This makes assessment of physeal closure and skeletal maturity an important component of surgical decision-making when considering osteotomy in juvenile hallux valgus. Herein, we report a case of juvenile hallux valgus in a 17-year-old girl who underwent surgical treatment and achieved a favorable functional outcome one year postoperatively. This case report demonstrates the short-term outcomes of modified Mitchell osteotomy in a skeletally mature patient with juvenile hallux valgus and may provide useful information for considering surgical timing and recurrence risk.

Case Presentation

A 17-year-old girl presented with bilateral metatarsophalangeal (MTP) joint pain in her big toes 14 months before surgery. She had no history of participating in regular sports. Her height was 165 cm, her weight was 60.0 kg, and her body mass index was 22 kg/m^2. Her mother had no history of hallux valgus.

Although the patient wore an orthosis (Super toebick®, Ota, Shimane, Japan) for hallux valgus for three months, the pain persisted. She then visited our clinic. The right hallux valgus was clearly detected in the weight-bearing position (Figure *1A*). When viewed from the foot end, the second toe deviated dorsally (Figure *1B*). She experienced pain on the medial and plantar surfaces of the right first MTP joint. Tenderness was detected at the proximal plantar aspect of the first metatarsal base. Symptoms were aggravated during standing and walking. Discomfort was elicited on the medial aspect of the right first MTP joint during passive varus stress. No laxity was observed in the MTP joint.

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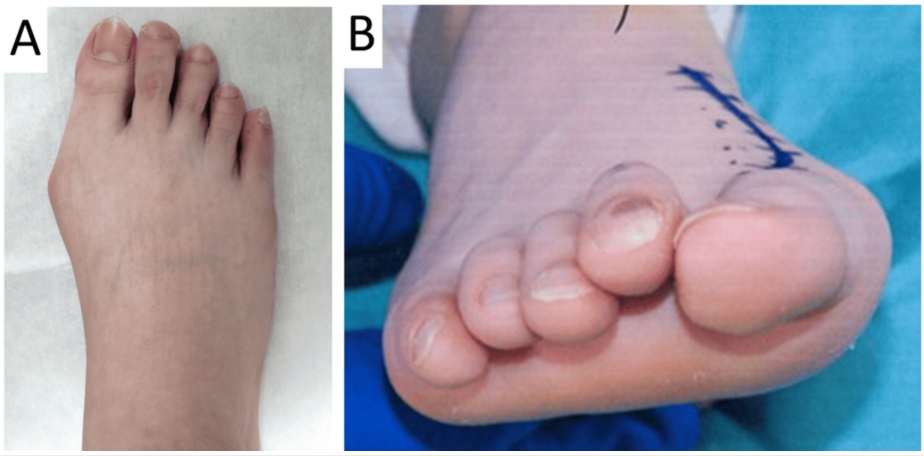

FIGURE 1: Preoperative macroscopic findings of the right foot

On weight-bearing, the right hallux valgus is shown (A). When viewed from the foot end, the second toe is deviated dorsally (B).

In the preoperative anteroposterior weight-bearing X-ray findings, the hallux valgus angle (HVA) was 38°, the intermetatarsal angle between the first and the second metatarsals (M1M2A) was 15°, and the intermetatarsal angle between the first and the fifth metatarsals (M1M5A) was 30° (Figure *2A*). Additionally, the sesamoid view revealed that the sesamoid position was grade 1 according to the Hardy classification [12], and the tibial sesamoid revealed slight atrophic changes (Figure *2B*). In the standing lateral view of the ankle and foot, the calcaneal pitch angle [13] was 15°, indicating that the longitudinal arch of the right foot was preserved without pes planus (Figure *2C*).

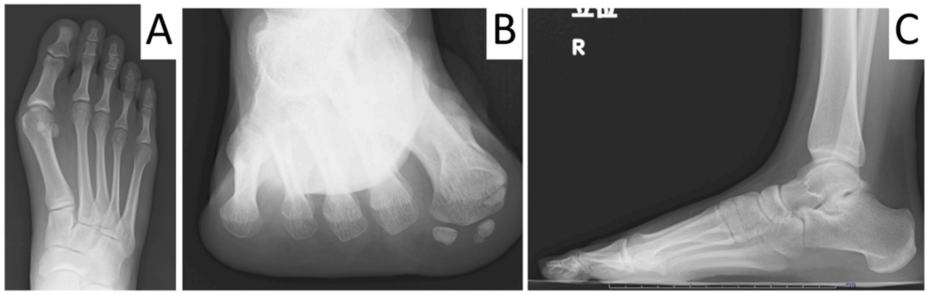

FIGURE 2: Preoperative X-ray findings of the right foot and ankle

(A) The hallux valgus angle (HVA) was 38°, the M1M2A 15°, and the M1M5A 30°. (B) Sesamoid view. The tibial sesamoid showed slight atrophy. (C) Standing lateral view. The calcaneal pitch was 15°, suggesting preservation of the longitudinal arch of the right foot.

MIM2A: intermetatarsal angle between the first and the second metatarsals; M1M5A: intermetatarsal angle between the first and the fifth metatarsals

Regarding the preoperative self-administered foot evaluation questionnaire (SAFE-Q) [14], the pain and pain-related, physical functioning, social functioning, shoe-related, and general health and well-being subitem scores were 50, 68.1, 29.2, 25, and 60, respectively. Because she was unable to run due to pain, the sports activity subitem could not be evaluated (Figure *3*).

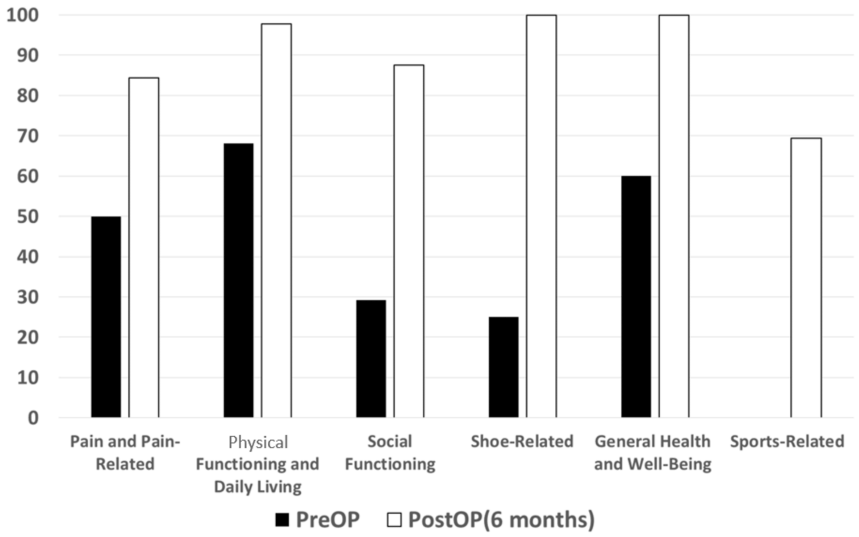

FIGURE 3: Changes in self-administered foot evaluation questionnaire scores

All subitems increased markedly at 12 months postoperatively. The shoe-related and general health and well-being categories reached the maximum score. Black bars indicate preoperative values; white bars indicate values at 12 months postoperatively.

Because the patient's condition was refractory to orthotic treatment and she could not go to school on foot and participate in physical education class, she and her family hoped for an additional approach. Then, surgical treatment for right hallux valgus was performed. Modified Mitchell osteotomy was selected for the operative procedure [11]. Her left foot X-ray findings showed that HVA was 28°, M1M2A was 17°, and M1M5A was 31°. However, she did not complain of left foot pain so much, so we did not perform a surgical procedure for the left foot.

Surgical technique

Under general anesthesia, the patient was placed in the supine position. A dorsal curved skin incision was then made. Soft-tissue realignment was performed. The adductor hallucis tendons, including the oblique and transverse portions, were incised stepwise.

Subsequently, the hallux MTP joint capsule was incised in a V-shape. The MTP joint was completely exposed. Modified Mitchell osteotomy consists of two transverse cuts connected by a vertical cut in the distal first metatarsal, creating a step-shaped configuration. Then, the distal fragment, including the metatarsal head, was translated laterally to correct hallux valgus. The distal and proximal fragments were contacted and fixed with two 1.2-mm-diameter Kirschner wires in a cross-shaped fashion. These wires were buried in the body. The two sesamoids were successfully reduced under image intensification.

The reflected dorsal MTP joint capsule was tightly repaired using cortical and supplemental sutures. The operative wound was closed after irrigation. Radiographic findings revealed an HVA of 18°, an M1M2A of 8°, and an M1M5A of 25° immediately after surgery (Figures *4A*, *4B*).

FIGURE 4: Postoperative X-ray findings

(A) Anteroposterior view of the right foot. After modified Mitchell osteotomy and fixation with two K-wires, the HVA improved to 18°, the M1M2A to 8°, and the M1M5A to 25°. (B) Oblique view of the right foot.

MIM2A: intermetatarsal angle between the first and the second metatarsals; HVA: hallux valgus angle; M1M5A: intermetatarsal angle between the first and the fifth metatarsals

Postoperative clinical course

Three weeks postoperatively, the patient was permitted to walk with full weight-bearing and arch support. By three months, the osteotomy site had healed, and she was permitted to walk without arch support. At 12 months, the HVA was 19°, the M1M2A was 11°, and the M1M5A was 27° (Figures *5A*, *5B*). The osteotomized surfaces exhibited clear bone healing. Macroscopic findings at 12 months after the surgery demonstrated that the hallux valgus was corrected and the dorsal deviation of the right second toe was resolved. The alignment of the toes was restored (Figures *6A*, *6B*).

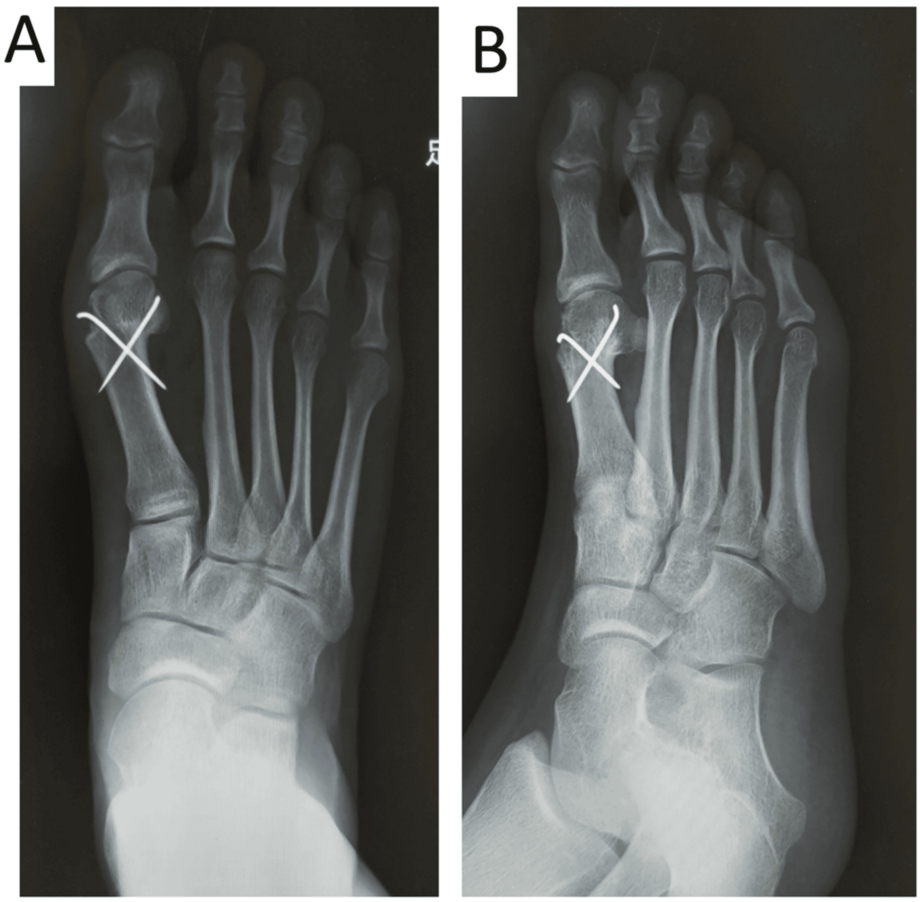

FIGURE 5: X-ray findings of the right foot (standing) at 12 months postoperatively

(A) Anteroposterior view of the right foot. The HVA was 19°, the M1M2A was 11°, and the M1M5A was 27°. The osteotomy site showed clear bone healing. (B) Oblique view of the right foot.

MIM2A: intermetatarsal angle between the first and the second metatarsals; HVA: hallux valgus angle; M1M5A: intermetatarsal angle between the first and the fifth metatarsals

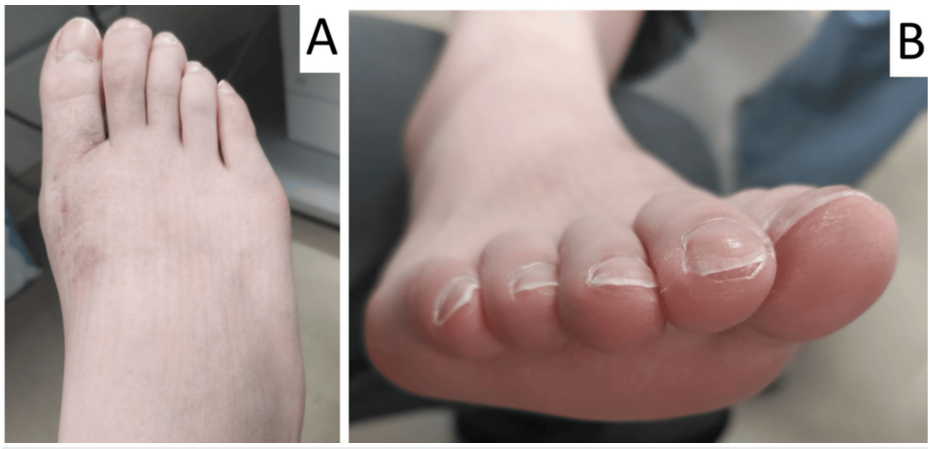

FIGURE 6: Postoperative macroscopic findings at 12 months

Hallux valgus was corrected (A), and dorsal deviation of the second toe was resolved (B).

Postoperative SAFE-Q scores at 12 months after surgery remarkably improved for each subitem (pain and

pain-related, 84.4; physical functioning, 97.7; social functioning, 87.5; shoe-related, 100; general health and well-being, 100; and sports activity, 69.4) (Figure *3B*). Specifically, shoe-related and general health and well-being subitems achieved perfect scores. No signs of wound infection, pin site deviation, or protrusion were detected 12 months after surgery.

Discussion

Juvenile or adolescent hallux valgus differs from adult hallux valgus in several important respects, including the potential influence of skeletal immaturity, generalized ligamentous laxity, first-ray instability, and a relatively high risk of recurrence after surgical correction. Therefore, surgical indications and procedure selection should be determined carefully, particularly in young patients. In the present case, conservative treatment with an orthosis failed to relieve symptoms, and the patient had persistent pain during standing and walking. In addition, closure of the metatarsal physis had already been confirmed. These findings supported the decision to perform surgical treatment.

A family history of hallux valgus has been reported in a substantial proportion of juvenile cases, and female predominance is also well recognized [1-3]. Ligamentous laxity and pes planus have also been described as possible contributing factors to the development or progression of juvenile hallux valgus [2,3]. However, in the present case, there was no maternal history of hallux valgus and no apparent MTP joint laxity, and the calcaneal pitch angle indicated preservation of the medial longitudinal arch. Thus, the deformity in this patient may not have been strongly associated with generalized ligamentous laxity or flatfoot. This point is clinically relevant because the underlying pathomechanism may influence the risk of recurrence and the choice of surgical procedure.

Although conservative management is generally recommended as the first-line treatment for juvenile hallux valgus, surgical intervention may be considered when pain and functional limitation persist despite adequate non-operative treatment [4]. However, the optimal surgical procedure remains controversial. Previous reports have described various procedures, including distal metatarsal osteotomy, proximal metatarsal osteotomy, the Lapidus procedure, Akin osteotomy, and minimally invasive techniques [5-10]. In adolescent patients, recurrence remains a major concern, and insufficient correction, residual metatarsus primus varus, uncorrected pronation of the hallux, sesamoid malreduction, and skeletal immaturity have all been considered potential contributors to recurrence.

Recently, minimally invasive procedures such as the SERI technique and DLMO have attracted attention for the treatment of juvenile or adolescent hallux valgus [8-10]. These techniques have been reported to provide satisfactory radiographic correction and clinical outcomes with relatively low surgical morbidity. In particular, favorable mid-term outcomes after the SERI technique have been reported, and recent reviews have suggested that contemporary surgical procedures can improve both radiographic parameters and patient-reported outcomes in adolescent hallux valgus [9,10]. Nevertheless, minimally invasive procedures are not free from complications or recurrence. In addition, the need for percutaneous Kirschner-wire fixation, pin-site care, and temporary wire protrusion for several weeks may cause anxiety or discomfort in some young patients. On the other hand, the procedure used in the present case was buried Kirschner wires, which cause non-anxiety for them.

In the present case, the modified Mitchell osteotomy was selected because the patient had symptomatic hallux valgus with confirmed physeal closure, and this procedure was familiar to the surgical team. The modified Mitchell osteotomy allows lateral translation of the distal first metatarsal fragment and can be combined with soft-tissue realignment around the first MTP joint. Although this technique is more invasive than some minimally invasive procedures, it provides direct visualization of the MTP joint and enables secure correction of the deformity.

In our previous report, modified Mitchell osteotomy for hallux valgus with shortening oblique osteotomy for lateral toes significantly reduced pain and improved walking ability in patients with rheumatoid arthritis. The procedure also resulted in a remarkable improvement from 31.7° to 17.1° in HVA and was maintained at five years after the surgery [11].

In this patient, the HVA improved from 38° preoperatively to 18° immediately after surgery, and the M1M2A improved from 15° to 8°. Reduction of the sesamoids was also achieved intraoperatively under fluoroscopic guidance. These findings suggest that adequate correction was obtained at the time of surgery.

At 12 months after the surgery, HVA increased to 19°, M1M2A increased to 11°, and M1M5A increased to 27°. Although the loss of correction was limited to a few degrees across all radiographic parameters, this finding should be discussed in the context of the recognized recurrence risk in juvenile hallux valgus.

Importantly, a clear bone union was achieved, the dorsal deviation of the second toe resolved, and the patient-reported outcomes improved markedly. The SAFE-Q scores improved in all evaluated domains, particularly in the shoe-related and general health and well-being subscales, both of which reached 100 points. These results indicate that the procedure provided not only radiographic correction but also

meaningful functional improvement and high patient satisfaction.

Although the SAFE-Q scores improved postoperatively, the clinical significance of this change should be interpreted with caution because the minimal clinically important difference for SAFE-Q in juvenile hallux valgus has not been clearly established. The slight increase in radiographic angles during follow-up should be interpreted cautiously. Recurrence after surgery for juvenile hallux valgus has been reported even after apparently adequate correction, and longer follow-up is necessary to determine whether the observed changes represent early recurrence or only minor postoperative remodeling.

A previous report showed the clinical outcome of smooth-pin fixation and a trapezoidal step-off osteotomy for 46 adolescent patients with a painful hallux valgus deformity. The study showed overall excellent or good results in 91% of cases and concluded that modified Mitchell osteotomy is a satisfactory surgical procedure for adolescent hallux valgus deformity [15].

In another report, a long-term follow-up (seven years) was conducted for 30 cases who had a total of 51 Mitchell procedures to correct adolescent (the average age of cases was 15 years) hallux valgus deformities [16]. Outcomes were rated as excellent in 19 feet, good in 16, fair in 6, and poor in 10. Of the fair and poor groups, recurrence of the deformity due to insufficient bony union was detected.

Two reports [15,16] clarified that approximately 60%-90% of cases with adolescent hallux valgus showed excellent or good results, although a few cases showed the recurrence of the deformity. The present case is a single case with a short follow-up period of 12 months. Therefore, the long-term durability of correction remains unclear. Continued observation until skeletal and functional stability is confirmed is warranted.

In summary, the present case suggests that modified Mitchell osteotomy can be an effective surgical option for symptomatic adolescent hallux valgus after physeal closure, particularly when conservative treatment has failed. Careful assessment of skeletal maturity, deformity pattern, sesamoid position, and patient-specific concerns remains essential for selecting the appropriate procedure.

Conclusions

We report a case of juvenile hallux valgus in a 17-year-old girl refractory to conservative treatment, treated with modified Mitchell osteotomy after confirmation of physeal closure. At 12 months postoperatively, patient-reported outcomes and radiographic parameters improved compared with preoperative findings. This case suggests that modified Mitchell osteotomy may be a potential treatment option for skeletally mature adolescents with juvenile hallux valgus; however, further studies with larger cohorts and longer follow-up are required to determine the durability of correction and the risk of recurrence.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Naoki Kondo, Nariaki Hao

Acquisition, analysis, or interpretation of data: Naoki Kondo, Nariaki Hao, Rika Kakutani, Kenichi Honma, Hiroyuki Kawashima

Drafting of the manuscript: Naoki Kondo, Kenichi Honma

Critical review of the manuscript for important intellectual content: Naoki Kondo, Nariaki Hao, Rika Kakutani, Hiroyuki Kawashima

Supervision: Naoki Kondo

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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