



## Consequences of Avulsion Fracture of the Proximal Phalanx Caused by a Technical Failure of Hallux Valgus Surgery



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### ABSTRACT

Several cases of avulsion fracture of the proximal phalanx of the big toe during the lateral capsular release procedure were observed. However, these fractures have not been reported as a complication of hallux valgus surgery. The purpose of the present study was to report the proximal phalanx base fracture as an unrecognized complication and to evaluate the clinical and radiographic consequences of this complication. We retrospectively reviewed 225 feet that had undergone hallux valgus surgery involving proximal chevron osteotomy and distal soft tissue release from May 2009 to December 2012. Of these 225 feet (198 patients), 12 (5.3%) developed proximal phalanx base fracture postoperatively. These patients were assigned to the fracture group. The remaining patients were assigned to the nonfracture group. Patients were followed to observe whether the fractures united and whether degenerative changes developed at the first metatarsophalangeal joint because of this fracture. The mean follow-up period was 36 (range 12 to 72) months. All the subjects in the fracture and nonfracture groups underwent weightbearing anteroposterior and lateral radiographs of the foot at the initial presentation and final follow-up point. The 2 groups were compared with respect to the hallux valgus angle, intermetatarsal angle, range of motion, American Orthopaedic Foot and Ankle Society score, satisfaction, and degenerative changes. No significant differences were found in age, follow-up period, hallux valgus angle, intermetatarsal angle, range of motion of the first metatarsophalangeal joint, American Orthopaedic Foot and Ankle Society score, satisfaction, and degenerative changes between the 2 groups. Ten (83.3%) of the 12 fractures healed, 2 (16.7% of the fractures, 0.89% of the operated feet) progressed to asymptomatic nonunion, and 3 (1.33%) developed first metatarsophalangeal joint degeneration. Avulsion fracture of the proximal phalanx of the big toe is an uncommon complication of hallux valgus surgery. It seems to be caused by excessive tension placed on the lateral soft tissues that attach to the base of the proximal phalanx at the time of plantar lateral soft tissue release. However, this fracture does not seem to cause significant clinical problems.

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Distal soft tissue repair, combined with first metatarsal osteotomy, is indicated for an incongruent (subluxated) hallux valgus deformity (1–4). As the degree of hallux valgus increases, the lateral capsule of the first metatarsophalangeal joint (MTPJ) and the adductor tendon become a deforming force. In most surgical procedures designed to correct moderate to severe degrees of hallux valgus, the soft tissue

structures on the lateral aspect of the first MTPJ must be released to reduce the subluxated joint (5–8).

Coughlin (9) stated that failure of the lateral joint capsular tissue is one of the complications associated with hallux valgus surgery. A significant lateral MTPJ contracture develops in most patients with a severe hallux valgus deformity. After lateral capsular release, a large gap is created that can be as long as 1 cm. With a defect of this size, it is uncommon for adequate tissue to re-form across this defect. This places the hallux at increased risk of a postoperative hallux valgus deformity. Mann and Coughlin (6) observed that hallux valgus occurred most commonly in feet in which a more severe deformity was corrected. To avoid this complication, the lateral joint capsule can be initially perforated with multiple small puncture incisions. Next,

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with varus pressure on the hallux, the lateral capsule is gradually torn and the capsular tissue “stretched out.”

We experienced some cases of avulsion fracture of the proximal phalanx of the big toe during the lateral capsular release procedure. However, these fractures have not been reported as a complication of hallux valgus surgery. Therefore, the purpose of the present study was to report the proximal phalanx base fracture as an unrecognized complication and to evaluate the clinical and radiographic consequences of this complication.

**Patients and Methods**

Our institutional review board approved the present study. From January 2009 to December 2012, 230 patients (267 feet) underwent surgery (proximal chevron osteotomy and distal soft tissue release with or without Akin’s osteotomy) for symptomatic hallux valgus deformity performed by 1 surgeon (Y.U.P.). The indications for operative intervention were intractable pain isolated to the first or second MTPJ region associated with a hallux valgus deformity refractory to shoe modifications, nonsteroidal anti-inflammatory medications, and activity modifications. Of the 230 patients (267 feet), 32 (13.9%) (42 feet [15.7%]) were excluded from the present study. The reasons for exclusion were a short follow-up period (<1 year; 20 patients, 26 feet), a history of inflammatory arthritis (5 patients, 9 feet), a history of degenerative arthritis (4 patients, 7 feet), and trauma (3 patients, 3 feet). A total of 198 patients (225 feet) were included in the present study.

Of the 198 patients, an avulsion fracture of the proximal phalangeal base developed in 12 patients (12 feet) during the operation (distal soft tissue procedure, as evidenced by the immediate postoperative radiographs.) These patients were assigned to the fracture group. The remaining patients were assigned to the nonfracture group. The nonfracture group included 186 patients (213 feet) consisting of 7 (3.8%) males and 179 (96.2%) females, with a mean age of 51.7 (range 14 to 74) years. The patients were followed to observe whether these fractures united and whether degenerative changes developed at the first MTPJ because of this fracture. The mean follow-up period was 36 (range 12 to 72) months. All subjects in the 2 groups underwent weightbearing anteroposterior and lateral radiographs of the foot at initial presentation and the final follow-up visit.

To evaluate the clinical consequences, we used the American Orthopaedic Foot and Ankle Society (AOFAS) hallux metatarsophalangeal–interphalangeal scale preoperatively, immediately postoperatively, and at the last follow-up visit (10). We asked the patients about their satisfaction, and the responses were categorized as “very satisfied,” “satisfied,” “dissatisfied,” or “very dissatisfied.” We also checked for any symptoms such as pain or tenderness over the proximal phalanx base at the last follow-up visit.

For the radiographic assessments, foot anteroposterior and lateral weightbearing radiographs were taken preoperatively, immediately postoperatively, and at the last follow-up visit to measure the hallux valgus angle (HVA) and the first intermetatarsal angle. The HVA was defined as the angle formed by the intersection of the diaphyseal axes of the proximal phalanx and the longitudinal axis of the first metatarsal, determined by connecting the center of the first metatarsal head and the center of the proximal articular surface. The first intermetatarsal angle (IMA) was defined as the angle subtended by the lines bisecting the longitudinal axes of the first and second metatarsals. Degenerative changes of the first MTPJ were classified as follows: grade 1, mild sclerosis of adjacent surfaces of the joint; grade 2, narrowing of the cartilage space, in addition to sclerosis of surfaces of the joint; grade 3, narrowing of the cartilage space, with osteophytes and cystic changes; or grade 4, complete loss of the cartilage space, with an increase in the severity of sclerosis and cystic changes (8). All radiographs were analyzed by 3 observers, and the values were recorded in a computer database. Two observers were orthopedic foot and ankle specialists from 2 different institutions and 1 was a third-year orthopedic resident from another institution.

*Surgical Procedure*

The operative technique consisted of distal soft tissue release through a dorsal first web approach, excision of the medial eminence, plication of the medial joint capsule, and proximal chevron first metatarsal osteotomy. The distal soft tissue procedure included release of the adductor hallucis tendon from its attachment at the base of the proximal phalanx and fibular sesamoid, detachment of the fibular sesamoid-metatarsal ligament, and transection of the transverse metatarsal ligament and lateral capsulotomy. During capsulotomy, perforation of the lateral first MTPJ capsule was performed with several puncture wounds. Next, the lateral capsule was gradually torn and the capsular tissue stretched out with manual varus pressure on the hallux. (This could have led to the development of an avulsion fracture of the proximal phalanx.)

The proximal chevron osteotomy involved a separate medial incision, beginning at the proximal phalanx medially, continuing proximally along the medial border of the metatarsal, and ending at the metatarsocuneiform joint. The point of the apex of chevron osteotomy was marked at 1.3 cm distal to the metatarsocuneiform joint. Next, a 60° transverse chevron osteotomy was performed. The correction was then

accomplished by a combination of a lateral slide and tilt of the distal fragment, and the proximal fragment was pulled medially with a freer elevator. The osteotomy was then fixed with 2 medially placed 1.2-mm Kirschner wires, which ran from proximally to distally and from medially to laterally across the osteotomy and into the metatarsal head. Any medial overhanging edge at the osteotomy site was excised, and this bone was used to fill any medial gap. The Kirschner wires were left under the skin.

Next, the base of the proximal phalanx was exposed subperiosteally, and a medial closing wedge osteotomy was performed as reported by Akin (11). The cut was directed away from the articular surface to parallel the concavity of the base of the proximal phalanx, and a 1- to 2-mm wedge of bone was removed. The osteotomy closure was maintained with Kirschner wire fixation. The capsular incision was carefully imbricated with nonabsorbable sutures to hold the toe in the corrected position. Skin closure was performed with interrupted nylon sutures.

After surgery, a gauze wrap dressing was applied, taking care not to pronate the toe or force it into varus. The patients were allowed to ambulate wearing a postoperative shoe immediately after surgery with weight borne on the heel and lateral aspect of the foot. In addition, prompt active and passive MTPJ motion exercises were encouraged. The Kirschner wires were usually removed at 6 weeks postoperatively with the patient under local anesthesia. Subsequently, soft shoe wear was allowed. Postoperative radiographs were obtained immediately following the operation.

*Statistical Analysis*

All continuous variables are expressed in terms of the mean ± standard deviation. Some ordinal variables (satisfaction, degenerative changes) were expressed for each number of ranks. A nonparametric statistical analysis method (Mann-Whitney U test) was used to compare the 2 groups (fracture and nonfracture) with respect to the HVA, IMA, ROM of the first MTPJ, AOFAS score, satisfaction, and degenerative changes (Table). Statistical significance was accepted at *p* ≤ .05.

**Results**

No significant differences were found in age, follow-up period, HVA, IMA, ROM of the first MTPJ, AOFAS score, satisfaction, or degenerative changes between the 2 groups (Table). The incidence of observed avulsion fracture of the proximal phalanx was 5.3% (12 of 225 feet). The AOFAS score for the avulsion fracture group improved

**Table**

Comparison between the avulsion fracture and nonfracture groups (N = 225 feet in 198 patients)

| Variable              | Avulsion Fracture Group (n = 12) | No Fracture Group (n = 213) | <i>p</i> Value |
|-----------------------|----------------------------------|-----------------------------|----------------|
| Age (y)               | 57.8 ± 10.1 (38 to 71)           | 51.7 ± 12.7 (14 to 74)      | .136           |
| Gender                |                                  |                             | —              |
| Male                  | 0                                | 7                           |                |
| Female                | 12                               | 206                         |                |
| Follow-up period (mo) | 34.9 ± 17.9 (19 to 64)           | 36.4 ± 17.8 (12 to 72)      | .739           |
| HVA                   |                                  |                             |                |
| Preoperatively        | 36.8 ± 7.2 (26 to 50)            | 34.0 ± 8.5 (17 to 68)       | .205           |
| Final visit           | 10.0 ± 7.0 (2 to 25)             | 8.2 ± 5.1 (0 to 24)         | .443           |
| IMA                   |                                  |                             |                |
| Preoperatively        | 16.7 ± 4.0 (13 to 27)            | 14.7 ± 3.1 (7 to 23)        | .082           |
| Final visit           | 6.1 ± 2.1 (3 to 10)              | 6.0 ± 1.8 (0 to 12)         | .877           |
| First MTPJ ROM        |                                  |                             |                |
| Preoperatively        | 80.0 ± 3.0 (75 to 85)            | 79.8 ± 2.6 (70 to 85)       | .831           |
| Final visit           | 56.3 ± 8.6 (45 to 70)            | 60.5 ± 7.0 (50 to 75)       | .096           |
| AOFAS score           |                                  |                             |                |
| Preoperatively        | 49.1 ± 5.8 (39 to 61)            | 49.1 ± 5.7 (38 to 80)       | .991           |
| Final visit           | 89.7 ± 7.5 (67 to 95)            | 90.8 ± 4.4 (57 to 95)       | .901           |
| Satisfaction          |                                  |                             | .758           |
| 1                     | 7                                | 135                         |                |
| 2                     | 4                                | 60                          |                |
| 3                     | 1                                | 16                          |                |
| 4                     | 0                                | 2                           |                |
| Degenerative changes  |                                  |                             | .550           |
| 0                     | 9                                | 176                         |                |
| 1                     | 1                                | 30                          |                |
| 2                     | 2                                | 6                           |                |
| 3                     | 0                                | 1                           |                |
| 4                     | 0                                | 0                           |                |

Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society; HVA, hallux valgus angle; IMA, intermetatarsal angle; MTPJ, metatarsophalangeal joint; ROM, range of motion.

Data presented as mean ± standard deviation or number of patients.

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