Treatment of Advanced Stages of Hallux Rigidus with Cheilectomy and Proximal Phalangeal Osteotomy

Surgical Technique

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Based on an original article: *J Bone Joint Surg Am.* 2013 Apr 3;95(7):606-10.

Introduction

We believe that a combination of cheilectomy and proximal phalangeal osteotomy can be used successfully (with an 85% satisfaction rate¹) in patients with advanced hallux rigidus, including those in whom it is classified as Hattrup and Johnson² Grade III or as Coughlin and Shurnas³ Grade III or IV (extensive degeneration of the joint involving >50% of the articular surface).

Hallux rigidus (degenerative arthritis of the first metatarsophalangeal joint) has an unknown etiology, and proposed theories include trauma, an elevated first ray, an abnormally long first ray, and a genetic predisposition for flattening of the metatarsal head^{4,5}. Surgical management includes joint reconstructive procedures such as cheilectomy, metatarsal osteotomy, and phalangeal osteotomy as well as joint salvage procedures that include arthrodesis, interpositional arthroplasty, resection arthroplasty, and implant arthroplasty⁵⁻⁸. The authors of some studies have concluded that patients with Coughlin and Shurnas Grade-III or IV hallux rigidus, as determined with radiographic evaluation, should be treated with arthrodesis³.

In 1952, Bonney and Macnab described a dorsal closing wedge osteotomy of the proximal phalanx for early treatment of "hallux flexus" in adolescents⁹. Following this procedure in adolescents, Kessel and Bonney found a mean improvement of 39° in dorsiflexion; however, this improvement came at the expense of plantar flexion, which decreased from 50° preoperatively to 25° postoperatively¹⁰. Moberg later extended the indications for this osteotomy to the adult population as he described a functional transfer of plantar flexion to dorsiflexion¹¹. The procedure shifts the limited

motion dorsally by positioning the phalanx into a more dorsiflexed position¹¹.

In 2000, we began to employ a combination of cheilectomy and proximal phalangeal osteotomy in patients with Hattrup and Johnson Grade-III disease who otherwise would need an arthrodesis.

Cheilectomy and proximal phalangeal osteotomy is done in the following four stages.

Step 1: Surgical Approach

Begin with a dorsal approach to the first metatarsophalangeal joint and phalanx.

- Place the patient in the supine position.
- Exsanguinate the foot with an Esmarch bandage and leave the bandage wrapped securely over copious undercast padding (Webril) as a tourniquet at the ankle.
- Make a dorsal longitudinal skin incision from the interphalangeal joint to the middle of the metatarsal (Fig. 1).
- Mobilize the extensor hallucis longus tendon medially along with the dorsomedial cutaneous nerve.
- Mobilize the periosteum of the phalanx, the metatarsophalangeal joint capsule, and the periosteum of the neck of the metatarsal both medially and laterally.

Step 2: Cheilectomy

Remove osteophytes and the dorsal third of the first metatarsal head.

- Remove osteophytes on the proximal phalanx and the metatarsal head with a rongeur and remove any loose bodies from the joint.
- With an oscillating saw, remove the dorsal third of the metatarsal head in line with the shaft. Take care to avoid notching the metatarsal neck or removing too much of the head (Figs. 2-A and 2-B).

Step 3: Proximal Phalangeal Osteotomy

Perform a 3-mm dorsal-based closing-wedge osteotomy of the proximal phalanx.

- Place baby Bennett retractors on either side of the base of the proximal phalanx at the metaphyseal-diaphyseal junction to retract the periosteum and protect the extensor hallucis longus and nerve.
- Place a Kirschner wire from dorsal to plantar across the proximal phalanx, approximately 8 mm distal to the metatarsophalangeal joint, in order to determine the osteotomy location (Fig 3-A). Confirm the positioning with a lateral fluoroscopic image (Fig. 3-B).
- With an oscillating saw, cut the phalanx parallel to the joint surface extending just to, but not through, the level of the plantar cortex using the Kirschner wire as a guide.
- Make a second cut starting 1 to 2 mm more distally and angled so as to meet the first cut on the plantar cortex, thus removing a bone wedge measuring 3 to 4 mm in thickness dorsally due to the saw blade thickness (Fig. 4). The target amount of correction is 3 mm in all patients.
- Remove the wedge of bone and perform a slow osteoclasia of the plantar cortex. This can be facilitated by perforating the plantar cortex with multiple Kirschner-wire passes.
- Close the dorsal opening of the osteotomy and temporarily fix it with a Kirschner wire placed just medial or lateral to the projected course of the screw (Fig. 5).
- Place a 2.0-mm fully threaded cortical screw in lag fashion and countersink the head (Fig. 6).
- Remove the Kirschner wire and check the stability of the osteotomy site fluoroscopically (Fig. 7).

Step 4: Closure and Postoperative Protocol

Close the metatarsophalangeal joint capsule and skin.

- Close the periosteum and metatarsophalangeal joint capsule with a running 3-0 absorbable suture after irrigation.
- Release the tourniquet and achieve homeostasis.
- Wash the wound thoroughly, and close it with 4-0 Monocryl (poliglecaprone) and 4-0 nylon sutures. Apply a soft dressing.
- Allow the patient to walk immediately in a stiff postoperative shoe for four weeks, and then allow shoe wear as tolerated.
- At two weeks postoperatively, obtain radiographs, remove sutures, and start seated toe-raise exercises.
- At six weeks, allow the patient to resume unrestricted activities.

Results

We reviewed the results in eighty-one patients with advanced hallux rigidus who were treated with a combination of cheilectomy and proximal phalangeal osteotomy. The average age was fifty-five years (range, twenty-six to seventy-nine years) at the time of surgery, and the patients were followed for an average of 4.3 years (range, 2.2 to nine years). The average amount of degeneration of the articular cartilage of the first metatarsal head was estimated intraoperatively by measuring the extent of complete cartilage loss with a sterile ruler. It was determined to be 75% (range, 67% to 100%), indicating that all of these patients had advanced hallux rigidus.

Preoperative Grading of Hallux Rigidus

The standing preoperative radiographs revealed that all toes were classified as Hattrup and Johnson Grade III. With use of the Coughlin and Shurnas classification, thirty-one toes were classified as Grade III, and fifty toes exhibited a painful midrange of motion, classifying them as Grade IV. Postoperatively, all toes remained in the Hattrup and Johnson Grade-III category radiographically.

Clinical Examination and Scores

Maximum dorsiflexion of the great toe improved from a mean of 32.7° preoperatively to a mean of 59.7° at the time of final follow-up. This change of 27° was significant ($p < 0.05$). The mean American Orthopaedic Foot & Ankle Society (AOFAS) score

was 67.2 points preoperatively and 88.7 points at the time of final follow-up, a difference of 21.5 points ($p < 0.05$). Sixty-nine (85%) of the eighty-one patients were either satisfied or very satisfied with their procedure, and twelve patients (15%) were not satisfied. Eighty-four percent of the patients stated they would undergo the procedure again under similar circumstance, 15% stated that they would not, and one patient was unsure.

Radiographic Data

All osteotomy sites healed as demonstrated radiographically by three months. There were no malunions, and no patient exhibited a loss of or change in the position of the osteotomy. A comparison of preoperative and final postoperative radiographs showed continued loss of metatarsophalangeal joint space width with a mean decrease of 0.3 mm (range, -1.8 to $+0.6$ mm; preoperative mean: 1.2 mm; postoperative mean: 0.9 mm), measured at the center of the metatarsal head. Overall, two-thirds of our patients had a measurable postoperative decrease in metatarsophalangeal joint space width. A comparison of preoperative and final follow-up radiographs of the interphalangeal joint showed that only one patient had radiographic signs of interphalangeal joint arthritis preoperatively and no signs of interphalangeal joint arthritis were found on postoperative radiographs of any other patient.

Complications

Four patients underwent subsequent arthrodesis of the first metatarsophalangeal joint, one at one year, two at three years, and one at seven years postoperatively.

What to Watch For

Indications

- Advanced hallux rigidus.

Contraindications

- Patients with $<10^\circ$ of metatarsophalangeal plantar flexion from neutral.

Pitfalls & Challenges

- Laceration of the extensor hallucis longus is possible with use of the oscillating saw.
- Removing too much bone from the proximal phalanx may lead to a metatarsophalangeal dorsiflexion (extension) deformity. Intraoperative evaluation just before beginning the osteotomy can help to avoid this by ensuring that the metatarsophalangeal joint

can be plantar flexed at least 20° ; if there is $<20^\circ$ of plantar flexion, remove less bone or abort the osteotomy. The minimum plantar flexion required postoperatively that one should strive for after the osteotomy is closed is 0° .

- A complete osteotomy may occur due to penetration or fracture of the plantar cortex. A mini-locking plate or crossed Kirschner wires may be used to secure stability in such cases.
- Failure to countersink the screw head may cause the head to be prominent; this may lead to extensor hallucis longus damage or metatarsal head wear and/or impingement.
- A screw that is too long may lead to flexor hallucis longus damage, while one that is too short may lead to loss of fixation postoperatively. Ideally, the screw is placed so that it crosses the osteotomy site at 45° as seen on the lateral radiograph, and the tip of the screw exits the cortex just medial or lateral to the flexor hallucis longus.

Clinical Comments

A joint-sparing procedure (cheilectomy and proximal phalangeal osteotomy) has many advantages over a joint-sacrificing procedure (fusion), including immediate walking in a stiff-soled postoperative shoe, the potential to participate in sports activities that require dorsiflexion of the first metatarsophalangeal joint, and the ability to wear shoes with different heel heights. Furthermore, our union rate was 100% and the reported rate of nonunion after fusions of the first metatarsophalangeal approaches 15%^{8,9,12-14}. We believe that, when compared with metatarsophalangeal arthrodesis, the combination of cheilectomy and proximal phalangeal osteotomy provides the advantages of greater improvement in functional scores, more shoe-wear choices, and a quicker postoperative recovery.

Although we continue to perform arthrodesis of the first metatarsophalangeal joint in some patients with advanced cases (especially those with little or no motion and those over seventy years of age), we offer cheilectomy and proximal phalangeal osteotomy as an alternative to patients who present with high-grade hallux rigidus.

The biggest drawback of the procedure is that revision to a metatarsophalangeal fusion with a dorsal plate has the potential to be problematic. As the proximal phalanx is now extended more than normal, there is a tendency to fuse the ray in slight dorsiflexion when a plate that does not contour well to the proximal phalanx is used. We therefore first

stabilize the fusion with one or two lag screws before placing the plate, which is contoured by hand to securely bridge the fusion site. In the four patients in our study who underwent conversion to a fusion following a failed cheilectomy and osteotomy, all joints fused.

We have been pleasantly surprised at the longevity of these clinical results even in severe cases of advanced hallux rigidus. All of our patients exhibited marked (at least 67%) loss of articular cartilage on the metatarsal head, yet they responded well to a joint-sparing procedure. We believe that the

radiographs in the majority of cases will continue to exhibit signs of worsening osteoarthritis as this operation does not resurface the joint and thus progressive deterioration of the joint space over time is inevitable.

This surgical technique provides a reasonable option for patients with advanced hallux rigidus who do not wish to undergo a fusion of the first metatarsophalangeal joint. The operation is reproducible, the osteotomy is not technically demanding, and the procedure allows for a relatively early return to weight-bearing activities.

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Disclosure: None of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of any aspect of this work. None of the authors, or their institution(s), have had any financial relationship, in the thirty-six months prior to submission of this work, with any entity in the biomedical arena that could be perceived to influence or have the potential to influence what is written in this work. Also, no author has had any other relationships, or has engaged in any other activities, that could be perceived to influence or have the potential to influence what is written in this work. The complete **Disclosures of Potential Conflicts of Interest** submitted by authors are always provided with the online version of the article.

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Figures

Fig. 1

A dorsal longitudinal incision extending from the interphalangeal joint to the middle of the metatarsal is made.

Fig. 2-A

The position of the oscillating saw before removal of dorsal osteophytes and the dorsal third of the metatarsal head. Care should be taken to avoid notching the metatarsal neck or removing too much of the metatarsal head.

Fig. 2-B

The metatarsal head after removal of dorsal osteophytes and the dorsal third of the metatarsal head.

Fig. 3-A

A Kirschner wire marks the proposed osteotomy location.

Fig. 3-B

A lateral fluoroscopic image confirms the position of the Kirschner wire.

Fig. 4

A sterile ruler demonstrates that 2 mm of bone has been removed from the dorsal aspect of the proximal phalanx.

Fig. 5

The osteotomy site has been closed and is being held with a Kirschner wire, placed just medial or lateral to the projected course of the screw.

Fig. 6

A 2.0-mm fully threaded cortical screw is placed in lag fashion, and the head is countersunk.

Fig. 7

Intraoperative fluoroscopic image showing the stability of the osteotomy site after screw placement.

Fig. 1

Fig. 2-A

Fig. 2-B

Fig. 3-A

Fig. 3-B

Fig. 4

Fig. 5

Fig. 6

Fig. 7