

THE KELLER BUNIONECTOMY

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William Keller produced two articles, the first appearing in 1904 and the second in 1912, describing a bunionectomy which essentially resected the medial eminence of the first metatarsal head and the base of the proximal phalanx for treatment of hallux valgus deformity. Due to the ensuing popularity, this procedure became known as the Keller procedure. William J. Keller was not the first to describe the procedure. Reidel as early as 1886 and Davies-Colley in 1887 had previously described similar procedures.

Keller's original technique utilized a 2" incision. The medial exostosis was removed by the use of a rongeur. The base of the proximal phalanx was freed dorsally, medially, laterally, and plantarly preserving the periosteum and then removed using a Gigley saw. The preserved periosteum/capsular tissue was used to cover the exposed surface of bone.

The Keller procedure has retained a great deal of its original popularity over the last 80 years. Accordingly, there are strong proponents and strong critics of this technique. It is primarily used today in the United States as a joint destructive type procedure for the correction of a painful, dislocated, or arthritic joint. In 1959, DuVries indicated that patients "with disability (following the Keller) represent a larger group than from any other operation employed for alleviation of this deformity." However, Wrighton indicated that "those who perform the Keller operation do not need to report their results, because they know them to be good."

The major complications associated with the Keller procedure fall into two distinct categories (Table 1). The first is associated with disruption of the intrinsic muscular function. With resection of the proximal phalangeal base the insertion of the four intrinsic foot muscles (abductor hallucis, adductor hallucis, flexor hallucis brevis, and the extensor hallucis brevis) is generally eliminated. The tibial and fibular sesamoids are intricate parts of the flexor hallucis brevis, the adductor and abductor hallucis muscles. The sesamoids will retract proximally with the complete disruption of their insertion of the intrinsic muscles. This can lead to loss of the plantar purchase, an unstable or floppy flail hallux, recur-

rence of the abduction deformity of the hallux, dorsal dislocation of the hallux and/or increased lateral weight transference leading to metatarsalgia, keratosis, or stress fractures of the lesser metatarsals.

TABLE 1

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1. Disruption of the intrinsic muscle function
 - A) loss of plantar purchase of the hallux
 - B) flail hallux
 - C) recurrence abduction deformity
 - D) hallux elevatus
 - E) keratosis or painful metatarsalgia sub second
 - F) lesser metatarsal stress fracture
 2. Excision of proximal phalangeal base
 - A) shortened hallux
 - B) painful pseudoarthrosis with base contacting metatarsal head
 - C) painful first metatarsal cuneiform joint
 - D) failure or revision rate (approximately 5%)

TABLE 2

**COMPLICATIONS OF THE IMPLANT ARTHROPLASTY
OF THE FIRST METATARSOPHALANGEAL JOINT**

1. Technique related complications
 - A) prolonged edema and disability
 - B) increased incidence of infection
 - C) dislocation
2. Inherent potential complications
 - A) bony overgrowth
 - B) breakage or absorption of implant
 - C) limitation of range of motion
 - D) tissue reactivity to silastic or sharding
 - E) more traumatic
 - F) limited to patients with good bone stock
 - G) progressive degeneration
 - H) failure or revision rate of greater than 10%
 - I) procedure limited in previously infected area

The second set of complications can be due to the amount of bone resected from the base of the proximal phalanx. Excessive osseous resection at this level will lead to a significantly shortened hallux which will be cosmetically unacceptable. There will always be some shortening of the hallux, but both Hardie and Clapman, and Ganley have indicated that the large majority of patients have a great toe that is longer than the second. Inadequate resection can lead to painful pseudoarthrosis especially if no interposition of soft tissue is utilized to cover the head or the base of the proximal phalangeal stump.

However, with all these possible complications, Ganley reports a failure or revision rate to be only 5%. The advantages of the procedure advocated by its proponents include a patient group that is generally happy with the overall results of the surgery. The painful first metatarsophalangeal joint symptoms essentially resolve. The loss of the intrinsic and decreased purchase power has not been significantly problematic in the patient population that is many times propulsive preoperatively. Increased lateral transference of weight bearing is a complication that can occur in almost any bunion procedure and needs to be controlled by biomechanical means. The flail toe, or loss of intrinsic function may not lead to dorsal dislocation or recurrence, if the extensor hallucis longus tendon is lengthened and the extensor hallucis brevis is resected. The medial capsular tissue can be reinforced with tendon or fascial graft according to Ganley, or reattached to the stump of the proximal phalanx via drill holes according to McGlamry. Postoperative splintage of the deformity is utilized for an adequate period of time (a minimum of 6 weeks) to help maintain the correction. The loss of the intrinsic muscle function may be necessary for pain relief, for correction due to the longstanding deformity, and due to any coexistent limitation of dorsiflexion.

In the early 1970's, silastic implant replacements were introduced in an attempt to eliminate some of the complications of the Keller procedure. There were hemi-implants, angulated hemi-implants, and total implants. These primarily were utilized in an attempt to maintain length and preserve some degree of purchase power and function of the hallux. Initially, they were thought to be able to resist deformity or re-deforming forces. It quickly became known that the silastic implants were primarily spacers and could not really resist deforming forces for any length of time. In addition, the implants themselves created an additional set of complications (Table 2).

There have been a number of modifications of the Keller operation in an attempt to avoid some of the potential complications (Table 3). A variety of contradictory reports exist regarding the transfixation of the first metatarsophalangeal joint to maintain separation or a space.

There are a variety of ways to interpose soft tissue, most of which are effective. However, adequate bone must be resected and the raw bone or cartilage must be completely covered with the soft tissue of choice for the best results. Ganley stressed the need for lengthening the extensor hallucis longus tendon to prevent dorsal dislocation or recurrent abduction deformity when the insertion of the intrinsic muscles had been eliminated. McGlamry stressed the need for re-establishing intrinsic muscle activity to the hallux and recommended drill holes plantarly to reattach the intersesamoid ligament, thereby re-establishing the force of the flexor hallucis brevis. He also emphasized re-attaching the medial capsular flap to the stump of the proximal phalanx via drill holes. Ganley on the other hand reinforced the medial structures with a tendon graft from the extensor hallucis brevis. The long flexor tendon of the hallux has also been reattached to the stump of the proximal phalanx to give more propulsive power to the hallux. Fusion of the first metatarsophalangeal joint leads to the ultimate stability. However, it also leads to lack of motion and will often cause difficulties in women with different heel heights and in men if they are very active in sports, or have a job that requires bending and squatting.

Finally, the synthetic joint implants have gained a great deal of popularity in the last 20 years. However, now we are seeing some of the complications of long term use and a higher incidence of revision or failure being necessary. In some European quarters, it is recommended that the implants be removed after 2 years in an attempt to avoid later complications, yet the temporary use prevents severe shortening which may occur if the implant were not used at all.

TABLE 3

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1. Distraction of the joint by internal fixation (K-wire, staple)
 2. Interposing capsular tissue in a variety of manners
 3. Lengthening of the extensor hallucis longus tendon
 4. Re-anastomosis of the sesamoidal ligament
 5. Re-attachment of the intrinsic muscles to the proximal phalangeal stump
 6. Tenodesis of the flexor hallucis longus to the remaining proximal phalanx
 7. Fusion of the first metatarsophalangeal joint
 8. Spacing via synthetic joint implant
 9. Reinforcing the medial capsular tissue by a variety of means

In 1988 a review of the Keller bunionectomy was undertaken at Hillside Hospital. This was a retrospective study done to help us become more aware of the results one can expect from the Keller procedure. Between 1984 and 1986 approximately 36 Keller arthroplasties were performed in 31 patients. A complete preoperative evaluation including range of motion studies were performed. There were 29 females and 2 males with an average age of 69 years, ranging from 42 to 84. These figures include 9 patients with first metatarsophalangeal joint implants (2 hemi-implants and 7 totals). Of these 31 patients 3 were deceased, 5 had moved from the area and 9 did not respond to several written invitations, nor could they be reached by telephone. The remaining 14 patients agreed to be seen for evaluation of the surgical results. They represented a total of 16 Keller procedures. Prospective data on these patients included preoperative symptoms, clinical appearance, quantitative and qualitative ranges of motion and associated lesions. Roentgenographic measurements (intermetatarsal angle, hallux abductus angle, relative metatarsal length, first metatarsal declination, tibial sesamoid position) were also available. As some individuals did not completely fulfill the criteria for the study, the series proved to be smaller than originally anticipated.

The follow up examination was performed on average at 38 months and ranged from 29 to 52 months after the initial surgery. The operations were performed by a total of 7 podiatric surgeons. The typical procedure based upon operative reports included 1) dorsal medial incision, 2) T or U capsulotomy, 3) resection of 1/3 to 1/2 the proximal phalanx, 4) capsular closure over the metatarsal head, 5) lengthening of extensor hallucis longus, 6) no reattachment of the flexors, 7) Lawrence total implant in 5 of the 16 feet evaluated.

The patients were evaluated objectively and subjectively utilizing standard forms. They were given a questionnaire to rate their cosmetic result, present activity level, amount of discomfort, and their rating of the overall result. The independent evaluator (JS) performed a biomechanical range of motion testing which included resting position, assisted dorsiflexion, unassisted dorsiflexion, and assisted plantar flexion. He also reviewed the quality of motion, tracking or tract bound crepitus, and symptoms with range of motion. The objective form involved measuring the length and alignment of the hallux, the scar, toe purchase, activity level of the individual, and their discomfort.

RESULTS

The total range of motion of the first metatarsophalangeal joints decreased postoperatively from an average of 66 degrees to 52 degrees with an average loss of dorsiflexion of 7 degrees. The hallux abductus angle was reduced an

average of 20 degrees. The tibial sesamoid position was usually improved by unit.

The remaining stump of the proximal phalanx was in much closer proximity to the first metatarsal head when implants were not used. The distance between phalanx and the metatarsal measured without an implant averaged 3.3 mm, whereas it was approximately 10 mm. when implants were utilized. Substantial shortening of the hallux was seen in 73% of those cases where an implant was not used, but in none of the cases where implant arthroplasty was performed. Rotational or angulation abnormalities of the hallux were observed in 70% of the cases.

Radiographically the intermetatarsal angle decreased an average of 2.9 degrees (excluding the 1 case where a base wedge osteotomy was performed). Only one patient complained of a painful scar postoperatively. However, three patients were found to have one of the following: hypertrophic scar, discoloration of the scar, and numbness along the incision site. Despite these findings, each of the patients was satisfied or extremely satisfied with their surgical outcome.

Hallux purchase was found to be good to fair in 60% of the cases. In 6 feet, or 40% of the cases, the hallux did not purchase the ground on full weight bearing and the result was rated as poor.

Regardless of the inadequacies perceived by the observer, overall patient satisfaction with the surgery was 84%. Only 2 patients were either dissatisfied or extremely dissatisfied with their surgical result. Both these patients were among the three that experienced serious postoperative complications. Patient number 3 had a cerebrovascular accident postoperatively from which he failed to recover and is now non-ambulatory. Patient number 7 developed a hallux malleus bilaterally resulting in severe discomfort and pain caused by irritation from the shoes. Patient number 14 developed osteomyelitis postoperatively requiring a second surgery to debride additional portions of the proximal phalanx. This resulted in excessive scarring and fibrosis with resultant limitation of motion.

Of the 5 total Lawrence implants, none of them showed significant shortening. There was one that demonstrated a recurrence of the hallux abducto valgus. Three of the 5 were either extremely satisfied or satisfied. Of particular note, purchase power was good in 1, fair in 3 and poor in 1. First metatarsophalangeal joint range of motion increased in 3 of the 5 total implant patients, whereas without the implants the first metatarsophalangeal joint range of motion generally decreased. None had a painful range of motion.

SIGNIFICANT FINDINGS

1. Only 3 of the 16 procedures resulted in increased motion of the first metatarsophalangeal joint and these 3 were total Lawrence implants.
2. Mal position of the hallux was a very common finding (70%).
3. Purchase of the hallux was frequently decreased or lost in 73%.
4. Despite the results patient satisfaction remained high at 84%.
5. Hallux extensus or hallux malleus from overpowering the extensor hallucis longus muscle has been reported in the literature as one of the most common complications. In our series only 1 patient (bilateral procedures) developed this postoperative deformity. It appears that Ganley is correct when he recommends routine lengthening of the extensor hallucis longus in the Keller procedure to prevent this disabling complication.

CONCLUSION

Patient satisfaction with the Keller procedure was quite high at 84%. Favorable results in the patients' eyes must therefore be based on criteria other than recurrence or rotational or angulation deformities (70%), decreased range of motion (81%), and reduced hallux purchase power (73%). The high patient satisfaction rate seems to be because of the relief of pain and ability to wear "normal" foot gear. All but 2 patients had relief of pain postoperatively and all patients stated they were able to return to regular shoes after their surgeries.

Take home message:

The Keller arthroplasty is a joint destructive procedure designed primarily for relief of pain at the first metatarsophalangeal joint. Patient selection and preoperative patient expectations generally will lead to a very satisfactory result. The procedure should be used in the elderly with degenerative joint changes and impaired function of the first metatarsophalangeal joint. If utilized for hallux limitus it must be noted that generally in the long term, range of motion will not be increased although painful motion may be eliminated. Therefore, the use of the Keller procedure in a younger hallux limitus or rigidus patient must be done with caution. The patient and the surgeon should be aware that angulation, rotation, and shortening are common following this procedure. Furthermore, some loss of purchase power is to be expected. However, none of these complications seemed to interfere with the patients ability to wear regular shoes or perform their daily activities. Suturing the short or long flexors to the proximal phalangeal stump may increase the purchase power of the hallux postoperatively. This was

not done routinely in our series. However caution should be given to reattaching the short flexors in the face of limited dorsal range of motion. The Keller procedure has passed the test of time when the appropriate patient and realistic expectations are identified preoperatively.

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