

Revision of Failed Keller Arthroplasty with Distraction Bone Block Arthrodesis

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Abstract: The Keller arthroplasty is a common surgical procedure indicated for end stage hallux limitus and hallux rigidus in the senior population. The Keller procedure helps to provides correction and a reduction in pain to allow the patient to return to activity faster. The recovery period is much shorter and less complicated especially when compared with the first metatarsophalangeal joint (MTPJ) arthrodesis and implant arthroplasty. Over the years, the Keller arthroplasty has fallen out of favor due long-term complications, functional impairment of biomechanics of the great toe, and difficulties in salvaging failures. Salvaging options are limited due to the bone deficit created by the Keller arthroplasty and generally consist of first MTPJ arthrodesis with bone graft/filler. The purpose of this article is to present a case study of a 66-year old female who underwent a distraction bone block arthrodesis after failed keller arthroplasty about 8 months prior.

Key words: hallux rigidus, keller arthroplasty, bone block arthrodesis, patellar wedge graft

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The Keller arthroplasty was first described in 1904, by William L. Keller and was most commonly used for hallux valgus deformities. Over the years, the procedure has often been used in senior patients (>60) with advanced hallux valgus or hallux rigidus with arthrosis.¹ The procedure consists of removing the base of the proximal phalanx of the hallux, the medial eminence of the first metatarsal, as well as a lateral soft tissue release. The purpose of this procedure is to correct the bunion deformity as well as allow the first metatarsal phalangeal joint (MTPJ) to be put through range of motion without pain or crepitus. Although the Keller arthroplasty is often successful, it has fallen out of favor due to long term complications, functional impairment of first ray biomechanics, and difficulties in salvaging failures.²

There are many complications associated with the Keller arthroplasty reported in the literature. The most common complications associated with the procedure include first ray instability, transfer metatarsalgia, “cock up” deformity, excessive shortening of the toe, and recurrence of the deformity. Recurrence is often associated with poor correction of the intermetatarsal angle or with excessive shortening of the toe.³ When these complications require salvage surgery, options are limited due to the bone deficit created at the base of the proximal phalanx.⁴ The literature is scarce in evaluating different salvage techniques, however, salvage arthrodesis using bone graft seems to be the most widely accepted procedure available.

The purpose of this article is to present a case study of a 66-year old female who underwent a distraction bone block arthrodesis after failed keller arthroplasty about 8 months prior.

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Case Study

66-year-old female with past medical history significant for hyperlipidemia, hypothyroidism, and vitamin D deficiency presented to clinic with complaint of right 2nd toe pain. About 8 months prior, she underwent a right Keller arthroplasty and cheilectomy for hallux rigidus. After about 3 months, she started to develop painful deviation of her right 2nd toe but denied pain to her right 1st MTPJ. The pain seemed to improve slightly when she wore her custom orthotics but she denied any other remedies. She was unable to tolerate the pain any longer and opted for surgical correction.

Physical exam was notable for tenderness to palpation of her right sub-2nd metatarsal head with fat pad atrophy and callus formation. Pain was also elicited on range of motion of the 2nd MTPJ. Visually, there was medial deviation of the 2nd digit towards the hallux with claw toe contracture (reducible). Negative Lachman's test. Instability of the right first MTPJ.

Weightbearing radiographs were obtained of both feet for comparison and surgical planning. On the AP, the right foot x-ray reveals where the Keller arthroplasty was performed. Only a portion of the proximal phalanx remains and there is residual first MTP arthritis and a slightly shortened Hallux compared to the contralateral film. There is also a slightly lateral deviation of the 2nd metatarsal with mild subluxation of the 2nd digit medially. (Figure 1). On the lateral view of the right foot there is extension of the 2nd proximal phalanx on the 2nd metatarsal as well as flexion at the PIPJ and DIPJ indicating a claw-toe deformity of the right 2nd toe.



Figure 1. Anterior-posterior (AP) radiograph of bilateral feet revealing previous Keller arthroplasty (R) with medial subluxation of the 2nd digit at the 2nd MTPJ.



Figure 2. Lateral radiograph of the right foot revealing 2nd digit claw-toe deformity.

Due to the previous Keller arthroplasty one year prior, the patient's right first ray had become unstable causing transfer metatarsalgia as well as medial deviation of her 2nd digit towards the hallux. It was explained in detail to the patient that in order to correct her right 2nd digit deformity, the instability of the first ray would also have to be addressed to correct the root of the problem. The patient agreed and opted for surgical intervention due to continuous pain to her right 2nd digit as well as exhausted conservative methods. The patient was consented for a bone-block arthrodesis of the right first MTPJ using a patellar wedge graft as well as 2nd digit IPJ fusion and Weil osteotomy of the 2nd metatarsal.

Pre-operatively the patient was given a popliteal nerve block to the right leg for pain control. The patient was placed under general anesthesia for the procedure and given 2-grams Ancef. A tourniquet was applied to the right thigh and set to 300mmhg. The foot was prepped in the normal sterile fashion and time-out was performed.

First, attention was directed to the distal anterior-medial tibia for collection of bone marrow aspirate (BMA). A small 1-2 cm incision was performed with care was taken to avoid the saphenous nerve and bluntly dissected with hemostats to the level of bone. Insertion of a trocar needle into the distal tibia was performed. Using the BMA cannula assembly, about 5-10cc of BMA was obtained and set aside for use later.

Attention was then directed to the right first MTPJ where a dorsal medial incision was made from the dorsal IPJ of the hallux to just proximal to the first MTPJ. Dissection was performed in the normal fashion to expose the first MTPJ and previous Keller arthroplasty site. The remaining joint capsule was

noted to be thick with mild fibrosis circumferentially around the joint. The remaining articular cartilage of the first MTPJ was noted to have significant degenerative changes with erosions and osteophyte formation. The base of the proximal phalanx was absent, and the proximal shaft was noted to have cystic changes. (Figure 3)



Figure 3: Intra-operative image of previous keller arthroplasty with degenerative and cystic changes of the remaining proximal phalanx and first metatarsal head.

Once the joint was exposed, the base of the remaining proximal phalanx and the head of the metatarsal were prepared using a cup and cone type reaming system. The patellar wedge graft was also prepared this way and hydrated in the bone marrow aspirate collected earlier. The joint was flushed with normal saline and the patellar wedge was placed in between the head of the metatarsal and base of the proximal phalanx. The toe was placed in neutral rectus alignment with 5-10 degrees of dorsiflexion “built in” at the arthrodesis site.

The graft was temporarily fixated with multiple K wires. A headless compression screw was inserted from the distal aspect of the proximal phalanx and directed proximally through the bone graft and into the head of the first metatarsal. After compression was obtained, a Y type dorsal locking plate was positioned over the remaining portion of the proximal phalanx, bone graft, and distal first metatarsal. Next, multiple 2.7mm fully threaded cortical locking and non-locking screws were then used to secure the plate and the fusion site. Good apposition of the bone with the graft site was noted and excellent compression was obtained. (Figure 4)

Next, attention was directed to the dorsal aspect of the 2nd MTPJ. Dissection was performed down to the level of the 2nd MTPJ as well as the 2nd PIPJ. The 2nd metatarsal osteotomy was performed with a micro sagittal saw from dorsal distal to plantar proximal at the distal meta-diaphyseal region. The distal capital

fragment was translated 2-3 mm dorsally and fixed with a 2.5 mm cannulated headless compression screw. Finally, the medial and lateral collateral ligaments at the proximal interphalangeal joint were released. The head of the proximal phalanx and base of the middle phalanx were resected with a micro sagittal saw and fixated with a retrograde 1.6 mm intramedullary K-wire to stabilize the 2nd toe. The 2nd digit was then placed in a neutral rectus position at the level of the 2nd MTPJ and a 1.6 mm K-wire was driven in a retrograde fashion across the second MTPJ in the 2nd metatarsal. The distal portion of the K-wire was then bent and capped.



Figure 4. Intra-operative image of the first MTPJ bone block arthrodesis with a dorsal Y type plate and compression screw fixation. Second metatarsal weil osteotomy with headless compression screw fixation. Second PIPJ arthrodesis with K-wire fixation.

All incisions were then flushed with copious amounts of saline, closed, and the foot was placed in a modified Jones compression dressing with a short leg splint. Patient was taken to PACU and follow up scheduled for one week. Patient was instructed to remain non-weightbearing to the operative limb and to keep the dressing clean, dry, and intact until follow up appointment

Post-operative course as follows:

- NWB in a modified jones compression with short leg splint x 1 week
- Transition to a short leg boot and remain NWB
- 2 weeks: Sutures removed
- 4 weeks: Pin removed from 2nd IPJ fusion site

- 8 weeks: WB as tolerated in short leg boot with buddy splinting of the 2nd digit to the 3rd.
- 3 months: WB as tolerated in stiff sole shoe

At two weeks follow-up, the patient was doing well with pain well controlled. The incision sites were well coapted. Residual soft tissue swelling was noted. The sutures were removed at this time and patient was to remain NWB in a short leg boot.

At four weeks follow up, the patient related substantial improvement in pain and swelling to the surgical site. Radiographs were performed at this time. All hardware is intact with good position of the first MPTJ fusion site as well as the second PIJP fusion site. Mild diastasis noted to the distal first MPTJ fusion site is noted between the base of the proximal phalanx and the patellar wedge bone graft. (Figure 5). Pin was removed from the 2nd IPJ fusion site at this time.

At 8 weeks follow up, the patient had little to no pain in the 2nd toe or fusion site and started transitioning to WB as tolerated in a short leg boot with buddy splinting of the 2nd digit to the 3rd in order to maintain good alignment of the 2nd toe. Patient did complain of some pain sub-3rd metatarsal at the time.

At 3 months follow up, the patient was pain free from the first and second digits of the right foot and transitioned to WB as tolerated in a stiff sole shoe. Patient was still complaining of slight tenderness sub-3rd metatarsal head. Radiographs were performed at this visit. All hardware was intact and alignment of the first and 2nd digits was maintained. There seemed to be some residual gapping to the distal first MTPJ fusion site, only slightly improved from the 2-week post-operative imaging. At this time, a bone stimulator was suggested but patient denied because it was not covered by insurance.



Figure 5: AP view right foot at 2 weeks post-operative. Hardware intact, good neutral alignment of the 1st MPTJ and 2nd PIJP arthrodesis sites. Slight gapping to the distal first MPTJ fusion site



Figure 6: AP view right foot at 3 months post-operative. Hardware intact and alignment maintained. Mild gapping to the distal first MTPJ arthrodesis site.

After 6 months follow up, patient was doing well without pain to the right foot. On radiograph evaluation, the non-union remained but was asymptomatic per the patient. The decision was made to leave it alone and have the patient follow up in one year for re-evaluation.

Discussion

Failed resection arthroplasty of the first MTPJ, such as the Keller procedure, creates a challenging situation for both the patient and the surgeon. Often the resulting deformities created by a failed resection arthroplasty can be more taxing on the patient than the original deformity itself.⁴ A few of the complications that can arise such as first ray instability, transfer metatarsalgia, “cock up” deformity, excessive shortening of the toe, and recurrence of the deformity are often recalcitrant to conservative methods and require surgical correction.³ The literature suggests that the extent of the resection of the proximal phalanx of the hallux dictates functional outcome. Most authors agree that removing between one-third to one-half of the proximal phalanx leads to ideal functionality with less recurrence rates.⁵ By resecting less than one-third of the bone, there is an increased risk of insufficient decompression at the first MTPJ, leading to recurrence. By resecting more than one-half of the proximal phalanx, the result is often an unstable toe leading to first MTPJ instability. With decreased stability of the first MTPJ, excessive loads are then placed on the 2nd/3rd MTPJs resulting in transfer metatarsalgia. This can also lead to medial deviation of the 2nd and 3rd digits towards the hallux creating a cross-over deformity. There is also evidence to suggest that detachment of the flexor hallucis brevis tendon may result in cock-up toe deformity.⁵ Modifications have been made to this procedure to help minimize these deformities, however, poor surgical technique and surgical planning dictate that these consequences still arise.

In the setting of first MTPJ instability as a result of resection arthroplasty, the only widely accepted salvage procedure is first MTPJ arthrodesis.⁶ At the expense of mobility, a first MTPJ fusion can successfully address first MTPJ instability, poor alignment, as well as

transfer metatarsalgia. One study by Machecek et al, looked at salvaging Keller resection arthroplasty with either first MTPJ fusion (A) or repeat Keller arthroplasty/ soft tissue release (B). Twenty-eight patient underwent first MTPJ fusion in group A vs twenty-one patients who underwent either repeat Keller arthroplasty or soft tissue release with a mean follow up time of 36 months. They found that out of the twenty-eight patients who underwent first MTPJ fusion, twenty-six achieved complete fusion and twenty-three cases resulted in good to excellent results. In group B, only six of the twenty-one cases went on to good to excellent results. Eleven patients were dissatisfied, and valgus deviation and cock-up deformity had recurred in most patients at the time of follow up.

Although there is evidence suggesting that first MTPJ fusion can be a successful treatment for resection arthroplasty, implementing an intercalary bone graft to the arthrodesis site has been shown to decrease fusion success rates. Roukis looked at non-union rates in first MTPJ arthrodesis without intercalary bone graft and found that the overall non-union incidence was 5.4% (153/2,818) with symptomatic non-union occurring in 32.7% (50/153) of all non-unions or 1.8% total incidence.⁸ Myerson et al, looked at non-union rates in patients undergoing first MTPJ arthrodesis using bone graft for restoration of length. They found that arthrodesis occurred in 19/24 (71.9%) at about 13.3 weeks and non-union occurred in the remaining 5 individuals. Of the five remaining, 3/5 (60%) were symptomatic or 12.2% of the total incidence.⁹ By comparing the results, it appears that by incorporating bone graft into the first MTPJ arthrodesis site there is a 6x increase risk of non-union. The literature is scarce on this topic and further literature would be needed to validate this more precisely.

Conclusion:

Keller arthroplasty is a valid surgical procedure for the treatment of severe hallux valgus as well as hallux rigidus deformities. Often the procedure is successful and does not require subsequent intervention; however, when complications occur, they can be complicated. Although the literature suggests that bone block arthrodesis may result in lower fusion rates overall, it is often the only salvage procedure available after failed resection arthroplasty.

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