

# Phalangeal autologous bone graft for flail digit subluxation: A case report

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## Abstract

A 70-year-old patient was referred for a surgical opinion with a flail digit. Flail digit occurs as a result of over resection to the head of the proximal phalanx beyond the surgical neck and proximally into the shaft. The patient was complaining of a symptomatic right fourth digit (pain 7/10 on a Visual Analogue Scale) that had previously undergone two failed hammer toe surgeries resulting in symptomatic plantar hyperkeratosis with no history of ulceration or infection. The patient was surgically managed with autologous bone graft harvested from an adjacent digit biphalangic phalanx. Six months postoperative, the patient presented asymptomatic. Anatomical alignment, digital stabilisation and function were achieved. Full autologous graft consolidation was confirmed radiographically. Favourable patient-reported outcomes using the Manchester–Oxford Foot Questionnaire showed improvement in all domains. Currently, there is no published case study or description utilising our surgical technique to treat flail digit deformity.

## Keywords

Flail toe, bone graft, autograft, autologous graft, autogenous, allograft

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## Introduction

Hammer toe correction is challenging with potential complications including recurrent deformity, infection, vascular compromise, sensory deficit, persistent swelling, instability, malalignment, floppy and flail toe.<sup>1–5</sup> Myerson and Filipino<sup>1</sup> described the flail toe as a deformity present at the proximal interphalangeal joint and results due to over resection to the head of the proximal phalanx beyond the surgical neck and proximally into the shaft.<sup>2–4</sup> Iatrogenic flail toe lacks stability, structural integrity and motor control.<sup>4</sup> The rate of post-operative flail digit deformity following hammer toe surgery is not known.<sup>1</sup> Symptoms of flail digit may present as burning symptoms, lack of toe purchase, metatarsalgia and displease with aesthetic appearance of their digit.<sup>2,4</sup>

Multiple surgical procedures have been described to address flail toe deformity including syndactylisation, implant arthroplasty, distraction arthrodesis, osteocutaneous flap callus distraction, and digital amputation.<sup>1,3,4,6,7</sup> When salvage procedures are considered, their aims are to reduce pain, restore length and achieve stabilisation – long term.<sup>2,4</sup>

Syndactylisation involves anastomosing the affected flail toe to the adjacent toe for stability.<sup>8</sup> Implant arthroplasty and distraction arthrodesis restore toe length with the aim of achieving parabola and functional capacity of the digit through stabilisation and cosmesis.<sup>1–4</sup>

Autografts is the gold standard for bone graft material due to its osteoconductive, osteoinductive and osteogenic properties,<sup>9,10</sup> and no risk of disease transmission or host rejection.<sup>11</sup> However, major disadvantages of autograft harvesting from the lower extremity are donor site and related complications<sup>12,13</sup> including neurologic compromise, infection, pain and iatrogenic fractures.<sup>12,14</sup> Furthermore, graft failure and reduced/damaged vascularity and poor soft tissue coverage are also associated complications.<sup>2</sup> Another limitation is added surgical time and a separate incision.<sup>10</sup> Contrary to these limitations, a retrospective review by Mahan et al.<sup>2</sup> reported no complications to the donor sites, such as haematoma, residual pain, nerve injuries, stress fractures, infections or wound care.

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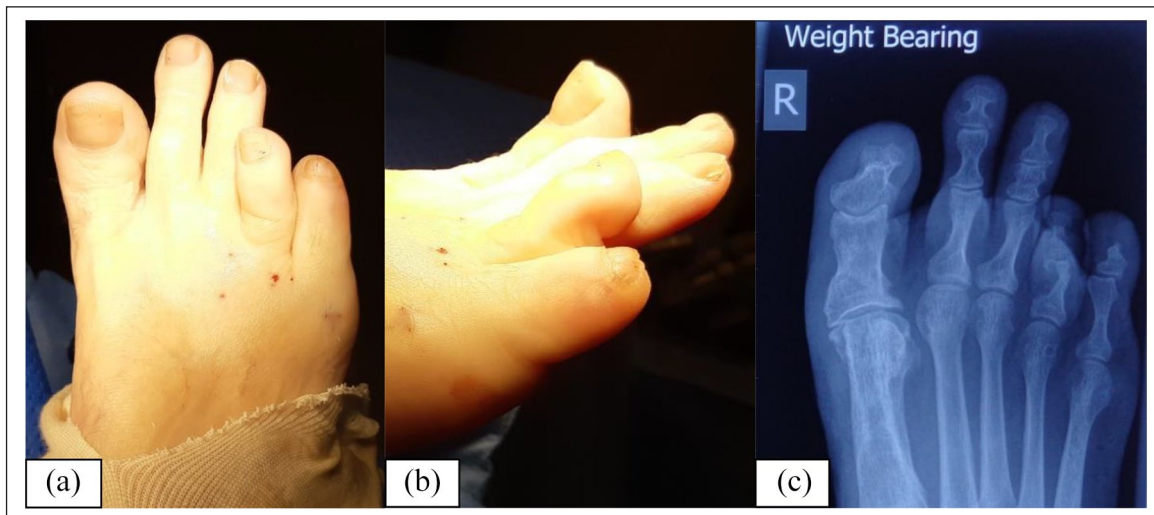
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**Figure 1.** (a) Dorsal plane view of the pre-operative flail deformity with an abnormal digital parabola. (b) Sagittal plane view of the pre-operative flail deformity. (c) Pre-operative radiograph demonstrating flail fourth digit and biphalangic fifth digit.

## Case report

### Presentation and examination

A 70-year-old patient was referred for a surgical opinion complaining of symptomatic right fourth digit that had previously undergone two failed hammer toe surgeries. Pain was 7/10 on a Visual Analogue Scale (VAS) with symptomatic plantar hyperkeratosis requiring periodic debridement with no history of ulceration or infection.

On clinical examination, the foot displayed abnormal digital parabola with a short fourth digit that was elevated at the metatarsophalangeal joint and hyperextended at the proximal interphalangeal joint (Figure 1(a) and (b)). No vascular and neurological complications were present.

Standing anterior posterior and oblique X-rays examinations displayed osteophytosis to the fourth proximal phalanx with subluxation. Uniform cortical thickness and trabeculae patterns were present to overall skeletal foot morphology. A biphalangic fifth digit was evident (Figure 1(c)) and chosen as an autologous bone graft. Biphalangic autologous bone graft was favoured due to its skeletal morphology not requiring time-consuming remodelling intraoperatively and thus reducing tourniquet time.

### Surgical technique

The procedure was undertaken under ankle block using ropivacaine hydrochloride 0.75% using ultrasound guidance. Patient was positioned supine with an ankle tourniquet and routine pre-operative measures taken.

A transverse incision was made over the fourth metatarsophalangeal joint and an extensor digitorum longus tenotomy and dorsal capsulotomy performed with plantarflexory tension to the digit until the metatarsophalangeal joint

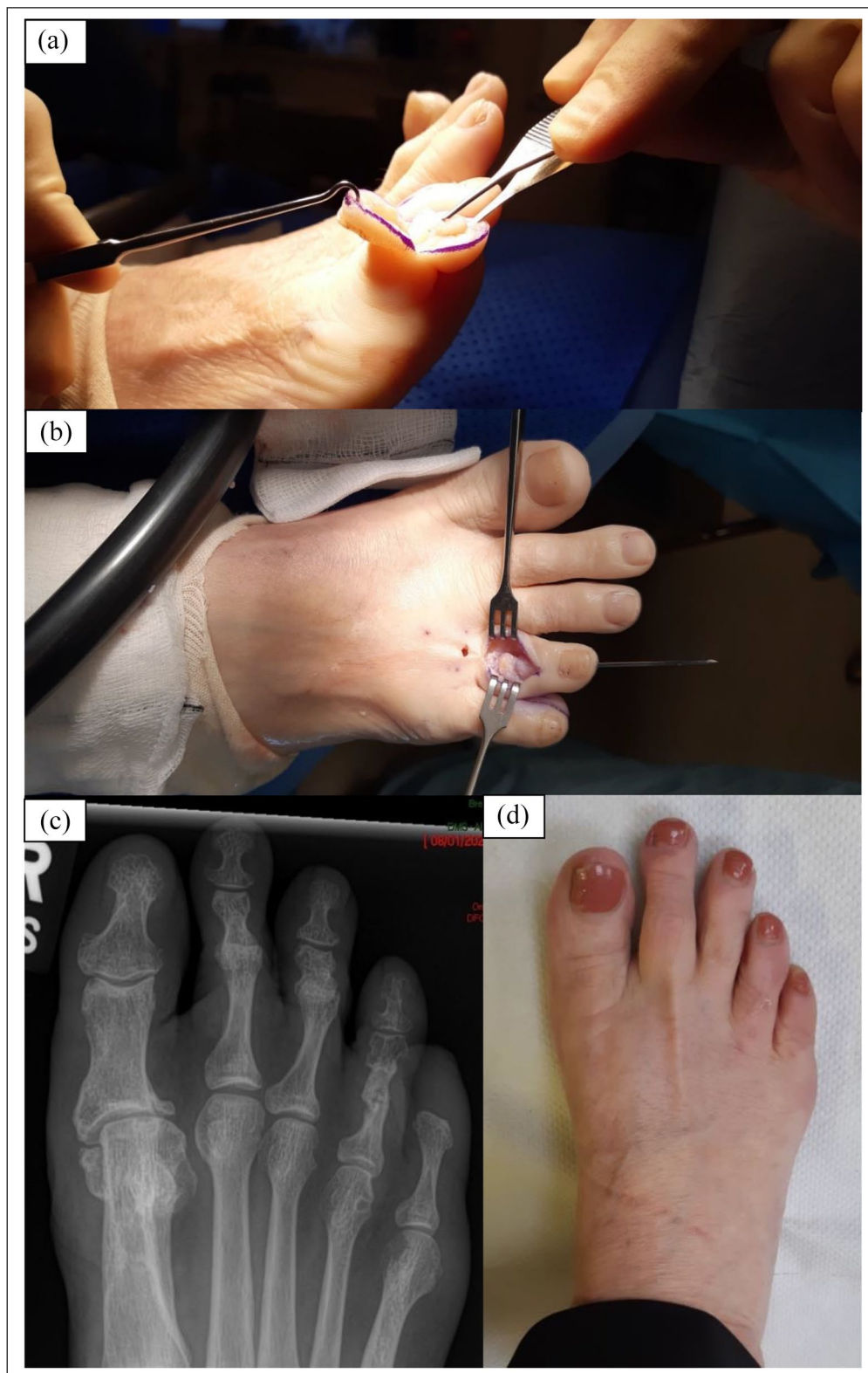
contracture was neutralised. A longitudinal incision was made over the 4th proximal interphalangeal joint and deepened to deep fascia layer and a linear incision made over the extensor digitorum longus tendon to bone. The capsule and periosteal layers were reflected off the distal proximal phalanx and base of the intermediate phalanx. Arthroplasty site was debrided of scar tissue and bone ends prepared for graft with power instrumentation. Graft length was determined by distraction of the digit ensuring an acceptable digital parabola.

A transverse linear incision was made over the apex of the fifth digit and deepened to bone and soft tissues reflected off the phalanx (Figures 2(a)). The biphalangic distal phalanx was disarticulated and enucleated.

The graft was prepared to fit as an inter-locking fragment cup and cone shape ensuring surfaces met with good apposition. The graft was introduced and interlocked and stabilised with antegrade and retrograde technique using 1.4 mm Kirschner wire (Figures 2(b)). Wounds were irrigated with saline and skin closure achieved using 4.0 Prolene®.

Following tourniquet deflation a standard sterile post-operative dressing was applied. Immediate postoperative weight bearing was allowed using a flat shoe with agreed rest and restrictions for the initial 3 days.

At 6 weeks, X-rays demonstrated fine trabeculae patterns crossing the margins of the graft indicating satisfactory osteoclastic resorption and osteoblastic activity. Kirschner wire was removed and further direction on daily splinting agreed using micropore surgical tape to achieve digital stabilisation. The patient remained in a rigid soled trainer for a further 6 weeks and advised to perform non-impact light duties only. At 6 months review, the X-ray showed full bone consolidation, fine alignment, and length of the 4th digit was achieved (Figure 2(c)).



**Figure 2.** (a) Biphalangic graft harvesting from fifth digit. (b) Dorsal view of stabilised inter-locking graft using smooth Kirschner wire. (c) Postoperative 6 months X-ray with full graft consolidation. (d) Postoperative aligned fourth digit in ground contact and parabola achieved.

On palpation, the digit was asymptomatic, and sensation was intact. When weight bearing, the digit maintained ground contact and alignment, and the patient was asymptomatic (Figures 2(d)). The fifth digit and site from which the graft was harvested from was asymptomatic and caused no concerns in footwear or during activity.

At 6 months postoperative, the patient noted their foot was 'much better' with no discomfort and a Patient Satisfaction Questionnaire-10 (PSQ-10) score of 98%. Pain (VAS) reduced from 7/10 to 0/10. The Manchester–Oxford Foot Questionnaire showed a significant reduction in all three domains (walking/standing: reduced from 85 to 0; social interaction reduced from 75 to 0; and pain from 90 to 0).

## Discussion

Multiple procedures have been described to manage iatrogenic flail digit with autologous or allograft technique.<sup>1–4</sup> The incidence of flail digit occurring after proximal interphalangeal joint arthroplasty is not reported.<sup>1</sup> There is limited evidence on how to best manage this condition, but there is significant variation in surgeon practices such as graft size, preparation and application method when managing flail toe.<sup>10–12</sup>

Distraction arthrodesis with both allograft and autograft technique have been shown to achieve good postoperative outcomes;<sup>1,2</sup> however, it is apparent with allograft procedures there is additional costs and safety issues.<sup>15</sup> Evidence suggests there is no statistically significant difference in bone healing when comparing allograft to autogenous graft in foot and ankle surgery.<sup>10</sup> When cases performed ipsilateral calcaneal grafts, this adds to tourniquet time and the physiological stress of two areas requiring healing as well as risks of complications; however, there were no reported complications to the graft sites.

The use of external Kirschner wire for temporary stabilisation was used to stabilise the graft,<sup>1–3</sup> but each study varied in their size of wires and instrumentation for their techniques for graft preparation and positioning. There was variation to report if the Kirschner wire was driven into the metatarsal head or not for added stability. This increases the risk of wire breaking although it was not reported in any of the studies to have occurred.

The risks of pin tract infection are present when using Kirschner wires and they occurred in some cases requiring K-wire removal,<sup>1</sup> although Mahan et al.<sup>2</sup> reported no infections using the same fixation technique. External fixation system was employed by Lamm and Andes.<sup>4</sup> Infection was reported; however, the total duration of external fixator use in each of the stages it was used may have increased the chances for this to have occurred. The use of Kirschner wires are the most commonly employed procedures and bioabsorbable implants or fixation may allow closed procedures to be performed without pin tract infection risks.

Further large-scale studies are required to identify the cause of reported complications and establish if they are associated with specific management techniques, surgeon factors or patient factors. The techniques for bone harvesting, preparation, and stabilisation requires attention. A standardised approach would benefit all surgeons who may surgically manage flail digit with an interpositional bone graft. Bioabsorbable fixation techniques may be considered in comparison to traditional Kirschner wire techniques.

## Conclusion

This case study is the first to report successful correction of flail toe using autologous bone graft from a biphalangic fifth digit phalanx achieving full-graft consolidation, symptomatic reduction, restored stability, function and alignment with no areas of symptomatic hyperkeratosis formation. The procedure for graft harvesting described in this case study is technically less demanding with the process of graft preparation simple in comparison to traditional graft techniques taken from larger bones of the foot.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

## Ethical approval

Our institution does not require ethical approval for reporting individual cases or case series.

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## Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

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