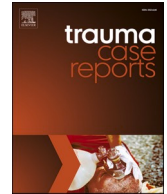




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Case Report

Iliac crest bone graft with radial forearm flap for thumb reconstruction: A case report

Dwi Purnomo Setyo Budi^{a,1}, Mochamad Sadabaskara^a, Filberto Budhy^{b,2}, Bontor Daniel Sinaga^{a,*}^a Department of Orthopaedics and Traumatology, MRCCC Siloam Hospitals Semanggi, Jakarta, Indonesia^b Department of Orthopaedic and Traumatology, Dr.Cipto Mangunkusumo Hospital, Faculty of Medicine Universitas Indonesia, Jakarta, Indonesia

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ABSTRACT

Traumatic thumb amputation is a serious injury that requires replantation or reconstruction. Toe-to-thumb transfers method have great survival and patient satisfaction in thumb reconstruction. Alternative method like Iliac Crest Bone Graft (ICBG) with flaps may help surgeons achieve maximum results. A 32-year-old male presented with occupational traumatic right thumb amputation. After initial debridement and K-wire installation, the thumb became necrotic. An ICBG with radial forearm flap was performed after the patient denied a toe-to-thumb transfer. Follow-up demonstrated viable flap, no infection, good joint mobility, and improved Kapandji and DASH scores. Osteoplastic reconstruction of the thumb using ICBG method is valuable for amputations around the metacarpophalangeal level preserving native anatomy and function. Radial forearm flaps are advantageous due to their thin, pliable and ability to preserve the radial artery. However, donor morbidity and potential complications should be considered. ICBG with radial forearm flap showed promising result.

Level of evidence: Level IV (Therapeutic).

Introduction

Occupational traumatic thumb amputation is a severe injury that can significantly impact an individual's quality of life and functionality. Replantation of thumb amputations has been a subject of extensive research, focusing on survival rates and functional outcomes [1]. Studies have shown that primary attempts at replantation involve radical debridement and may require the use of long vein grafts in challenging cases [2]. However, in cases where replantation is not feasible, revision amputation and reconstruction has been considered as an alternative, with studies indicating varying functional outcomes and therapeutic costs compared to replantation. Alternative techniques such as toe-to-thumb transfers have been explored, showing high survival rates and patient satisfaction scores [3].

The use of Iliac Crest Bone Graft (ICBG) in traumatic thumb amputation is a well-established technique in reconstructive hand

* Corresponding author at: Department of Orthopaedics and Traumatology, MRCCC Siloam Hospitals Semanggi, Garnison Dalam Street Number 2-3, Jakarta, Indonesia.

E-mail address: bontordaniel.md@gmail.com (B.D. Sinaga).

¹ Department of Orthopaedics and Traumatology, MRCCC Siloam Hospitals Semanggi, Garnison Dalam Street Number 2-3, Jakarta, Indonesia.

² Department of Orthopaedic and Traumatology, Dr.Cipto Mangunkusumo Hospital, Faculty of Medicine Universitas Indonesia, Pangeran Diponegoro Street Number 71, Central Jakarta Jakarta, Indonesia.

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surgery. ICBG has been widely utilized in various orthopaedic procedures due to its excellent osteogenic properties and structural support. Studies have shown that ICBG is effective in reconstructing bone defects in the thumb, preserving native thumb anatomy, and avoiding amputation [4]. Additionally, ICBG has been successfully used in cases of thumb metacarpal reconstruction, demonstrating its versatility and efficacy in addressing traumatic injuries. The technique of ICBG harvesting has also been refined, with reports on the use of piezosurgery to reduce morbidity associated with bone graft harvesting [5]. Furthermore, the outcomes of ICBG in thumb reconstruction have been compared with other graft sources, highlighting the unique advantages of ICBG in restoring thumb function and structure.

Moreover, the use of radial forearm flaps has gained prominence in soft tissue reconstruction procedures for complex cases. These flaps offer versatile options for soft tissue coverage and have been successfully utilized in various reconstructive surgeries, including thumb reconstruction [5]. Additionally, the radial forearm flap has been used as a bridge in lower extremity reconstruction, highlighting its adaptability and effectiveness in different clinical scenarios [6]. Furthermore, the flow-through radial forearm flap has been described as a valuable technique in lower extremity reconstruction, emphasizing its utility beyond traditional applications [6].

In this study, we presented a case of occupational traumatic thumb amputation treated with iliac crest bone graft with radial forearm flap. This study aims to detail the therapeutic outcomes and procedural considerations of this case. In addition, we also aim to provide insights into the surgical technique, postoperative care, functional recovery, and overall patient satisfaction, thereby contributing valuable data to the existing body of knowledge on complex hand reconstructions after severe occupational injuries.

Case report

A 32-year-old male presented with occupational traumatic thumb amputation of right hand. The patient suffered an injury to his right thumb after being hit by a cutting machine while working. He complained of severe pain and his thumb was almost completely cut off (Fig. 1A). The patient went to the hospital in rural area, then underwent debridement surgery and K-wire installation. One week later, the patient was checked and found that the thumb was black and numb (Fig. 1B). Then, the patient was referred to advanced hospital for surgery. Initially the patient was advised to undergo a toe-to-thumb transfer, but the patient refused. Ultimately, bone graft from the iliac was the method of choice. A tricortical-shaped bone graft was harvested from the iliac crest. The length of the graft is adjusted to the patient's thumb needs. And then it's positioned and fixated with locking plate to the metacarpal bone (Fig. 2). A radial forearm flap was done to provide soft tissue cover. A two-week follow up showed the flap was viable, no sign of infection, and good mobility of CMC joint occurred. After six months, the flap was still viable, the CMC joint function was intact so the grasp and pinch function still existed (Fig. 3). The examination results indicated an improvement in the function of the patient's thumb and hand, with the Kapandji score increasing to 6 from 4 at three months, and the DASH score improving to 20.5 from 40.9 at three months.

Discussion

Osteoplastic reconstruction of the thumb is a valuable technique indicated in cases of amputation at or around the metacarpophalangeal level, especially when patients are not suitable candidates for or decline toe transfer procedures [7]. This method involves a reverse-flow forearm osteocutaneous flap and has been shown to be effective in thumb reconstruction following traumatic amputations [7]. When comparing different methods of thumb reconstruction, osteoplastic reconstruction is highlighted as one of the common techniques alongside bone lengthening, pollicization, and toe-to-hand transfers [8]. Studies have indicated that osteoplastic thumb reconstruction can provide functional outcomes comparable to microsurgical reconstruction, making it a viable option for select patients [8].

In cases where amputation is necessary, the level of amputation can significantly impact hand function. For instance, amputation at the metacarpophalangeal joint can result in a 40 % loss of function in the affected hand, while amputation at the interphalangeal joint of the thumb leads to a 10 % loss of function [8]. Additionally, amputations at the metacarpophalangeal joint are noted to be poorly tolerated, emphasizing the importance of selecting appropriate reconstruction techniques [7]. While osteoplastic reconstruction is a valuable option, other methods such as pollicization of the index finger, toe-to-thumb transfers, and distraction lengthening are also available for thumb reconstruction [8]. Each of these techniques has its advantages and considerations, highlighting the importance of individualized treatment approaches based on patient-specific factors and preferences.

ICBG is a well-established technique in reconstructive surgeries, including thumb metacarpal reconstruction post-amputation. The use of ICBG in such procedures has shown promising outcomes. Lim & Babineaux presented a case where the entire thumb metacarpal bone was reconstructed using a tricortical iliac crest bone graft, successfully preserving the patient's native thumb and avoiding amputation [4]. This highlights the effectiveness of ICBG in maintaining structural integrity and function post-amputation. Discussed reconstructing an amputated thumb using a nonvascularized bone block graft from the iliac crest, emphasizing the commonality of this procedure in thumb reconstruction surgeries [8].

In order to correct bone shortages and restore thumb function following trauma-related amputation, iliac crest bone transplants are frequently utilized in thumb restoration. Because they are readily available and can aid in bone mending, they are regarded as a dependable choice [5]. According to studies, iliac crest bone grafts work well for anatomical reconstructions, helping to stabilize joints and replace missing bone. It has been possible to prolong the thumb's initial ray and improve soft tissue covering and structural integrity by using iliac crest bone transplants. [5]

Although there are benefits to this approach, there are also negative aspects to it. The potential for donor site morbidity when removing bone from the iliac crest is a major drawback. This may result in problems at the donor site include nerve injury, persistent pain, and cosmetic abnormalities [5]. Furthermore, the use of autogenous bone grafts, such as the fibula or iliac crest, for



Fig. 1. Clinical picture of the (A) nearly amputated thumb across the CMC and MCP 1 joint. A week after the first replantation surgery, (B) the thumb became necrotic.

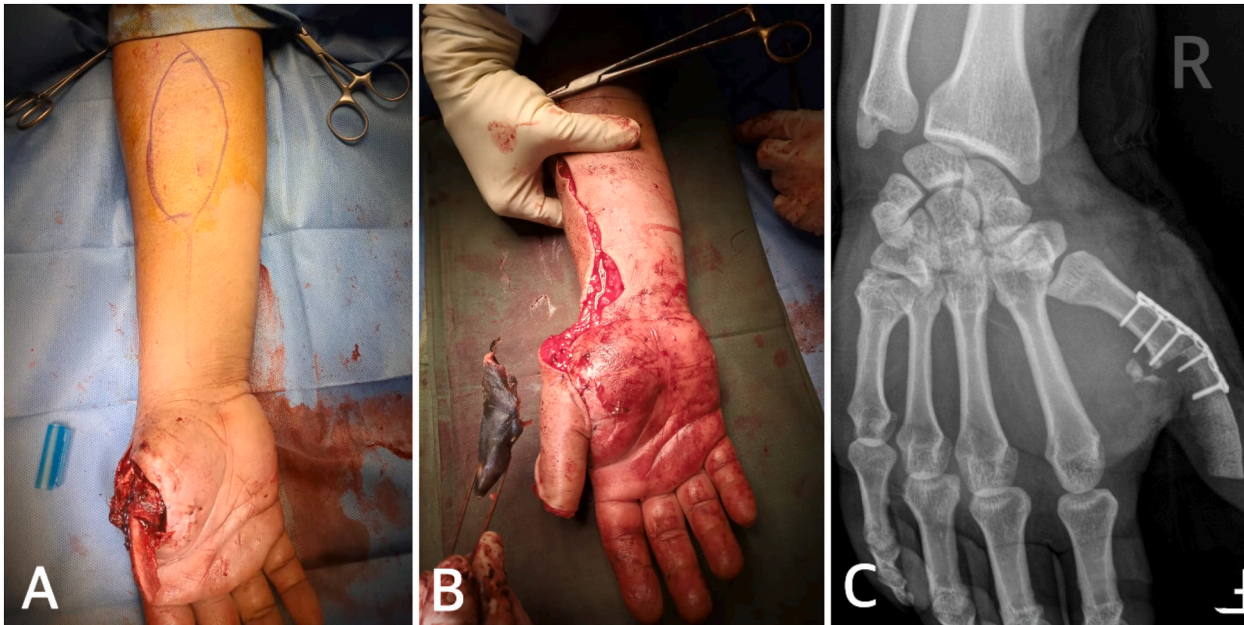


Fig. 2. Intraoperative (A) Iliac crest bone graft with (B) radial forearm flaps on the right thumb. Postoperative (C) radiograph show good alignment of the thumb.



Fig. 3. A six-month follow-up, photographs of the hand in (A) dorsal and (B) palmar view show good local state with viable flap. The thumb joint mobility and function like (C) grasping is still preserved.

reconstruction carries the danger of pseudoarthrosis and graft dislodgement, which can jeopardize the procedure's overall success [5]. Moreover, nonvascularized bone grafts—such as those derived from the iliac crest—may not be as viable as osteoconductive matrices when used for defects longer than 6 cm, which could have an effect on the reconstruction's long-term results [8].

Osteoplastic reconstruction of the thumb serves as a crucial technique in cases where toe transfer is not feasible or desired. The choice of reconstruction technique should be carefully considered based on the patient's unique circumstances and treatment goals.

After a catastrophic thumb amputation, the radial forearm flap has been successfully used in thumb reconstruction. Thumb function and appearance have been successfully preserved with this technology [9]. The thin and malleable nature of the radial forearm flap makes it especially useful for visually delicate areas like the hand. It has been characterized as a dependable and adaptable choice for soft tissue reconstruction of the upper limb, particularly in thumb reconstruction instances [9]. When covering moderate-sized hand and wrist lesions, the flap's capacity to maintain the radial artery without compromising it is essential [9]. It has been noted that the radial flap is an excellent technique for reconstructing the thumb, particularly when there are significant and distant skin abnormalities on the hand [9]. Furthermore, soft tissue abnormalities surrounding the thumb have been successfully covered by the reverse radial forearm flap, which in some circumstances provides vascular input for toe transplants [10]. This flap's larger arc of rotation, which makes it simple to apply to the recipient site, has made it a highly regarded alternative for covering soft tissue abnormalities in the hand and wrist [10].

Conclusion

The use of iliac crest bone graft with radial forearm flap in amputated thumb in our case showed promising result. Osteoplastic reconstruction of the thumb is highlighted as a valuable technique for restoring function post-amputation, especially when toe transfer procedures are unsuitable or declined, offering outcomes comparable to more complex microsurgical techniques. The utilization of iliac crest bone grafts (ICBG) supports successful thumb metacarpal reconstruction, preserving thumb structure and function, while also allowing for the treatment of complex bone pathologies. However, it is essential to consider individual patient factors and the potential drawbacks of donor site morbidity and complications associated with bone grafting when selecting the most appropriate reconstruction method.

Author contributions

All Authors have accepted responsibility for the entire content of this. Manuscript and approved its submission.

Consent

We were able to obtain written informed consent from the patient for the publication of this case report and its accompanying images.

CRediT authorship contribution statement

Dwi Purnomo Setyo Budi: Supervision, Conceptualization. **Mochamad Sadabaskara:** Supervision, Conceptualization. **Filberto Budhy:** Writing – original draft, Visualization. **Bontor Daniel Sinaga:** Writing – original draft, Visualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

- [1] E.D. Sears, K.C. Chung, Replantation of finger avulsion injuries: a systematic review of survival and functional outcomes, *J. Hand Surg. Am.* 36 (4) (2011) 686–694.
- [2] S.R. Sabapathy, H. Venkatramani, R. Bharathi, P. Bhardwaj, Replantation surgery, *J. Hand Surg. Am.* 36 (6) (2011) 1104–1110.
- [3] P.Y. Lin, S.J. Sebastin, S. Ono, L.T. Bellfi, K.T. Chang, K.C. Chung, A systematic review of outcomes of toe-to-thumb transfers for isolated traumatic thumb amputation, *Hand* 6 (3) (2011) 235–243.
- [4] S. Lim, K.L. Babineaux, Reconstruction of an entire thumb metacarpal, *Plast. Reconstr. Surg. Glob. Open* 4 (2) (2016) e610.
- [5] L.P. Ylikontiola, V. Lehtonen, G.K. Sándor, Piezo harvesting of bone grafts from the anterior iliac crest: a technical note, *Ann. Maxillofac. Surg.* 6 (1) (2016) 94.
- [6] Ö. Özkan, Ö. Özkan, G. Bektas, A. Cinpolat, Experiences with the flow-through radial forearm flap as a bridge in lower extremity reconstruction, *Microsurgery* 36 (2) (2015) 128–133.
- [7] Y. Liu, E.A. Miller, C.E. Wee, A. Prsic, D. Eble, D.S. Kao, Osteoplastic thumb reconstruction in the immediate setting: a case series, *Plast. Reconstr. Surg. Glob. Open* 10 (6) (2022) e4385.
- [8] S.M. Kumta, Unfavourable results in thumb reconstruction, *Indian J. Plast. Surg.* 46 (2) (2013) 294.
- [9] D. Vulovic, J. Kozarski, Z. Curcic, N. Stepic, M.A. Vucetic, D. Rakic, et al., Radial flap in reconstructions of the hand - case series study, *Serbian J. Exp. Clin. Res.* 23 (4) (2022) 373–381.
- [10] J. Kim, A.P. Yoon, Reverse radial forearm flap to provide arterial inflow to a toe transfer, *Hand* 12 (2) (2016) 154–161.