CASE REPORT

# The Role of Selective Soft Tissue Pollicization for Thumb and First Web Reconstruction – A Case Report

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## Abstract

Hand injuries from firecrackers require precise repair, especially when the thumb is involved due to its crucial role in grasping, pinching, and daily activities. In this study, we evaluate the outcomes of selective soft tissue pollicization in a patient who sustained fireworks injuries, including multiple wounds, amputations with bone exposure, digital nerve transections, and extensive soft tissue damage across several fingers. Numerous methods exist to achieve optimal results, each with benefits and downsides. Through comprehensive assessment and meticulous surgical technique, we present the therapeutic management of a case that necessitated a selective approach to reconstruction, with focusing on preserving neurovascular bundles and tendons. Post-surgery, the patient regained full sensation and functional movement in the first metacarpophalangeal and interphalangeal joints, closely mirroring a normal thumb, enabling effective grasping, pinching, and opposition movements for daily tasks.

**Level of evidence:** V

**Keywords:** Case report, Firework injury, Hand injury, Pollicization, Trauma

## Introduction

Hand injuries exhibit a spectrum of severity depending on the mechanism of injury, with firework-related trauma representing a particularly debilitating category. Such incidents precipitate myriad irregular injuries affecting both bone and soft tissues. Typically, the trauma involves extensive bone damage, significant soft tissue loss, wound contamination, skin disintegration and tendon injury. These complexities render the reconstructive process particularly challenging, necessitating astute surgical judgment to determine the optimal reparative strategy.[1-5]

Management of soft tissue injuries varies, encompassing approaches from primary repair to more complex procedures such as grafting or the utilization of flaps for adequate coverage. Concurrently, bone reconstruction methods are diverse and include immobilization, Open Reduction and Internal Fixation (ORIF), screw or plate osteosynthesis, and arthrodesis for intraarticular fracture. In certain scenarios, bone grafting or even amputation with subsequent free transfer of another finger may be warranted.[6,7]

Following debridement, the surgeon must conduct a thorough assessment of the trauma's extent. The ensuing steps involve stabilizing bone fractures, revascularizing tissues if necessary, and ensuring the repair of soft tissues and skin coverage. Paramount to the success of these interventions is the establishment of a stable blood supply, often necessitating microsurgical anastomosis of phalangeal vessels to circumvent amputation. Tendon repair is approached with a preference for primary intervention, provided there is no imminent risk of shortening or contracture. If these risks exist, it is better to opt for a secondary repair later. Skin coverage techniques are selected based on the patient's injury location and nature, with direct closure, skin grafts, local flaps, or free flap transfers being viable options. Specifically, full-thickness skin grafts are favored for volar hand injuries due to their superior functional and aesthetic outcomes.[8-10]

## Case presentation

A 9-year-old patient was airlifted to hospital following a firecracker trauma and a third-degree burn to the right hand. The initial evaluation revealed loss of sensation in the thumb, a deep wound and soft tissue defect on the thumb's

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anterior side, and amputation of the distal phalanges of the index and middle fingers. Further diagnostic assessment disclosed multiple fractures with significant osseous depletion of the thumb, accompanied by avulsion trauma and extensive detachment of neurovascular bundles, in addition to a circular defect in the skin and soft tissue of the proximal phalanx and the first interdigital space. Evaluation of the index finger revealed distal phalanx ablation, with concurrent comminuted open fracture of proximal phalanx Gustilo type IIIB, skin and soft tissue defect and compromise of neurovascular bundle at the distal of middle phalanx level. The injury to the middle finger included distal phalanx ablation, a dislocated fracture of the proximal phalanx and a third-degree burn.

The patient received immediate emergency care on the first day of admission. Intraoperative exploration revealed highly contaminated wounds and a significant soft tissue and bone defect of the proximal phalanx of the index finger. Initial treatments included serial debridement, followed by multiple Epigard, Suprathel changes and stabilization of fractures with K-wires to prevent bone and joint function loss [Figure 1, A and B].

Following adequate wound preparation and MRI confirmation of adequate perfusion, and in light of necrotic bone in the index finger accompanied by the third-degree burns, fractures, as well as damage to the neurovascular bundle in the thumb and significant soft tissue loss, we conducted a selective second ray resection. This procedure included debridement of the necrotic bone and tissue in the thumb, index finger and first web space, while carefully maintaining the integrity of both the flexor and extensor tendons of the thumb.

Furthermore, because of a third-degree burn injury and a heightened risk of thrombosis in the first dorsal metacarpal artery, the classic kite flap was deemed unsuitable. Concurrently, preserving the third and fourth neurovascular bundles and index finger's soft tissue, along with the thumb's flexor and extensor tendons, and the thumb's bony structure, compounded by the complex injury to the index finger's bone and the thumb's neurovascular trauma, making a standard pollicization using the index finger or toe-to-hand transfer was deemed suboptimal. Consequently, we opted for a strategic reconstruction of the thumb's soft tissue and the first web space defect, employing a bespoke modification of the first dorsal metacarpal artery flap, known as the kite flap, fashioned into a selective soft tissue pollicization configuration. Subsequently, the dimensions of the required flap were delineated on the residual index finger. The flap was dissected from the proximal interphalangeal joint, with the elevation layer located in the epitendinous gliding layer. After that, it was mobilized over the flap pedicle. Further, an incision was performed through the periosteum at the level of the second metacarpal, and the fascia overlying the first dorsal interosseous muscle was detached. Preservation of the subcutaneous tissue, subcutaneous veins, and the third and fourth neurovascular bundle within the pedicle was ensured and repositioned within the soft tissue. The cutaneous flap was meticulously thinned to maximize vascularized tissue preservation on the pedicle. Elevation of the flap pedicle was carried out in the subfascial plane, allowing for the identification and preservation of the feeding vessels, the third nerve, and residual branches of the superficial radial nerve. A flap pedicle width of approximately 3 cm was established, without further dissection of the vessels. Distally, the dissection extended to the middle phalanx to ensure complete separation of the affected tissue. This was followed by an osteotomy at the base of the second metacarpal, which facilitated the subsequent contouring of the soft tissue envelope. Once the flap pedicle was adequately mobilized, it was transposed in a wrap-around pattern to the remaining thumb. This covered the defect on the thumb and first web space, ensuring a tension-free adaptation at the recipient site [Figure 1, C and D].


**Figure 1. This figure shows firework-related trauma after primary debridement and post-pollicization result. (A) Soft tissue damage of the thumb and the first web (B) The third-degree burn and amputation of distal phalanges of index and middle finger (C) Dorsal side of the post-pollicization hand (D) Palmar side of the post-pollicization hand**

Postoperative monitoring revealed sustained vitality of the finger. The patient's recovery was facilitated by limb elevation and nonsteroidal anti-inflammatory drugs. Removal of wires was performed under general anesthesia a week after constructive surgery and a compressive glove was fitted during hospitalization.

As mentioned, the third and fourth nerve bundles were employed for innervation. The patient demonstrated notable improvements in performing grasping and pinching, as well as a marked enhancement in sensory perception. The success of this method was significant when compared to other surgical options like the kite flap, toe-to-hand transfer, radial forearm flap, and wrap-around flap techniques. Another benefit of this approach is the maintenance of the

hand's natural look, which is essential for the patient's satisfaction. Moreover, this method avoids scarring in unnecessary areas, thereby maintaining the integrity of the skin's appearance [Figure 2].

## Discussion

The management of severe complex hand injuries requires in-depth contemplation and decision-making. This is because a host of factors related to both the patient and the injury itself influence the treatment of such injuries. These factors include the patient's profession, age, pre-existing health conditions, smoking, alcohol consumption, and drug use, as well as the patient's expectations. The details of the injury are just as critical, encompassing the type and timing of the injury, any contracture in the thumb web space, the condition of the carpometacarpal joint, and particularly, the level of the injury, the extent of damage to the soft and bony tissues, and the functionality of the thumb and fingers.[11,12]

The therapeutic approach for hand injuries varies based on the type and level of injury. Potential treatments may encompass soft tissue reconstruction, nerve grafts, vascular grafts, bone grafts, deepening of web space, digit lengthening procedures, phalangization, tendon transfers, toe-to-thumb transfer, distraction osteogenesis, or pollicization.[11]


**Figure 2. Appearance of hand 3 months after the selective soft tissue pollicization. (A) Lateral (B) Palmar (C) Dosral**

The thumb contributes to 40% of the hand's functionality, primarily due to its unique capacity for opposition, as well as its role in grasping and pinching movements, which are essential for performing daily tasks.[12] Since its inception by Guermonprez in 1887, pollicization has emerged as the favored surgical intervention for cases of thumb amputation.[13] This technique typically involves the transposition of the index finger to the thumb's location, effectively transforming a non-functional hand into one that is capable of performing its duties. Notably, the application of vascularized soft tissue in pollicization procedures has been infrequently documented in medical literature.

Pollicization confers benefits such as enhanced aesthetics and mobility of the thumb, but it also involves a compromise in terms of a decreased number of fingers and possibly reduced grasping power. While it can be performed soon after the injury, elective pollicization is often preferred to improve results. This involves detailed neurovascular dissection to ensure proper motor and sensory function, adequate length for the digit transfer, and preservation of the tendons for thumb movement.

In this case, given the complex injury to the index finger's bone and the thumb's neurovascular trauma, precision is crucial. It is especially important to maintain the neurovascular bundle of the index finger to secure a sufficient length of the pedicle and adequate sensory and motor function and to prevent necrosis of the relocated digit. To restore thumb function, it is essential to adjust tendon tension precisely. The extensor digitorum tendon to the extensor pollicis longus tendon and the flexor digitorum profundus tendon of the index finger should be connected to the flexor pollicis longus tendon. Additionally, preserving the interosseous and lumbrical muscles of the index finger is crucial to maintain some adductive ability in the new thumb, preventing it from drifting towards the middle finger.

Rehabilitation after thumb pollicization surgery is critical. This therapy is essential for reorganization of brain circuits and training the hand to initially handle larger objects, then smaller ones, and finally to perform precise pinching movements. Sensory and movement reeducation post-surgery is vital to correct any misplaced sensations and to reestablish both sensation and motor control in the thumb.

## Conclusion

In cases of severe trauma, additional surgeries might be required to improve both the functionality and aesthetics of the hand following the initial procedure. The index finger is usually the preferred choice for pollicization. Even in the absence of its bone, the vascularized soft tissue can be utilized for thumb reconstruction in specific scenarios. The selective thumb reconstruction offers an excellent solution for rebuilding a damaged thumb and can often be completed in a single operation.

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