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**Case Report / Приказ болесника**

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# Clinical course and treatment outcomes of a crush hand injury caused by a corn picker

## Клинички ток и резултати лечења конквасантне повреде шаке задобијене берачем за кукуруз

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## Клинички ток и резултати лечења конквасантне повреде шаке задобијене берачем за кукуруз


## SUMMARY

**Introduction** Injuries caused by agricultural machinery often lead to functional impairment or amputation. Crush injuries of the hand present a complex surgical challenge due to simultaneous damage to bones, tendons, and nerves. Prompt, multidisciplinary management is crucial for optimal recovery.

**Case outline** We present a 55-year-old patient with a crush injury to the left hand involving the thumb, index, and middle fingers, with multiple phalangeal fractures, laceration of the extensor tendons, and a laceration-contusion injury of the fourth finger. After initial management, surgery was performed six hours after the injury and included debridement, fracture fixation with Kirschner wires, and primary tenorrhaphy of the extensor tendons. Secondary soft-tissue surgery was performed 26 days after the injury, following tissue demarcation. Postoperatively, the patient received triple intravenous antibiotic therapy, tetanus prophylaxis, anticoagulant prophylaxis, hyperbaric oxygen therapy, and early rehabilitation. The patient achieved a satisfactory functional recovery of the hand, with preserved peripheral perfusion, healed wounds, and gradual improvement in functional test scores over 12 months. Angulation of the index and middle fingers was noted, but hand function was sufficient for daily activities and a return to work.

**Conclusion** This case shows that even severe crush injuries of the hand can have an acceptable functional and aesthetic outcome with timely surgical intervention, fracture stabilization, tendon reconstruction, adjuvant therapies, and structured rehabilitation. An individualized, multidisciplinary approach is crucial for the successful treatment of complex hand injuries. Few cases describing treatment protocols and methods for such complex injuries have been published. Together, these measures can preserve tissue and provide a degree of functional recovery.


**Keywords:** crush injury of the hand; agricultural machinery injuries; corn picker injuries


## САЖЕТАК

**Увод** Повреде изазване пољопривредним машинама често доводе до функционалног оштећења или ампутације. Конквасантне повреде шаке представљају сложен хируршки изазов због истовремене повреде костију, тетива и нерава. Правовремено мултидисциплинарно збрињавање је кључно за оптималани опоравак.

**Приказ болесника** Приказујемо болесника старог 55 година, са конквасантном повредом леве шаке која је обухватала палац, кажипрст и средњи прст, са вишеструким преломима фаланги, лацерацијом екстензорних тетива и лацероконтузном повредом домалог прста. По иницијалном збрињавању оперативно лечење је изведено 6 сати од повреде и обухватило је дебридман, фиксацију прелома Киршнер иглама и примарну тенорафију екстензорних тетива. Секундарна хирургија меких ткива изведена је након 26 дана након демаркациије ткива. Постоперативно је примењена интравенска тројна антибиотска терапија, антитетанусна и антикоагулантна профилакса, хипербачна оксигентерапија и рана рехабилитација. Болесник је постигао задовољавајућу функционални опоравак шаке, са очуваном периферном перфузијом, зарастањем рана и постепеним побољшањем функционалних тест скорова у току 12 месеци. Примећена је ангулација кажипрста и средњег прста, али функција шаке задовољава за вршење животних активности и повратку послу.

**Закључак** Овај случај показује да чак и тешке конквасантне повреде шаке могу имати прихватљив функционални и естетски исход уз правовремену хируршку интервенцију, стабилизацију прелома, реконструкцију тетива, адјувантне терапије и структуирану рехабилитацију. Индивидуализован и мултидисциплинаран приступ кључан је за успешно лечење комплексних повреда шаке. Недовољно је случајева који приказују протоколе и методе лечења оваквих сложених трауматских типова повреда. Правовремена хируршка интервенција, стабилизација прелома, реконструкција тетива, адјувантне терапије и структурирана рехабилитација дају резултате у смислу очувања ткива и известан функционални опоравак.


**Кључне речи:** конквасантна повреда шаке; пољопривредне повреде; повреде берачем за кукуруз

## INTRODUCTION

The hand is one of the most complex anatomical structures of the human body, and its precise function depends on the interaction of bones, muscles, nerves, and a rich vascular network that

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provides adequate perfusion and functional tissue integrity [1, 2]. Hand injuries account for a significant proportion of all orthopedic injuries and are a leading cause of work-related disability in the general population [3, 4]. Hand injuries involving multiple fractures and damage to soft tissues, tendons, and skin present a major surgical challenge. Complex crush injuries pose a particular surgical and therapeutic challenge requiring an individualized treatment plan that includes osseous and joint stabilization, tendon and soft-tissue reconstruction, and preservation of the vascular supply [3, 5]. Injuries caused by agricultural machinery frequently result in amputation of the injured extremity, whereas few publications describe treatment strategies and protocols aimed at preserving tissue integrity [5]. Given that this was a complex crush (conquassant) hand injury, we present a combination of therapeutic techniques and a protocol intended to assist surgeons in clinical decision-making. According to the available literature, as well as the clinical experience within our department, these injuries typically require amputation. Therefore, our objective was to present a case of a patient whose digits and hand remained viable and functional following several months of rehabilitation. The patient has successfully returned to his daily activities and work.

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## CASE REPORT

A 55-year-old man sustained an injury caused by agricultural machinery (a corn picker). He suffered a severe crush injury of the thumb (proximal and distal phalanges) and of the index and middle fingers (proximal and middle phalanges), as well as a laceration-contusion injury of the fourth finger of the non-dominant hand (Figure 1). Initial management included radiographic evaluation (Figure 2), primary wound irrigation, dressing application, and immobilization with a forearm splint. The patient underwent surgery under a peripheral nerve block of the upper extremity six hours after the injury. A triple antibiotic regimen was

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administered: a third-generation cephalosporin (Azaran), 1 g intravenously twice daily for 10 days; an aminoglycoside (amikacin), 1 g intravenously once daily for 10 days; and metronidazole (Orvagil), 500 mg intravenously three times daily for seven days. The patient received anticoagulant prophylaxis (Fraxiparin, 0.6 mL subcutaneously once daily) and tetanus prophylaxis (Tetagam serum 250 IU/mL and Tetavaxal vaccine 40 IU/0.5 mL).

Multifragmentary fractures of the proximal and distal phalanges of the thumb, as well as fractures of the proximal and middle phalanges of the index and middle fingers were found. Defects of the extensor tendons of the thumb, index, and middle fingers were identified, together with extensive soft-tissue contusions over the dorsal aspect of the left hand and a laceration-contusion wound of the fourth finger. All flexor tendons were intact. The neurovascular bundle on the radial aspect of the thumb was lacerated beyond repair, whereas the neurovascular bundle on the ulnar aspect of the thumb was contused. Numerous collateral vessels were observed. The thumb exhibited delayed turgor, with paresthesias localized to both the radial and volar aspects. The neurovascular bundles for the index and middle fingers were contused; both digits showed delayed turgor and paresthesias extending over the proximal, middle, and distal segments. Considering the intraoperative neurovascular status, and with the patient's informed consent and high motivation, it was decided to forgo primary amputation of the digits and instead attempt digit-salvage procedures. Extensive debridement and irrigation were performed, followed by fracture fixation of the thumb, index, and middle fingers using Kirschner wires (K-wires) (Figure 3). The extensor tendons of the thumb, index, and middle fingers were injured at multiple levels, with both longitudinal and transverse defects ranging from 2 to 3 mm. According to the Verdan–Kleinert classification, the injuries to the index and middle fingers involved zones I, II, III, IV, and V. For the thumb, the injury was localized to zones I, II, and III. The skin over the dorsal aspect of the specified digits was lacerated and contused, with peripheral zones of necrosis and defects measuring 2 to 3 mm. It was decided to

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perform a primary extensor repair using interrupted 3-0 sutures to achieve coaptation (in the manner of a tenodesis). A volar forearm plaster splint was applied, positioning the hand in a functional resting position.

Hyperbaric oxygen therapy (HBOT) was initiated on the first postoperative day and consisted of twenty sessions according to the protocol of the Special Hospital for Hyperbaric Medicine, where it is tailored individually for each patient (the complete protocol is available there).

At 26 days post-injury, after demarcation of the necrotic tissue and because of exposure of the proximal interphalangeal (PIP) joint and the proximal phalanx of the middle finger, accompanied by local purulent discharge, debridement of the dorsal aspect of the finger was performed, along with skin remodeling, re-amputation through the middle third of the proximal phalanx of the middle finger, and stabilization with a single K-wire (Figure 4). Re-amputation was performed because it was determined that further complex reconstructive procedures aimed at salvaging the middle finger would compromise the results already achieved. The wounds healed by secondary intention. The sutures were removed three weeks after surgery. The K-wires were removed six weeks postoperatively, whereas the K-wire placed for the PIP joint and the proximal phalanx was retained for four weeks. Physical therapy was initiated immediately after K-wire removal at six weeks and was conducted at a specialized rehabilitation center over a total of six 15-day cycles. The administered therapies included paraffin therapy, laser therapy, magnetotherapy, and kinesiotherapy. Functional outcomes were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire at three, six, and twelve months postoperatively. The DASH score was 46.5 at three months, 18.33 at six months, and 4.16 at one year after surgery. Grip strength at the one-year follow-up was measured with a Jamar dynamometer: 48 kg on the right and 28 kg on the left. One year after the injury, the range of motion (ROM) of the injured wrist was measured with a goniometer: flexion 50°, extension

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24°, and a pronation–supination arc of 70°. Wrist motion of the uninjured hand measured 90° of flexion, 60° of extension, and 78° of pronation–supination. Angular deformities of the index and middle fingers were observed at the middle phalanx relative to the proximal phalanx in the coronal plane, measuring 18° for the index finger and 11° for the middle finger (Figure 5). The Total Active Motion (TAM) score after twelve months was calculated using the formula for the thumb and the formula for the second through fifth fingers. The range of motion values and TAM scores were as follows. For the thumb: MCP joint flexion: 20°, IP joint: 30°. Extension deficit: MCP joint: 0°, IP joint: 5°. The total score for the thumb was 45°, indicating a "poor" functional recovery.

For the index finger: MCP joint flexion: 90°, PIP joint: 0°, DIP joint: 5°. Extension deficit: MCP joint: 5°, PIP joint: 0°, DIP joint: 5°. The total score for the index finger was 85°, indicating a "good" functional recovery.

For the middle finger: MCP joint flexion: 75°, PIP joint: 0°, DIP joint: 5°. Extension deficit: MCP joint: 15°, PIP joint: 0°, DIP joint: 0°. The total score for the middle finger was 50°, indicating a "poor" functional recovery.

At the twelve-month follow-up, the patient reported no pain in the injured fingers. He had returned to agricultural work and expressed satisfaction with the overall outcome.

## DISCUSSION

Occupational injuries remain a major cause of morbidity and mortality worldwide. Studies conducted in India have shown that hand injuries, most commonly sustained in the workplace or during domestic activities, accounted for 24% of 855 evaluated patients. In Denmark, the

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incidence of occupational hand injuries was reported to be 1.7%, with the highest prevalence among workers in the manufacturing and construction industries [6].

In cases involving multifragmentary fractures associated with open and contaminated wounds, treatment usually involves reduction and internal fixation, as well as debridement and, when necessary, reconstruction of tendons and soft tissues according to a carefully planned surgical approach [7]. Initial debridement and irrigation are essential for reducing the risk of infection in injuries caused by agricultural machinery [8, 9, 10]. A shorter interval between injury and definitive treatment is associated with better clinical outcomes [8, 11]. Crush injuries of the hand frequently result in partial or complete amputation [12]. The surgical approach for complex hand fractures includes the use of K-wires for temporary or definitive stabilization, or locking compression plates (LCPs), which provide rigid fixation. The choice of fixation method depends on the fracture pattern, degree of comminution, and the condition of the surrounding soft tissues [7, 13].

K-wire fixation is a well-established technique for the operative treatment of hand fractures. In our case, multiple fractures were stabilized under fluoroscopic guidance using K-wires, a method widely accepted in the literature [7, 9, 13, 14] (Figure 3).

Adequate vascular supply and the condition of the digital vessels are among the most important determinants of tissue survival following severe hand trauma [15, 16]. In our patient, capillary refill was observed in the early postoperative period. Capillary refill time is a simple clinical test used to assess peripheral circulation by applying pressure to the nail bed or skin and measuring the time required for normal color to return after release of pressure [17].

HBOT was used as an adjunctive treatment modality because it increases tissue oxygen partial pressure, improves microcirculation, and promotes angiogenesis [18]. Regular wound care,

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appropriate antibiotic therapy, and continuous monitoring of tissue perfusion also play a crucial role in determining the final outcome [19].

Early rehabilitation remains one of the most important determinants of functional recovery after severe hand injuries, as there is a substantial risk of developing finger stiffness and contractures; therefore, timely and appropriately supervised rehabilitation is essential. In our patient, satisfactory functional recovery was achieved through a multidisciplinary treatment strategy that combined surgical intervention, adjunctive therapies, and structured physical rehabilitation [20].

Functional outcome assessment was performed using the DASH questionnaire, range-of-motion measurements, grip strength testing with a Jamar dynamometer, and TAM scoring, all of which are established and standardized assessment tools [12, 13]. The DASH questionnaire is a validated instrument used to quantify upper-extremity disability and limitations in activities of daily living and is widely applied in patients undergoing operative treatment of hand injuries [21, 22]. The Jamar dynamometer is a reliable instrument for objective assessment of grip strength in patients recovering from traumatic hand injuries [21, 22]. The TAM score is defined as the sum of active flexion at all joints of an individual digit minus the total extension deficit. Normal values are considered to be 270° for fingers and 170° for the thumb [23]. Measurements are performed using a finger goniometer with the wrist in a neutral position and the forearm pronated. Functional outcomes are classified as excellent (100% of normal motion), good (75–99%), fair (50–74%), and poor (< 50%) [24].

This case report shows that, despite the complexity of severe crush injuries, satisfactory functional outcomes can be achieved through a multidisciplinary treatment approach (surgical treat-

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ment, carefully guided early postoperative treatment, and long-term postoperative physical rehabilitation). These findings emphasize the importance of an individualized approach in the management of complex traumatic hand injuries.

**Ethics:** This case report was approved by the Ethical Committee of the University Clinical Center of Serbia, Belgrade, Serbia (No. 330/38, date 26.03.2026) and was conducted in accordance with the ethical standards of the Declaration of Helsinki.

**Conflict of interest:** None declared.

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## REFERENCES


1. Tan RES, Lahiri A. Vascular Anatomy of the Hand in Relation to Flaps. Hand Clin. 2020;36(1):1–8. [DOI: 10.1016/j.hcl.2019.08.001] [PMID: 31757342]
2. Bumbasirevic M, Stevanovic M, Lesic A, Atkinson HD. Current management of the mangled upper extremity. Int Orthop. 2012;36(11):2189–95. [DOI: 10.1007/s00264-012-1638-y] [PMID: 22923227]
3. Guidelines for management of crush injuries of the hand. J Clin Orthop Trauma. 2020;11(4):517–22. [DOI:10.1016/j.jcot.2020.03.028]
4. Mukit M, McCandless MG, Davidson JC, Hopper S, Jabbour JI, Davidson SF, et al. The Evolution of Hand Injuries at a State's Only Level I Trauma Center: A Look From the 1980s Through the Global Pandemic. Cureus. 2024;16(2):e54882. [DOI: 10.7759/cureus.54882] [PMID: 38533158]
5. David SS, Goel K. Knowledge, attitude, and practice of sugarcane crushers towards hand injury prevention strategies in India. Inj Prev. 2001;7(4):329–30. [DOI: 10.1136/ip.7.4.329] [PMID: 11770662]
6. Gerken M, Saller MM, Ockert B, Böcker W, Volkmer E. Detailed analysis of surgically treated hand trauma patients in a regional German trauma centre. PLoS One. 2023;18(3):e0283388. [DOI: 10.1371/journal.pone.0283388] [PMID: 36961845]
7. Ahmad S, Gupta T, Ansari S, Jain A, Barik S, Singh V. Intramedullary Crossed K-wire Fixation for the Hand Fractures is a Useful Treatment Modality: A Prospective Observational Study. Strategies Trauma Limb Reconstr. 2022 May-Aug;17(2):74–80. [DOI: 10.5005/jp-journals-10080-1556] [PMID: 35990184]
8. Song E, Seidelman J, Hammert W, Saltzman E. Diagnosis and Management of Hand Infections. J Hand Surg Am. 2024;49(12):1239–49. [DOI: 10.1016/j.jhsa.2024.09.001] [PMID: 39365240]
9. Heifner JJ, Rubio F. Fractures of the phalanges. J Hand Surg Eur Vol. 2023;48(2_suppl):18S-26S. [DOI: 10.1177/17531934231185219] [PMID: 37704026]
10. Wormald JC, Baldwin AJ, Nadama H, Shaw A, Wade RG, Prieto-Alhambra D, et al. Surgical site infection following surgery for hand trauma: a systematic review and meta-analysis. J Hand Surg Eur Vol. 2023;48(10):998–1005. [DOI: 10.1177/17531934231193336] [PMID: 37606593]
11. Keller MM, Jordaan PW. Traumatic hand injury management and outcomes: A case report. S Afr Fam Pract (2004). 2022;64(1):e1-e4. [DOI: 10.4102/safp.v64i1.5479] [PMID: 35532129]
12. Goodman AD, Got CJ, Weiss AC. Crush Injuries of the Hand. J Hand Surg Am. 2017;42(6):456–63. [DOI: 10.1016/j.jhsa.2017.03.028] [PMID: 28450098]
13. Greeven AP, Bezstarosti S, Krijnen P, Schipper IB. Open reduction and internal fixation versus percutaneous transverse Kirschner wire fixation for single, closed second to fifth metacarpal shaft fractures: a systematic review. Eur J Trauma Emerg Surg. 2016;42(2):169–75. [DOI: 10.1007/s00068-015-0507-y] [PMID: 26038026]
14. Palibrk TD, Lešić AR, Andjelković SZ, Milošević I, Stefanović RB, Milutinović SM, et al. Operative treatment of metacarpal and phalangeal fractures with Kirschner wire fixation--a review. Acta Chir Iugosl. 2013;60(2):49–52. [DOI: 10.2298/aci1302049p] [PMID: 24298738]
15. Khan M, Hayat W, Ullah H, Khan NH. Reconstruction of soft tissue defects of hand: A systematic approach. Pak J Med Sci. 2024 Jan-Feb;40(1Part-I):36–40. [DOI: 10.12669/pjms.40.1.7484] [PMID: 38196456]
16. Woznica V, Billich R, Třešková I. Loss injuries of the hand. Rozhl Chir. 2024;103(10):387–99. English. [DOI: 10.48095/ccrvch2024387] [PMID: 39772783]
17. Shinozaki K, Capilupi MJ, Saeki K, Hirahara H, Horie K, Kobayashi N, et al. Low temperature increases capillary blood refill time following mechanical fingertip compression of healthy volunteers: prospective cohort study. J Clin Monit Comput. 2019;33(2):259–67. [DOI: 10.1007/s10877-018-0159-7] [PMID: 29846867]
18. Ortega MA, Fraile-Martinez O, García-Montero C, Callejón-Peláez E, Sáez MA, Álvarez-Mon MA, et al. A General Overview on the Hyperbaric Oxygen Therapy: Applications, Mechanisms and Translational Opportunities. Medicina (Kaunas). 2021;57(9):864. [DOI: 10.3390/medicina57090864] [PMID: 34577787]
19. Anderson SR, Vincent JA, Wimalawansa SM. Multi-staged management of a mangled, exploded hand crush injury with long-term outcome: the critical link between surgery and therapy. BMJ Case Rep. 2022;15(5):e248429. [DOI: 10.1136/bcr-2021-248429] [PMID: 35606023]
20. Zhu C, He L, He T, Liang Y, Zhang BW, Zhao HY, et al. [Clinical effects of early rehabilitation treatment after repair surgery of skin and soft tissue defects accompanied by extensor tendon injury on the back of hand]. Zhonghua Shao Shang Yu Chuang Mian Xiu Fu Za Zhi. 2024;40(4):365–72. Chinese. [DOI: 10.3760/cma.j.cn501225-20230820-00057] [PMID: 38664031]
21. Gkotsi A, Bourdon C, Robert C, Schuind F. Normative values of the DASH questionnaire in healthy individuals over 50 years of age. Hand Surg Rehabil. 2021;40(3):258–62. [DOI: 10.1016/j.hansur.2020.12.010] [PMID: 33636383]


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22. Vaishya R, Misra A, Vaish A, Ursino N, D'Ambrosi R. Hand grip strength as a proposed new vital sign of health: a narrative review of evidences. J Health Popul Nutr. 2024;43(1):7. [DOI: 10.1186/s41043-024-00500-y] [PMID: 38195493]
23. Zyluk A, Janowski P. Results of the treatment of major, complex hand injuries. Pol Przegl Chir. 2011;83(2):87–94. [DOI: 10.2478/v10035-011-0014-8] [PMID: 22166286]
24. Lee JS, Kim YH. Factors associated with limited hand motion after hand trauma. Medicine (Baltimore). 2019;98(3):e14183. [DOI: 10.1097/MD.0000000000014183] [PMID: 30653167]

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**Figure 1.** Left hand injury caused by a corn picker

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**Figure 2.** Radiographs of the injured left hand in two projections

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**Figure 3.** Reduction and K-wire fixation of the phalangeal fractures

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**Figure 4.** Clinical appearance showing demarcation of necrotic tissue 26 days after injury

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**Figure 5.** Functional outcome after 12 months of rehabilitation

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