

Limb Salvage and Reconstruction of a Complex Upper Extremity Injury: A Case Report

Christos Koukos^{1,2}, Mikail Chatzivasiliadis³, Stylianos Kapetanakis³, David Latz⁴, S Samundeeswari⁵, Fredy Montoya⁶

Learning Point of the Article:

This case highlights the difficulty of deciding between limb salvage and amputation in complex trauma and states the importance of long-term functionality for patients, along with a structured approach to reconstruction.

Abstract

Introduction: Complex upper extremity trauma poses us with significant challenges in orthopedic and reconstructive surgery due to the complex anatomy and functional importance of the extremities. These injuries are often the result of high-energy mechanisms like motor vehicle collisions, which makes their management particularly demanding. Making the decision between limb salvage and amputation in such cases requires careful consideration of multiple factors such as functionality, risk of complications, and recovery.

Case Report: We describe the case of a 39-year-old male who had sustained an open fracture of the elbow, avascular necrosis of the olecranon, a displaced ulna fracture, and transections of the triceps tendon and ulnar nerve. We tried to salvage the limb through planned reconstructive surgeries despite the complexity of the injuries and recommendations for amputation.

Conclusion: Managing complex upper extremity trauma requires a structured approach that balances innovative techniques with effective infection control and soft-tissue reconstruction.

Keywords: Complex upper extremity trauma, limb salvage, reconstruction, tricep tendon rupture, sural nerve graft.

Introduction

Complex upper extremity trauma is a challenge in orthopedic and reconstructive surgery due to the complicated anatomy and functional role of the hand and arm. Such injuries are often the result of high-energy mechanisms which make their management very demanding. These kinds of traumas have a huge impact on the patient's quality of life, especially for individuals in professions where they are required to use their arms or hands. The goal in these cases goes way beyond achieving structural repair; it involves the restoration of motor and sensory function to enable the patient to reintegrate into daily life and work.

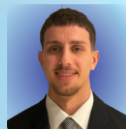
When considering salvaging the limb versus amputating, we need to carefully evaluate multiple important factors. Limb salvage aims to preserve functionality but often involves long treatments, higher costs, more surgeries, and the risk of complications. On the other hand, amputation offers quicker recovery and reduced risk of complications, but it leads to significant physical and emotional challenges [1,2].

We describe the case of a patient who sustained complex traumatic upper extremity injuries following a high-energy motor vehicle accident. We mention the series of reconstructive procedures and transformed what seemed like an unsalvageable injury into a successful outcome. In this case, we were faced with

Author's Photo Gallery



Dr. Christos Koukos



Dr. Mikail Chatzivasiliadis



Dr. Stylianos Kapetanakis



Dr. David Latz



Dr. S Samundeeswari



Dr. Fredy Montoya

Access this article online

Website:
www.jocr.co.in

DOI:
<https://doi.org/10.13107/jocr.2025.v15.i02.5224>

¹Sports Trauma and Pain Institute, Thessaloniki, Greece,

²Medical Center Wuppertal, Wuppertal, Germany,

³Department of Spine and Deformities, European Interbalkan Medical Center, Thessaloniki, Greece,

⁴Department of Trauma and Hand Surgery, Heinrich Heine University Hospital Duesseldorf, Duesseldorf, Germany,

⁵Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry, India,

⁶Sanatorio Aleman Clinic, Universidad de Concepcion, Concepcion, Chile.

Address of Correspondence:

Dr. Mikail Chatzivasiliadis,

Department of Spine and Deformities, European Interbalkan Medical Center, Thessaloniki, Greece.

E-mail: mikail@chatzi.com

Submitted: 12/11/2024; Review: 20/12/2024; Accepted: January 2025; Published: February 2025

DOI: <https://doi.org/10.13107/jocr.2025.v15.i02.5224>

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License <https://creativecommons.org/licenses/by-nc-sa/4.0/>, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms

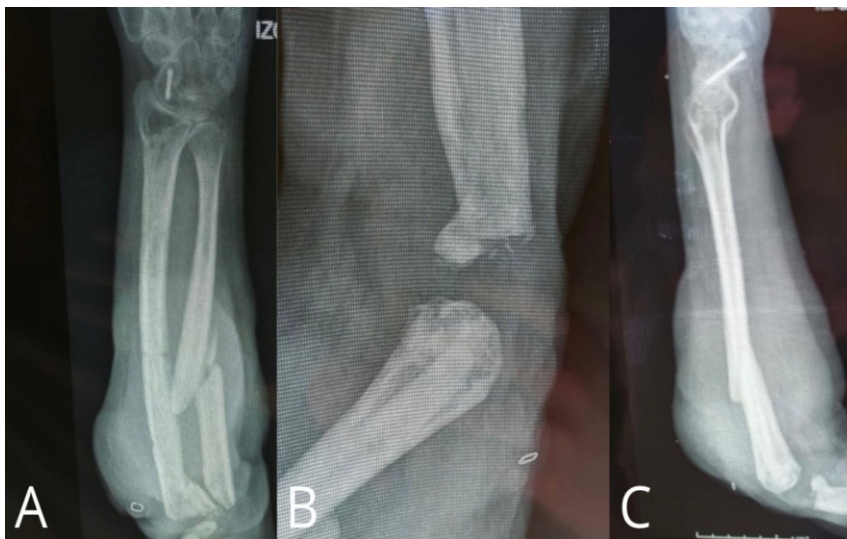


Figure 1: (A) Superior view and (B) lateral view of the displaced ulnar fracture, and (C) elbow view showing the open fracture of the elbow.

Physical examination revealed a large open wound of 20 × 10 cm over the elbow with exposed bone and tremendous soft-tissue damage. The injury included an open fracture of the elbow and avascular necrosis (AVN) of the olecranon, which had no signs of infection at the time of presentation. In addition, there was a displaced fracture of the ulna along with a complete transection of the triceps tendon and cubital (ulnar) nerve. These transection injuries resulted in considerable loss of elbow extension and sensory and motor deficits. The patient's medical history included a surgical repair of a scaphoid fracture 10 years ago, which might be unrelated to the current injury, but provided us with insight into his prior orthopedic care. The pre-operative X-rays are presented in Fig. 1.

the critical decision to either save the limb or amputate, and we chose to attempt reconstruction to give the patient the best chance at recovery.

Case Report

Clinical presentation

A 39-year-old male presented to the emergency department following a high-energy motor vehicle accident in which his car collided with a truck and got caught underneath it. The patient was reported to have been driving under the influence of alcohol and sustained severe trauma to his left upper extremity.

Initial management

The patient was taken to the operating room for emergency surgical debridement to remove the necrotic tissue and reduce the risk of infection (Fig. 2 and 3). A temporary external fixator was put in to stabilize the fracture and to preserve access for further reconstructive surgeries. The severed cubital nerve was identified and placed underneath the muscle to protect it from getting damaged (Fig. 4). After surgically stabilizing this patient, he underwent two additional debridement procedures to clean the wound and prepare it for reconstruction. A



Figure 2 & 3: Intraoperative images showing the extensive necrotic tissue encountered during the debridement surgery.



Figure 4: Intraoperative image showing the lesion of the ulnar nerve, with the white arrow pointing at the complete transection of the ulnar nerve.



Figure 5: Intraoperative image showing the placement of the total elbow prosthesis.

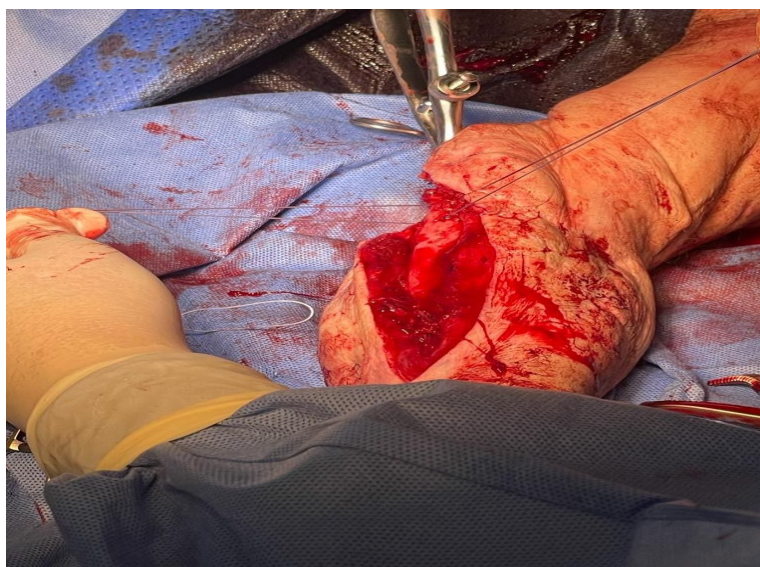


Figure 6: Intraoperative image showing the reconstruction of the triceps using a hamstring autograft augmented with FiberTape.

chlorhexidine-based wound irrigation solution (Irrisept) was utilized in these procedures, as it has been consistently effective in preventing infections in previous patients of ours.

Given the severity of the injuries and the complex challenges that had to be faced, some physicians recommended to amputate the arm. However, by leveraging the expertise of our multidisciplinary team of surgeons, the decision was made to try and spare the limb with reconstructive surgery.

Surgical intervention

Over the course of four surgeries, rotational and advancement flaps were used to repair the lateral forearm defect. The left subcutaneous tissue was temporarily exposed to make it easier for the tissue to granulate. In addition, during this phase a vacuum-assisted closure (VAC) system was applied as well to promote wound healing and to make sure that there was adequate vascularization of the wound bed. Once enough granulation tissue had developed, a skin graft from the patient's thigh was used to cover the forearm defect. This way we prepared the extremity for structural reconstruction.

Regarding the management of the necrotic olecranon, a partial debridement of the affected olecranon was performed which left a 3 × 4 cm wound. This remaining wound was closed with rotational flaps over the course of two additional surgeries. Throughout this phase, the external fixator remained in place.

Once the soft tissue had healed and the wound did not have any infections, the patient was ready to undergo reconstruction of the elbow and forearm. The displaced ulnar fracture was stabilized using a locking compression plate (LCP) and a total

elbow prosthesis was implanted as the damage to the elbow joint was too severe to restore the original joint (Fig. 5). Furthermore, a hamstring autograft was made, and secured into place using FiberTape. The intraoperative reconstruction of the triceps using the hamstring autograft is presented in Fig. 6.

Fortunately, the patient was found to have some compensatory function which was provided by the Berrettini anastomosis of the median and ulnar nerve. However, he still wanted better function of his hand as he needed it during his duty as a police officer. To address this, a microsurgeon performed a sural nerve graft 2 months after he had his last reconstructive surgery to bridge the gap in the affected ulnar nerve.

Surgical outcome

After all these reconstructive surgeries and nerve repairs, the patient ultimately had full range of motion in all joints of the affected upper extremity, with a graded muscle strength of M2-3. It is important to mention that he had no infections during his treatment and recovery, which highlights the effectiveness of wound care and infection control measures. At last, the patient was able to successfully return to his job as a police officer. Figs. 7 and 8 display the post-operative X-rays as well as the patient's doing the finger opposition exercise.

Discussion

Complex trauma of the upper extremities presents us with difficult challenges due to the complicated anatomy and functional importance of the hand and arm. These injuries are often the result of high-energy mechanisms and they frequently

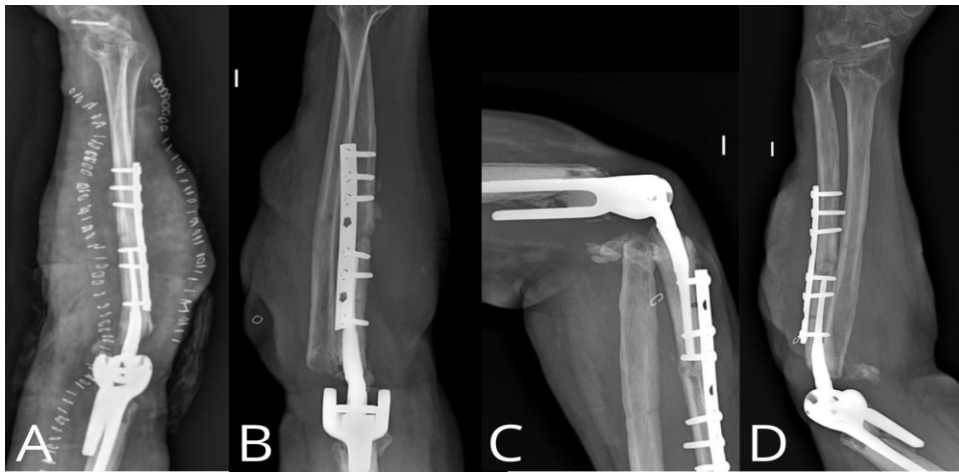


Figure 7: Post-operative X-rays showing bone reconstruction with a locking compression plate and a total elbow prosthesis.

involve the nerves, blood vessels, and soft tissues, not limited to the skeletal system. The upper extremity's close anatomical relationship between these neurovascular structures and bones makes these injuries difficult to manage and requires a deep understanding of the interplay of the form and structure of these extremities. The successful management of these types of traumatic injuries is measured by the degree of functional restoration, which enables the patient to reintegrate into society. Following an algorithmic approach based on trauma principles we can achieve a meaningful functional outcome even in the most challenging cases [3]. There are just a few similar cases in the literature. However, no case was as complete as the one which is being described in this paper.

The following case of a 39-year-old patient with an open elbow fracture is remarkably similar to our patient [4]. Both our cases involve soft-tissue loss, ulnar nerve damage, distal triceps loss, olecranon destruction, and instability of the elbow joint. In addition, the way this surgeon approached the reconstruction

also resembles our case. In this case, they did a repetitive radical debridement, VAC therapy, and covered the soft-tissue defect with a fasciocutaneous flap [4]. However, there are some key differences in the surgical management that emphasize the innovative strategies of our approach. They employed a total elbow arthroplasty which they reinforced with an autologous bone graft from the proximal radius. On the other hand, in our patient's treatment, we utilized a LCP for the displaced ulnar fracture. In addition, in our case, the triceps tendon which was damaged was reconstructed using a hamstring autograft hence restoring not only the passive extension as described by Cibula et al. but also active extension. Moreover, while this patient's ulnar neuropathy was not resolved, our case made use of a sural nerve graft to repair the ulnar nerve. These distinctions highlight the necessity of being able to adapt in managing such complex injuries and emphasize the uniqueness of our case. By integrating innovative techniques, we are able to provide key insights to optimize outcomes for similarly devastating injuries.

In another similar case report, Zeng et al. described a complex traumatic upper extremity injury where they faced the decision to either amputate or salvage the limb, like in our case. They ultimately chose to salvage the limb and in this way, we can demonstrate that both our cases are perfect examples of the potential for functional restoration of limbs through aggressive

reconstructive approaches [5]. However, again in this case the injury is described in the area of the forearm up to the wrist and not the elbow.

Triceps tendon ruptures are very rarely reported when discussing tendon injuries, with the majority managed through primary repair techniques [6]. Cases like ours which involve poor tissue quality need alternative strategies to ensure effective repair. The only available cases of triceps tendon ruptures with associated fractures or injuries are limited to the olecranon, which shows the rarity of our complex multi-injury case.

Weistroffer et al. and Wolf et al. described the use of hamstring autografts to reconstruct

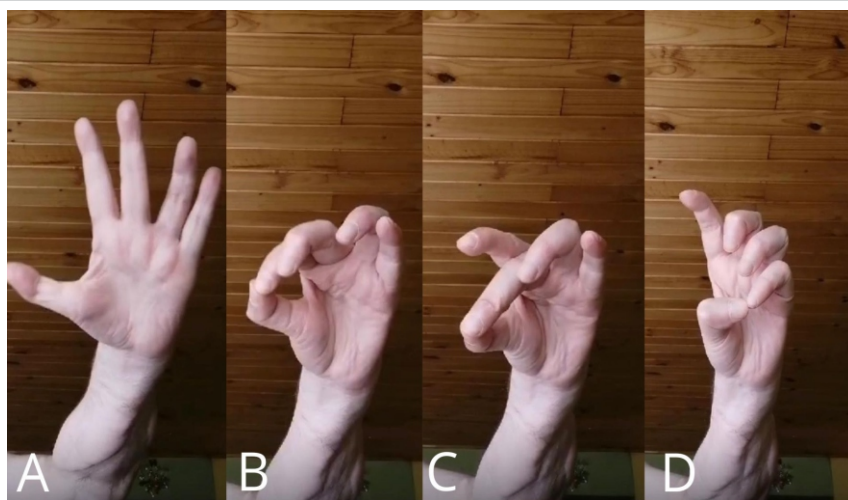


Figure 8: Images showing the patient performing finger opposition exercises, demonstrating functional recovery of fine motor coordination.

triceps tendons in recurrent cases of rupture or poor tissue quality [7, 8]. Weistroffer et al. used a Bunnell weaving technique with hamstring autografts, while Wolf et al. employed a crossing technique using Krackow sutures. Both approaches effectively addressed the poor triceps tendon quality [7, 8]. When we compare it to our case, the surgical techniques employed in these previously mentioned cases were less complex, which is most probably due to the isolated nature of these injuries. In our patient, we used a hamstring autograft augmented with FiberTape to address the poor quality of the native triceps tendon.

Schneider and Ek described a case which is the only documented literature of AVN of the olecranon, which they treated via arthroscopic assisted core decompression [9]. This minimally invasive approach successfully resolved the patient's symptoms and gained him full elbow function. In contrast, our case involved trauma-related AVN to the olecranon, including many other injuries. To address the AVN in our patient, we surgically debrided the necrotic tissue, followed by a total elbow arthroplasty to compensate for the extensive bone loss. Unlike the atraumatic case, our approach required a multidisciplinary strategy reflecting the functional demands in our case. Even though this case was isolated and not a complex traumatic injury, it is worth mentioning as it highlights the rarity of AVN of the olecranon and serves as an important reference that helps us understand and manage this uncommon pathology.

The present case shows that it is important to have a structured approach in managing complex trauma cases. The success that was achieved in this case is only made possible by great

multidisciplinary efforts. Recent articles emphasize that one of the most important factors required to achieve optimal outcomes in major upper extremity trauma when deciding between limb salvage and amputation is having tight collaborations between surgeons from multiple specialties [10, 11]. The present case is a key example of this principle, highlighting that a joint effort between different specialties could convert a devastating injury into a successful recovery.

Conclusion

This case demonstrates that when confronted with the decision to amputate or pursue limb salvage, opting to save the limb can lead to positive outcomes. Using innovative solutions, planning precisely, and a collaborative approach, we were able to restore function and allow the patient to return to his professional and personal life. The present case reflects the possibilities of modern reconstructive surgery in overcoming even the most challenging injuries.

Clinical Message

This case demonstrates the complexities of managing severe upper extremity trauma, particularly the critical decision that sometimes needs to be made regarding limb salvage and amputation. It highlights the importance of making functionality a priority for patients and integrating a structured approach to reconstruction. This report provides important insights into innovative surgical strategies and multidisciplinary collaboration that can serve as a guide for similar challenging cases in current clinical practice.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

References

1. Beeharry MW, Walden-Smith T, Moqem K. Limb salvage vs. amputation: Factors influencing the decision-making process and outcomes for mangled extremity injuries. *Cureus* 2022;14:e30817.
2. Qureshi MK, Ghaffar A, Tak S, Khaled A. Limb salvage versus amputation: A review of the current evidence. *Cureus* 2020;12:e10092. Erratum in: *Cureus* 2020;12:c38.
3. Ng ZY, Askari M, Chim H. Approach to complex upper extremity injury: An algorithm. *Semin Plast Surg* 2015;29:5-9.
4. Cibula Z, Hrubina M, Kiss J, Melisik M, Necas L. Complex open elbow fracture Gustilo-Anderson type IIIB treated with the primary elbow arthroplasty: A case report. *Chin J Traumatol* 2021;24:120-4.
5. Zeng Q, Cai G, Liu D, Wang K, Zhang X. Successful salvage of the upper limb after crush injury requiring nine operations: A case report. *Int Surg* 2015;100:540-6.
6. Anzel SH, Covey KW, Weiner AD, Lipscomb PR. Disruption of muscles and tendons; an analysis of 1, 014 cases. *Surgery*

1959;45:406-14.

7. Weistroffer JK, Mills WJ, Shin AY. Recurrent rupture of the triceps tendon repaired with hamstring tendon autograft augmentation: A case report and repair technique. *J Shoulder Elbow Surg* 2003;12:193-6.

8. Wolf JM, McCarty EC, Ritchie PD. Triceps reconstruction using hamstring graft for triceps insufficiency or recurrent rupture. *Tech Hand Up Extrem Surg* 2008;12:174-9.

9. Schneider AK, Ek ET. Isolated avascular necrosis of the

olecranon. *J Shoulder Elbow Surg* 2017;26:e198-202.

10. Nayar SK, Alcock HMF, Edwards DS. Primary amputation versus limb salvage in upper limb major trauma: A systematic review. *Eur J Orthop Surg Traumatol* 2022;32:395-403.

11. Xu AL, Jain D, Humbyrd CJ. The decision for amputation versus limb salvage in patients with limb-threatening lower extremity indications: An ethical analysis. *Orthop Clin North Am* 2025;56:67-74.

Conflict of Interest: Nil
Source of Support: Nil

Consent: The authors confirm that informed consent was obtained from the patient for publication of this case report

How to Cite this Article

Koukos C, Chatzivasiliadis M, Kapetanakis S, Latz D, Samundeeswari S, Montoya F. Limb Salvage and Reconstruction of a Complex Upper Extremity Injury: A Case Report. *Journal of Orthopaedic Case Reports* 2025 February;15(2): 49-54.