A Tale of Perseverance—A Ukrainian Soldier's Fight to Keep His Arm After a Blast Injury

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Introduction

Blast injuries can have disastrous outcomes in soldiers during wartime. In addition to psychological effects, a significant portion of these injuries unfortunately end with amputation.[1,2] In cases where the affected extremity is still intact, limb salvage techniques have continued to advance to preserve the limb and functionality of patients who sustain traumatic injuries to their extremities. Vascularized osseous grafts are a good option to provide soft tissue coverage and support for large bony defects from blast injuries[3] When complications such as infection arise, the ultimate priority is to preserve the structural integrity of the bone to allow for functional use of the limb. We present a case of a Ukrainian soldier who sustained life altering injuries and still fights to keep his left arm despite multiple setbacks.

Case Presentation

The patient is a 43-year-old male Ukrainian military referral who suffered a blast injury in May 2022. Orthopedic injuries included a left comminuted humeral shaft fracture, and a left comminuted femoral shaft fracture, ruptures of the cruciate ligaments of the left knee, and gunshot wounds to both hands (right index finger, left thumb metacarpal). The patient underwent left humerus open reduction internal fixation in Ukraine. This was unfortunately complicated by an infection. The left humerus hardware was removed, and an external fixator was placed then placed. This was further complicated by another fracture while in the external fixator, so a revision external fixator was placed.

On presentation to clinic, the patient was noted to have intact hand and elbow function. He had minimal shoulder range of motion since this injury. The patient's left humerus external fixator pins were draining as well. X-rays of his left humerus showed an external fixator in place with segmental bone loss and areas of persistent fracture lines along the midshaft of the humerus (Figure 1). His left lower extremity x-rays demonstrated healing of his left femur fracture with callous formation along the shaft (Figure 2). The patient unfortunately developed a foot drop after his injury with an inability to evert his foot. He also endorsed numbness along the dorsal aspect of his foot for which he wore a brace.

On mid-September 2023, the patient underwent a right vascularized fibular graft

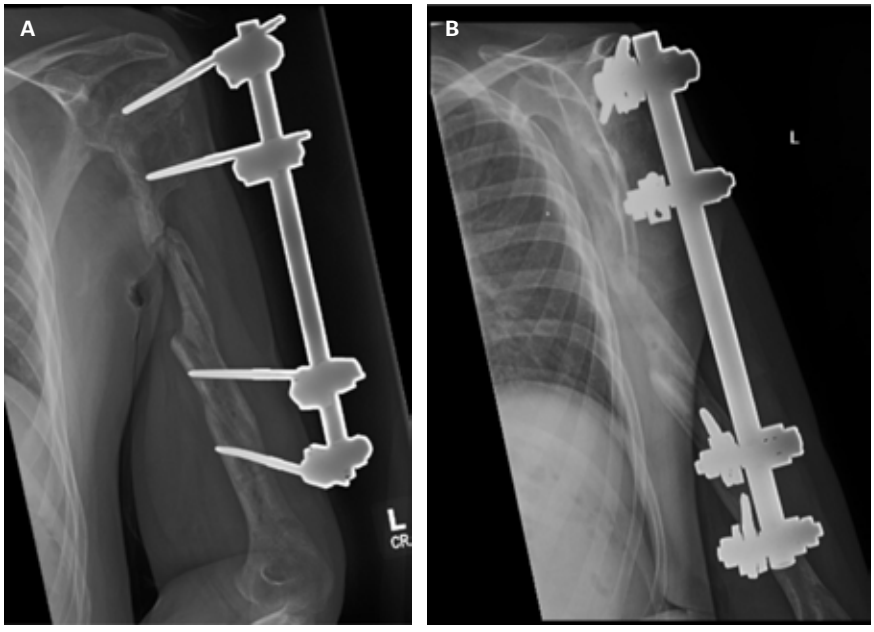

Figure 1. Left humerus x-rays. **(A)** AP **(B)** and lateral x-rays of the left humerus showing an external fixator in place. There is segmental bone loss and areas of persistent fracture lines along the midshaft of the humerus.

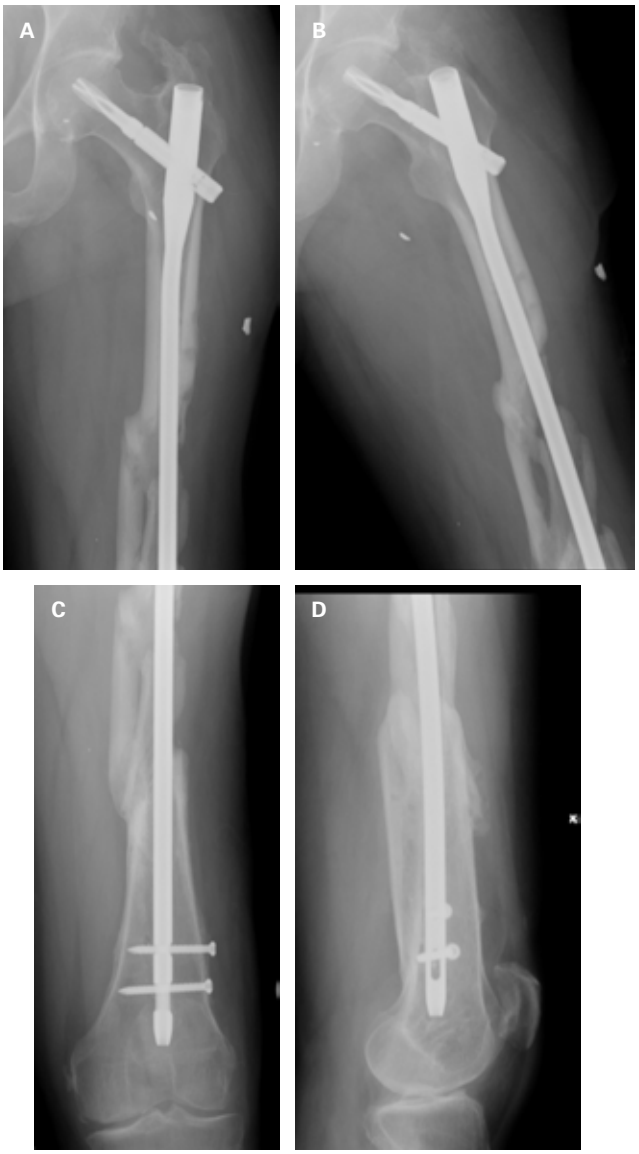

Figure 2. Left femur x-rays. **(A)** AP **(B)** Oblique proximal femur **(C)** and lateral of the distal femur showing LEFT femur showing callous formation along the midshaft of the femur. Multiple scattered metallic shrapnel/fragments about the thigh/proximal hip. Heterotopic ossification about the left hip is also noted.

with skin flap transfer to the left humerus due to the segmental bone loss (Figure 3). He also had a split thickness skin graft from his right thigh placed onto his right distal shin to cover the donor site. For further structural support to his left humerus, a bridge plate was placed as well. During the postoperative period, the left upper extremity flap became cool, signals grew faint, and an ecchymotic color change was noticed by the orthopedic team. On postoperative day 2 (POD2), he was taken back for left upper extremity flap exploration. A sizeable hematoma was found and evacuated. Thrombotic agents were applied to the flap site. Addition of a second venous outflow with the saphenous vein from the left leg was performed. A skin substitute was used for additional reinforcement. A clinical photo of the left upper extremity after this operation is shown in Figure 4.

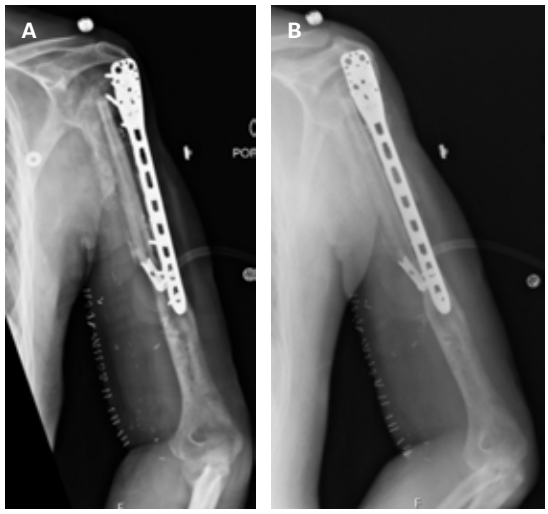

Figure 3. Left humerus x-rays after vascularized fibula graft. **(A)** AP and **(B)** lateral x-rays showing a lateral plate with screws. A large defect of the proximal humerus is filled with vascularized fibula graft. There is a plate remnant along the inferior margin of the bone graft. Severe glenohumeral arthritis is noted with evidence of remodeling.

Figure 4. Clinical photo of the left humerus demonstrating the flap on POD1 from hematoma evacuation and skin substitute placement. There is slight ecchymosis over the proximal portion of the flap. Flap edges are covered with xeroform. A posterior slab splint is in place for support of the extremity.

On POD6, the patient was found to have an acute superficial vein thrombosis of his right upper extremity. This was treated with therapeutic low molecular weight heparin. The patient subsequently developed left upper extremity flap proximal wound dehiscence.

On POD9, the patient underwent a removal of the skin paddle with fasciocutaneous flap transposition via a thoracoacromial perforator from his left upper chest to his left arm. Right thigh skin graft was taken to cover his left chest and left distal arm. A negative pressure wound

therapy (NPWT) sponge bolster to his left chest was applied to help with granulation at his left chest wall site. Surgical pathology from this operation yielded no growth. The NPWT was removed a few days after the operation. A clinical photo of the LUE after this operation is depicted in Figure 5. Further into his hospital course, it was noted that his right lower extremity had exposed peroneal tendons (Figure 6). His left humerus flap site also expressed purulent drainage.

Figure 5. Clinical photo of the left humerus demonstrating the flap on POD4 from left chest thoracoacromial perforator flap transposition to the left arm. There is progression of the distal flap ecchymosis. A drain is in place adjacent to the lateral aspect of the flap.

Figure 6. Clinical photo of the right lower extremity (lateral shin) demonstrating exposed peroneal tendon in the center of the skin graft recipient site.

On POD18, he underwent a left upper extremity irrigation and debridement and a right lower extremity irrigation and peroneal tendon debridement. Purulent drainage was encountered at the left upper extremity flap site. A NPWT sponge was applied to his left arm and right leg. On POD21, he underwent a left chest wall/left upper extremity (LUE) irrigation and debridement and a right lower extremity (RLE) irrigation and debridement with removal of the RLE NPWT. Skin substitute was used on his LUE and RLE at this time as well. OR Cultures from this operation grew Klebsiella pneumonia, Pseudomonas, Streptococcus mitis, Streptococcus oralis, Enterobacterales.

On POD29, the patient underwent a left chest wall, LUE, and RLE irrigation and debridement. A skin substitute was placed to his LUE and RLE. On POD30, a RUE ultrasound revealed a radial vein deep vein thrombosis (DVT) and basilic vein superficial vein thrombosis. The patient was started on a therapeutic heparin drip.

The patient developed an increase oxygen requirement and work of breathing. On POD36, sputum Cultures grew gram positive cocci, gram negative rods, and Klebsiella pneumonia.

Figure 7. Clinical photos postop day ten from a repeat LUE and RLE irrigation and debridement. **(A)** Right leg (distal lateral shin) showing robust granulation tissue and only a minimal amount of exposed peroneal tendon; **(B)** LUE showing a healthy flap with a small amount of granulation tissue and eschar on its distal portion. Drain is present lateral to the flap.

On POD38, the patient underwent a repeat LUE and RLE irrigation and debridement. Gross purulence was noted around the LUE flap site. Intra-operative cultures grew Pseudomonas. Clinical photos ten days after this procedure are shown in Figure 7. On POD46, the patient also developed acute respiratory distress syndrome during this time and was treated conservatively with Lasix as he was already on antibiotics.

On POD57, the patient underwent a LUE and RLE irrigation and debridement as well as split thickness skin grafting from the right thigh to the LUE and RLE (distal lateral shin). On POD65, the patient underwent a left upper extremity irrigation and debridement with removal of the humerus bridge plate (Figure 8). On POD85, the patient sustained a fall onto his left upper extremity and developed wound dehiscence at his flap site. On POD86, the patient underwent a left upper extremity examination under anesthesia, irrigation and debridement, and revision closure of his wound dehiscence. The patient was placed into a coaptation splint at that time. He was eventually transitioned to a Sarmiento brace. During his clinical stay, the patient had frequent dressing changes to his operative sites with wet-to-wet dressings.

During this clinical course, the patient was followed by the infectious disease specialists. They placed him on cefiderocol and daptomycin during his stay. He was ultimately discharged without antibiotics due to the pan-resistant nature of his grown infectious organisms. For his RUE DVT, he was eventually discharge on apixaban. The patient was admitted for sixty-nine days consecutive days during his longest hospital stay. He was discharged to acute rehab. He was made weight bearing as tolerated to his RLE and non-weightbearing to his LUE in an abduction brace and sling.

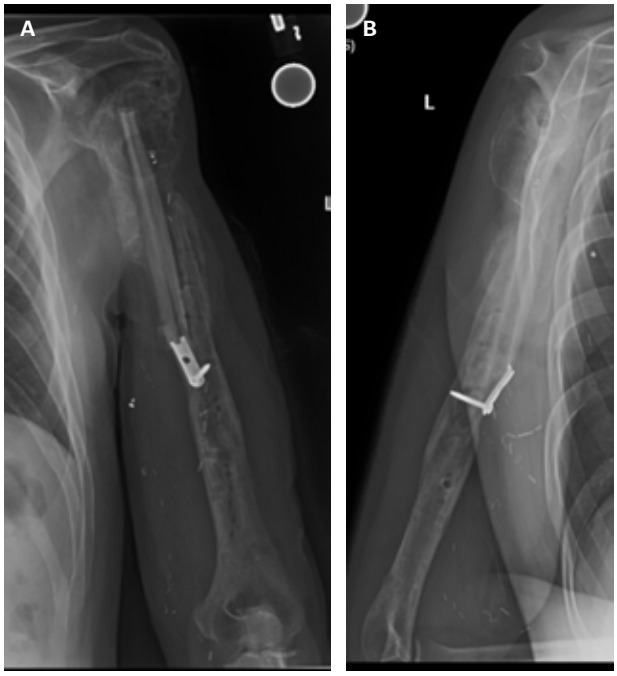

Figure 8. Left humerus x-rays. **(A)** AP and **(B)** lateral showing evidence of vascularized bone graft in the proximal femur. The bridge plate has been removed. Glenohumeral arthritis is noted.

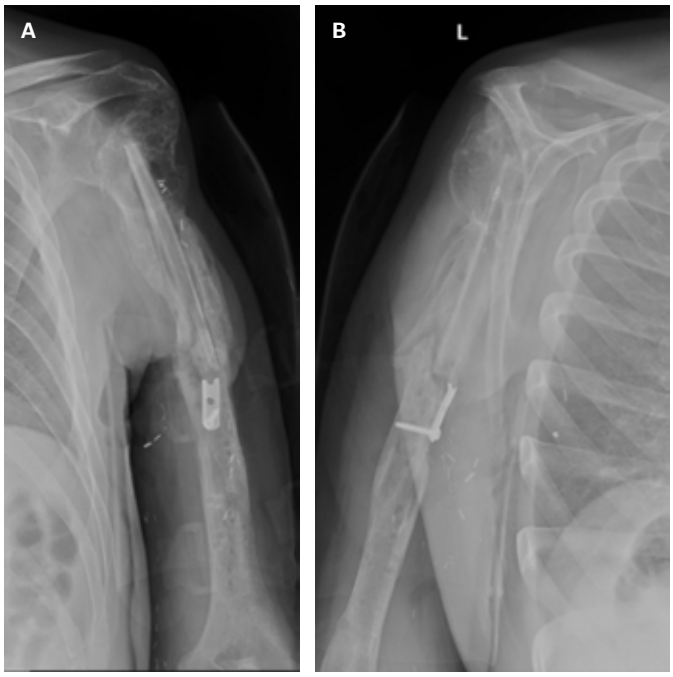

Figure 9. Left humerus x-rays from most recent follow up visit. **(A)** AP and **(B)** lateral showing evidence of vascularized bone graft in the proximal femur. The bridge plate has been removed. Fracture lines are still present but there is slightly more callus along the course of the humeral shaft compared to prior imaging. Glenohumeral arthritis is noted.

During his most recent clinic visit (six months postop), he noted to have no pain in his left upper extremity. There was no motion at the fracture site on clinical examination. X-rays at that time showed persistent fracture lines but slightly more callus along the course of the humeral shaft compared to prior imaging (Figure 9)

The patient followed with sports medicine for chronic left ACL/MCL sprain with arthrofibrosis in suprapatellar pouch for which a surgical arthroscopy with manipulation under anesthesia is recommended. He has also followed with foot and ankle specialists who recommend a tendon transfer versus an arthrodesis for his persistent foot drop. He is currently wearing an ankle-foot orthosis to manage this condition.

Discussion

Blast injuries can be life-altering injuries to soldiers during war time. To minimize the morbidity associated with these injuries, limb salvage is a viable option to preserve the injured limb. In the setting of significant bone loss or infection, vascularized fibula free flaps have been presented as an excellent source of bone to promote healing.[5,6] In the setting of severe proximal humerus bone loss, some have advocated for glenohumeral arthrodesis using a vascularized fibula bone graft.4 We did not elect for this procedure as the patient still had some shoulder range of motion which he wanted to preserve. Complications of vascularized osseous flaps include nonunion, infection,

and wound complications.[7] Flap hematomas can lead to flap failure because the increased pressure at the flap site makes it difficult for the tissues to get adequate perfusion. Infections of the flap should be treated promptly with irrigation and debridement and targeted antibiotics to have the best chance for flap viability and for osseous healing. Vigilance should be maintained by the inpatient team to ensure that changes in flap color, signal, or turgor are caught in a timely manner so that early interventions can minimize damage to the flap site. The importance of DVT prophylaxis and incentive spirometry should also be emphasized as DVTs/pulmonary embolisms and acute respiratory distress syndrome/pneumonia are complications that are associated with longer hospital stays and immobilization.

Conclusion

We present a case of a Ukrainian soldier with multiple devastating blast injuries. Despite many setbacks and complications along his clinical course, the patient was able to keep his left arm after a vascularized free fibula graft. In addition, the patient has reasonable functionality of that extremity and can perform his daily activities. The determination, resolve, and perseverance that this patient displayed along his clinical course is an inspiration to family, friends, and the medical staff who took care of him.

In the attachments (and with the patient's consent), there is a link to the patient's most recent clinical exam showing use of his left arm.

References

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