Complex Post-Traumatic Reconstruction of the Lower Limb: A Case Report on Managing Soft Tissue Defects and Deltoid Ligament Damage Using an ALT Flap With Fascia Lata Extension and Fascia Lata Graft

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Federico Ziani[1], Corrado Rubino[1,2], Anna Manconi[1], Giovanni Arrica[1], Claudia Trignano[3], Ilaria Ginatempo[2], Matilde Tettamanzi[1], Emilio Trignano[1,2]

[1]Plastic Surgery Unit, University Hospital Trust of Sassari, 07100 Sassari, Italy
[2]Department of Medicine, Surgery and Pharmacy, University of Sassari, 07100 Sassari, Italy
[3]Department of Biomedical Sciences, University of Sassari, 07100 Sassari, Italy

AIM: High-energy ankle traumas often lead to extensive soft tissue loss and ligament damage, making reconstruction both challenging and crucial for restoring stability and function. This study evaluated the effectiveness of using a free anterolateral thigh (ALT) flap with a fascia lata extension for addressing complex soft tissue defects and repairing the deltoid ligament in complex post-traumatic ankle injuries.

CASE PRESENTATION: A 38-year-old man was examined at the Plastic Surgery Unit three months after a motorcycle crash for reconstruction of a soft tissue defect and deltoid ligament repair. Clinical examination revealed a 3 × 5 cm soft tissue defect with bone exposure and ankle instability. Reconstruction was planned and performed using a free ALT flap with an extension of the fascia lata and a fascia lata graft for deltoid ligament repair. No complications of the flap and no clinical signs of local infection were observed. During the follow-up period of 12 months, the ankle stability and the gait were improved with a reduction in pain.

RESULTS: No complications related to the flap or clinical signs of infection were observed postoperatively. During the 12-month follow-up period, the patient exhibited improved ankle stability, reduced pain, and enhanced gait. At the one-year follow-up, the patient achieved a satisfactory functional outcome with an American Orthopedic Foot and Ankle Society (AOFAS) score of 79 points. The reconstructed tissue demonstrated adequate coverage, and the deltoid ligament repair provided joint stability. While flap bulkiness necessitated minor debulking surgery, the aesthetic and functional outcomes were satisfactory, with the patient expressing high satisfaction at 15 months post-surgery.

CONCLUSIONS: The ALT flap combined with fascia lata graft is a viable option for soft tissue loss and deltoid ligament injury in clinical cases. While the ALT flap offers numerous advantages, including ease of harvest, pedicle length, and versatility, its bulkiness may necessitate revision surgery. However, despite this drawback, the combination of ALT flap and fascia lata demonstrated positive outcomes in our patient, highlighting its effectiveness in providing adequate tissue coverage and repairing the deltoid ligament.

Keywords: ankle reconstruction; ALT free flap; fascia lata; deltoid ligament; deltoid ligament repair; lower limb; microsurgery; case report

Introduction

Foot and ankle traumas from road traffic accidents and crash injuries can have severe consequences due to the high-energy impact. Such accidents pose a considerable challenge for surgeons when treating soft tissue defects in the ankle region. These types of injuries commonly result in complex bone fractures, the loss of soft tissue, and damage to vital joint components, including tendons and ligaments. These structures are crucial for normal movement and stability of the ankle, and their loss necessitates functional reconstruction.

The deltoid ligament is considered the primary ligamentous stabilizer of the ankle joint [1]. It consists of superficial and deep components, both of which can suffer damage during a rotational ankle fracture. Surgical interventions for deltoid ligament injuries are often immediate in cases of unstable ankle fractures to prevent further complications. If deltoid ligament injuries are not addressed, they may give rise to conditions like osteoarthritis and planovalgus foot deformity [2].

This report details a case involving a complex injury that affected both the soft tissue and the medial ankle ligaments, with a particular focus on the anatomical reconstruction of the damaged deltoid ligament. This report aims to present a comprehensive approach to complex ankle reconstruction involving both soft tissue loss and deltoid ligament repair. The case has been reported in line with the Case Report (CARE) Guidelines to ensure the accuracy and completeness of the report (**Supplementary material**).

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Correspondence to: Federico Ziani, Plastic Surgery Unit, University Hospital Trust of Sassari, 07100 Sassari, Italy (e-mail: zianifederico@gmail.com).

Fig. 1. Photograph after the injury. The orange arrow indicates the loss of substance with bone exposure.

Case Presentation

In February 2023, a 38-year-old male patient, a non-smoker with a body mass index (BMI) of 24.6 and no comorbidities, sustained a crash injury resulting in an open fracture and dislocation of the right tibia and fibula, along with a tissue defect in the medial malleolar region and damage to the deltoid ligament (Fig. 1). Additionally, there was a displaced fracture of the tibia and fibula in the left lower limb. Upon arrival at the nearest emergency department, the orthopedic team applied an external axial fixator to the right limb (Fig. 2A). On the left limb, an open reduction and internal fixation (ORIF) with plates and screws was performed (Fig. 2B). A conservative approach was initially taken by primarily closing the wound at the ankle. On the left side, the fracture was stabilized by using plates and screws under general anesthesia.

One-week post-trauma, skin necrosis developed over the medial malleolus, prompting wound debridement and the application of negative pressure wound therapy (NPWT). In May 2023, the patient was referred to our Plastic Surgery Unit to assess the possibility of closing the wound and repairing the deltoid ligament, as the wound was not fully

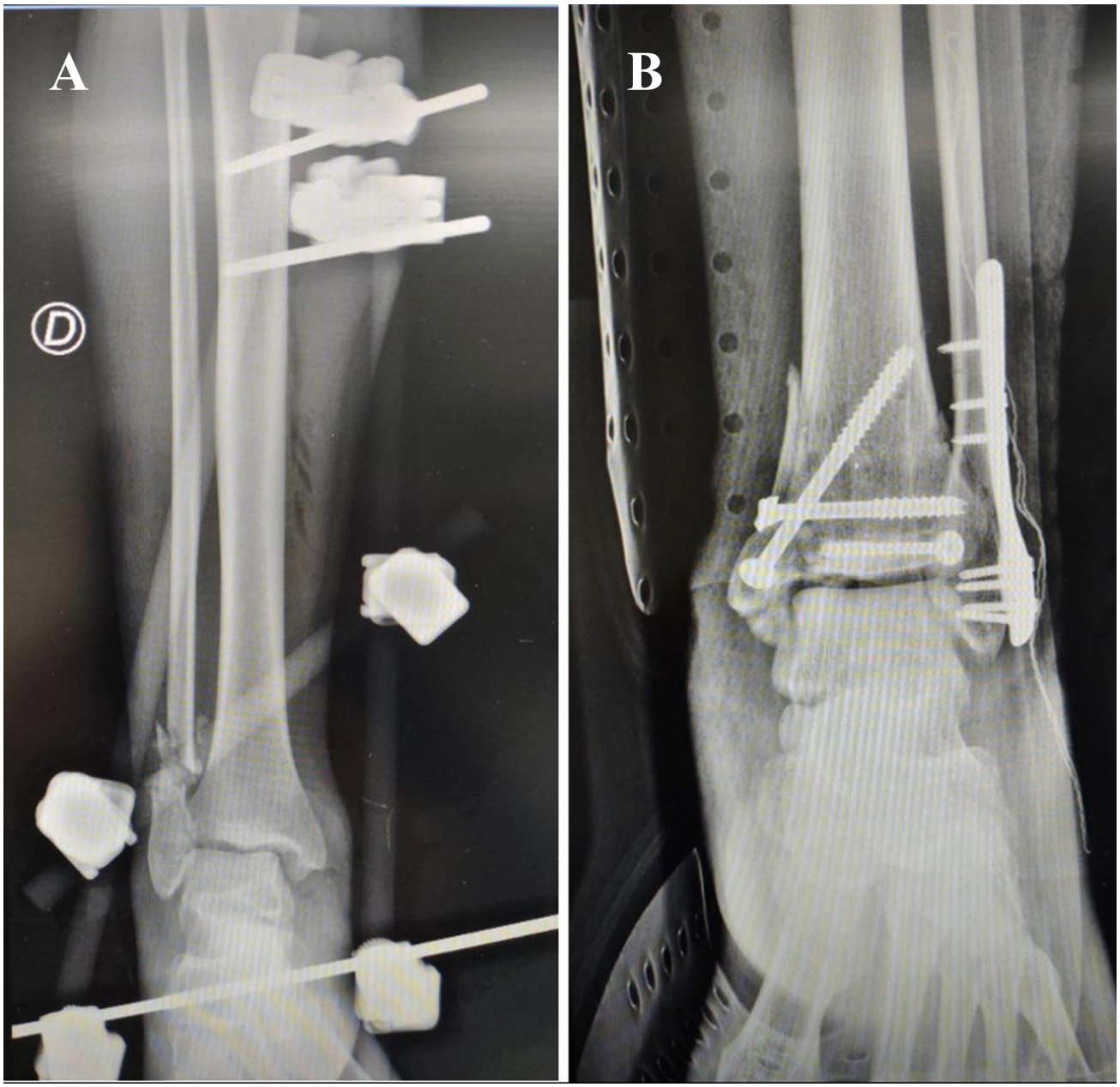

Fig. 2. Post-operative X-rays. (A) Right leg, post-placement of the external fixator for tibia fracture stabilization. (The letter "D" indicates the right side of the patient.) (B) Left leg, post-open reduction and internal fixation (ORIF) with screws and plates.

healed. Clinical examination revealed a 3 × 5 cm (15 cm^2) tissue loss with exposed bone affecting the medial malleolus area (Fig. 3). The patient also exhibited ankle joint instability.

The first surgical step involved meticulous debridement of the wound. The anterior tibial artery and veins were identified and prepared as recipient vessels (Fig. 4A,B). A 5 × 6 cm (30 cm^2) anterolateral thigh (ALT) flap with a fascia lata extension was raised (Fig. 4C,D), based on a septal perforator from the descending branch of the lateral circumflex femoral artery (Fig. 5A,B) and a fascia lata graft was harvested (Fig. 5C).

The fascia lata graft was shaped into a double ligament and anchored to reconstruct the damaged deltoid ligament (Fig. 6A). Additionally, the fascia lata extension was used to cover the new ligament. Vascular anastomoses were performed, including arterial end-to-side and venous end-to-end anastomoses using a 1.5 mm coupler (Fig. 6B). The donor site was closed primarily (Fig. 6C). The total duration of surgery was 300 min with a flap ischemia time of 40 min.

To prevent any foot movement, an ankle-foot orthosis was employed for 21 days. The postoperative period was uncomplicated, and the flap monitoring was based on a traditional careful periodic clinical observation, based on the evaluation of the color, turgor, temperature, capillary refill, and pinprick [3]. The patient was discharged after a 7-day stay and a rehabilitation program was scheduled.

Fig. 3. Preoperative photograph. The yellow arrow indicates a 3 × 5 cm wound with bone exposure.

Follow-up appointments for medication management were set for 9, 12, 15, 18, and 21 days post-surgery. Moreover, 15 days after surgery, the flap successfully survived, and the stitches were removed. The donor site on the left thigh healed, leaving a 14 cm linear vertical scar which was normochromic and normotrophic, with no signs of infection or dehiscence. At the 6-month follow-up, the patient could walk comfortably without pain and with good ankle stability (Fig. 7A,B). As the flap was bulky, debulking surgery was planned (Fig. 7C).

One year after the surgery, no ulceration was observed, and the function of the ankle was assessed using the American Orthopedic Foot and Ankle Society (AOFAS) ankle-hindfoot scoring system [4]. The AOFAS scoring system, as originally developed by Kitaoka *et al*. (1994) [5], has a maximum score of 100 points, combining subjective and objective clinical assessments, including pain, activity limitations, support requirements, gait, range of motion, stability, and alignment. Although the original AOFAS system does not provide an official categorization of out-

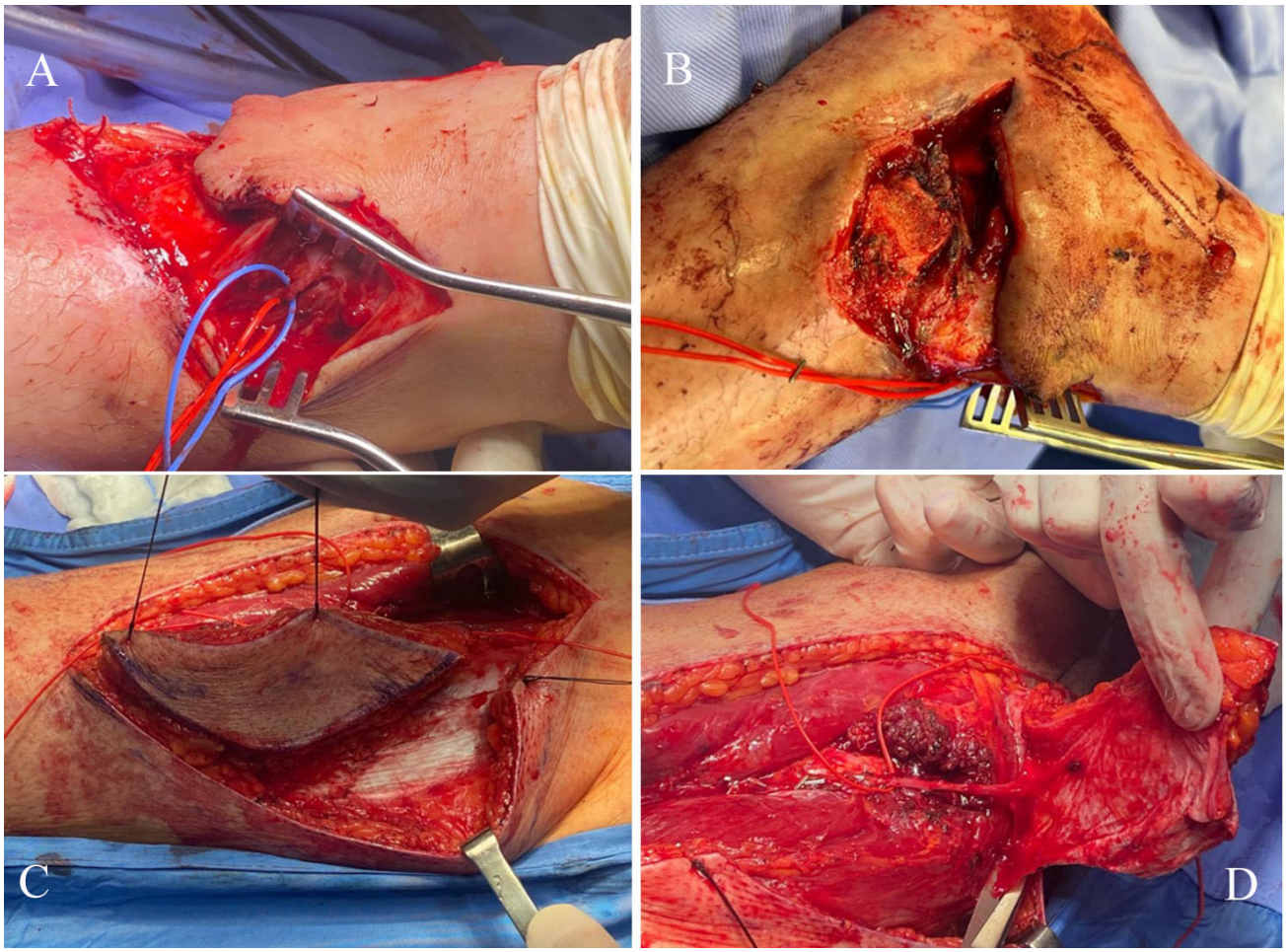

Fig. 4. Intraoperative photographs. (A,B) Preparation of the recipient vessels. (C) The perforator of the descending branch of the lateral circumflex femoral artery is shown between rectus femoris and vastus lateralis muscle. (D) The perforator is isolated.

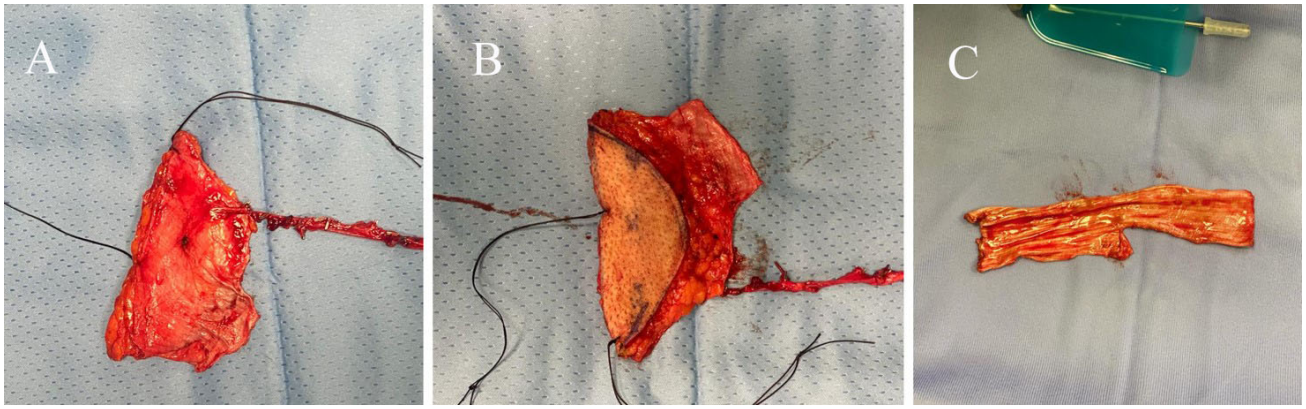

Fig. 5. Intraoperative photographs. (A,B) Anterolateral thigh (ALT) flap combined with an extension of the fascia lata; (C) fascia lata graft.

come scores, we adopted a classification commonly used in clinical studies to facilitate the interpretation of results [6]. According to this classification, scores ranging from 91 to 100 points are considered indicative of an excellent outcome, scores between 76 and 90 points reflect a good outcome, scores between 51 and 75 points indicate a fair outcome, and scores from 0 to 50 points correspond to a poor outcome. According to this categorization, the patient achieved a total score of 79 points, indicating a satisfactory functional outcome in the fair outcome category. Additionally, at the 15-month follow-up, the patient expressed satisfaction with the aesthetic result (Fig. 8). Postoperative assessments also considered the time taken to return to daily living activities, such as bearing weight on the re-

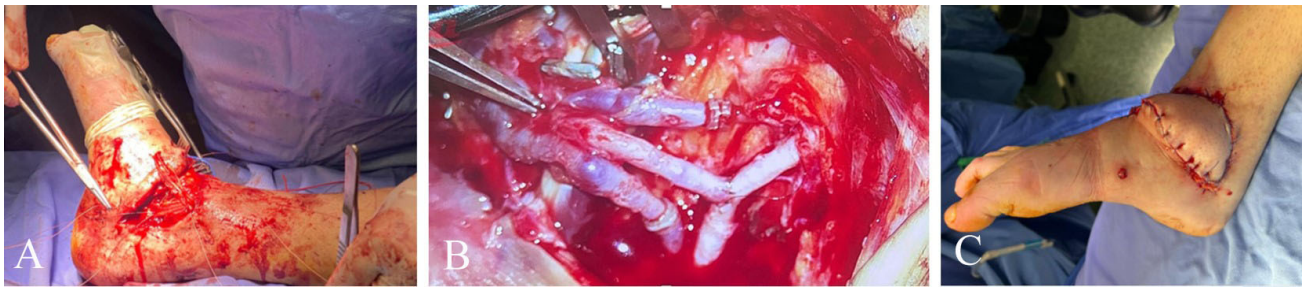

Fig. 6. Intraoperative photographs. (A) Deltoid ligament reconstruction. (B) Vessels anastomoses. (C) Sutures of the flap.

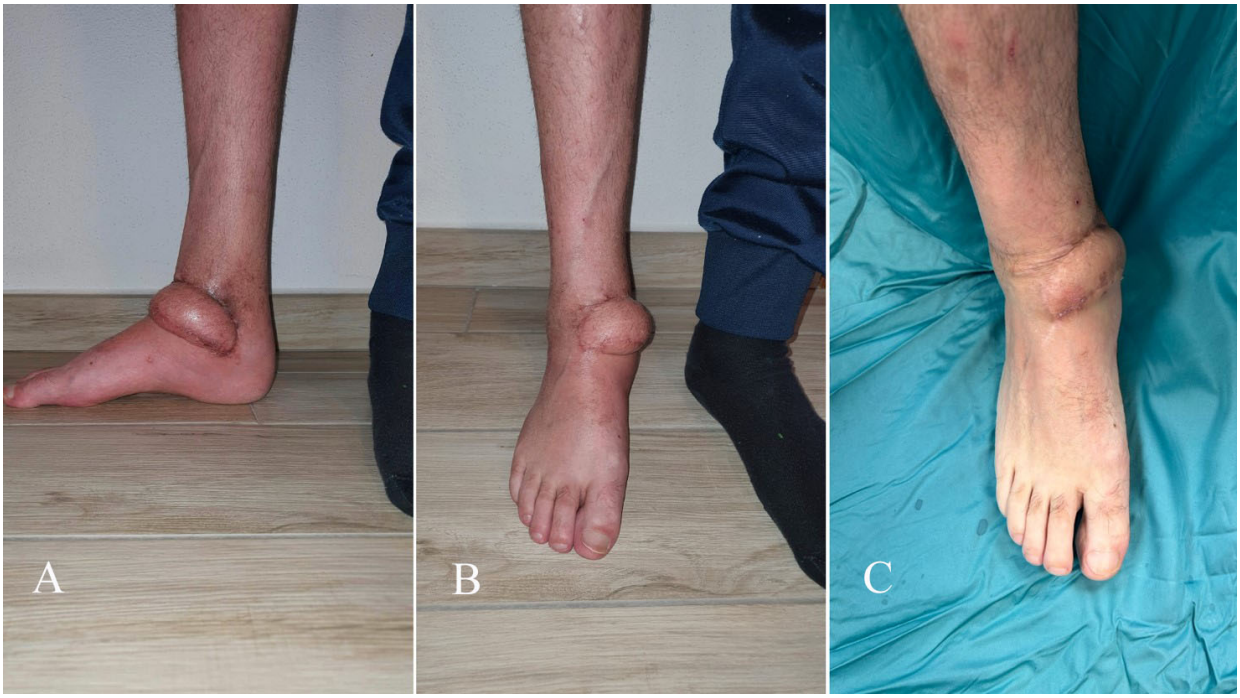

Fig. 7. Postoperative photographs. (A,B) 6-months follow-up. (C) 1-year follow-up.

constructed surface for at least 5 h per day, which was approximately 10 weeks.

Discussion

Distal lower extremity reconstruction following high-energy trauma can be a complex task since it often necessitates free tissue transfer for successful coverage of the underlying bones, joints, and tendons that are exposed [7]. In some cases, both soft tissue and bone or tendon structures can sustain significant damage, requiring meticulously coordinated planning to restore complete limb functionality [8,9]. Consequently, achieving optimal outcomes and facilitating the patient's functional recovery may demand additional procedures for bone repair and tendon or ligament reconstruction, beyond merely providing tissue coverage.

The deltoid ligament serves as the primary stabilizing structure of the ankle joint [1]. It is an integral component of the medial ankle ligamentous complex, consisting of a deep portion that restricts external rotation of the talus, and a superficial portion that prevents hindfoot eversion [10]. The contemporary consensus holds that the compromised deltoid ligament should be addressed [10,11]. If adequate tissue remains, primary repair employing suture anchor fixation to the medial malleolus is possible. In cases where reconstruction is necessary, either autograft or allograft may be employed [2]. A variety of soft-tissue reconstructive techniques for the lower limb have been shown to restore these critical functions, including NPWT or acellular dermal matrix (ADM) with skin grafting [12,13], local flaps [11], local pedicled flaps [12], and free flaps [13–19].

In our patient, NPWT had previously been utilized by the orthopedic team to maintain wound cleanliness and encourage healing, yet complete closure of the wound was not achieved. Moreover, due to the presence of an exposed area on a severely fragmented and deteriorated fracture, the use of an ADM was ruled out. Consequently, we opted to cover the defect directly with a flap. Although local flaps have been widely used to cover ankle and foot defects [14,20,21], we ruled out this option due to the high-energy trauma, which posed a risk of damage to the vessels and tissues near the wound, as well as an increased risk of fibrosis.

Fig. 8. Patient at 15-month follow-up.

Therefore, we chose to perform deltoid ligament reconstruction in conjunction with a free tissue transfer, to select a flap that could provide tissue from nearby regions specifically for ligament reconstruction. Among muscle flaps, the gracilis flap is usually an effective option for repairing ankle defects [22], and the gracilis tendon is commonly used by orthopedists for tendon or ligament reconstructions [23]. However, we decided against its use due to the short pedicle. Although angiography demonstrated the functionality of both the tibialis anterior artery and the tibialis posterior artery, we preferred the anterior tibial artery for anastomosis due to its distance from the trauma site. Given the high-energy nature of the trauma, there was a concern that the posterior tibial artery might still have sustained microtrauma, rendering it less ideal as the recipient vessel for the reconstruction [24]. Consequently, the vascular pedicle of the gracilis flap was deemed too short.

Sever *et al*. [25] suggested that the thoracodorsal artery perforator (TAP) flap is a viable alternative for soft tissue coverage, especially in lower extremities where the ideal reconstruction should be stable, thin, and resistant to friction forces from footwear. The TAP flap provides thinner skin, well-vascularized tissue with minimal donor-site morbidity, and a long pedicle [26]. However, this option requires intraoperative repositioning, a particularly complex and risky maneuver in the presence of the patient's external fixators. We decided to perform an ALT-free flap, which not only has a longer pedicle but also provides the opportunity to extend the flap to the lateral fascia, thereby enabling us to utilize a vascularized fascia graft. ALT-free flap is considered a workhorse for lower extremity reconstruction, including those with exposed bones and tendons [27]. The advantages of this type of flap include ease of harvesting, a long pedicle, and low donor site morbidity which are crucial in cases like ours involving high-energy trauma [27]. This also allowed us to harvest it as a graft, a procedure we performed to reconstruct the damaged deltoid ligament. The decision to use the fascia lata as the graft material was made to minimize the overall surgical impact on the patient. By utilizing the same donor site as the ALT flap, we avoided creating an additional surgical scar, thereby reducing postoperative morbidity and improving the patient's aesthetic outcome. The use of another graft source [28–30], while feasible, would have resulted in additional scars and potential donor site complications, which was not ideal given the already extensive nature of the trauma. To date, no study has reported using free ALT flap with an extension of fascia lata combined with fascia lata graft for the reconstruction of

the deltoid ligament and the coverage of soft tissue defects [31]. In a study by Son *et al*. [32], a free chimeric ALT flap with fascia lata was used to reconstruct the Achilles tendon and overlying skin defects, demonstrating that fascia lata can function as a tendon-like structure. Nakata *et al*. [33] have successfully utilized allogenic fascia lata for the reconstruction of lateral ankle ligaments, providing good alternatives to autologous grafts [34] or suture devices [31].

Our approach expands the reconstructive options available for complex cases, particularly in situations where soft tissue loss is combined with ligament damage. The fascia lata extension not only provides coverage for the soft tissue defect but also plays a critical role in creating a neocapsule, which supports joint stability. Notably, one potential disadvantage of the flap is that it is bulky [35]. A revision procedure under local anesthesia is usually sufficient to reduce the flap volume. Although our approach was successful for donor-site healing without complications, it is worth noting that alternative strategies, such as the use of polyurethane dressings with ibuprofen have demonstrated efficacy in reducing pain and promoting healing [36]. Such techniques may be particularly helpful in cases where donor-site healing is more challenging or prolonged. During the follow-up period, our patient experienced excessive bulkiness after reconstruction. A minor surgical revision effectively reduced the flap volume, allowing him to wear shoes and achieve full satisfaction.

Complex reconstructions, such as in our case, often require not only vascularized tissue but also supplementary grafts to ensure adequate volume for ligament and capsular reconstruction. In our case, both vascularized tissue and an additional fascia lata graft were required to fully restore the deltoid ligament and ensure joint stability. We opted for the ALT-free flap combined with an extension to the fascia lata to provide a vascularized fascia that would serve as a new capsule. This approach offered additional structure to the joint and covered the fascia lata graft, which was shaped as a double ligament and secured with a fixation on the anterior surface of the talus, the medial malleolus, and the medial and posterior surfaces of the calcaneus using four anchors.

While the results were positive, the use of the ALT flap combined with fascia lata is associated with risks, including compromised blood supply, infection, graft and flap failure, which are common considerations in free flap surgeries. Salvage techniques, such as pre-tie sutures and serial delayed closure, are promising for managing partial flap losses and improving outcomes, particularly in difficult zones where vascular compromise is more likely [37].

We chose fascia lata considering its abundant availability from the tensor fasciae latae, making it safe to harvest and providing sufficient tissue coverage and strength [35]. Although the fascia lata has been described in literature for reconstructions involving soft tissue defects [38], ours is the first report of its application in deltoid ligament reconstruction. For flap closure, we opted for a single-stitch suturing technique to prevent flap compression and the subsequent development of venous hypertension [39].

Conclusions

The combination of an ALT flap extended to incorporate the fascia lata, in conjunction with a fascia lata graft, offers surgeons a viable option for complex ankle reconstruction involving soft tissue loss and deltoid ligament damage. This method provides sufficient tissue coverage and addresses the critical need for ligament repair, thereby contributing to joint stability and improved functional outcomes. Furthermore, this intervention expands the reconstructive options available to surgeons dealing with challenging cases. Nevertheless, the potential limitations, including the need for additional grafts and the bulkiness of the ALT flap should be carefully considered during surgical planning. Future studies are needed to evaluate the long-term outcomes of this method.

Availability of Data and Materials

The data used or analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

The conception and design of the work: ET and CR; Methodology: FZ and MT; Validation: CR, CT and FZ; Formal analysis: IG, GA and AM; Investigation: ET, CT and AM; Data collection: AM and CT; Resources, ET; Writing-original draft preparation: FZ; Data analysis: GA and AM; Visualization: GA, AM, and CT; Supervision: CR; Writing-review & editing: AM and GA. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Ethical approval was deemed unnecessary in accordance with the Italian legislation on observational nature of the study. The study was conducted in full accord with the principles of the Declaration of Helsinki. The patient received detailed information and provided informed consent via telephone before inclusion.

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.62713/aic.3691.

References

[1] Loozen L, Veljkovic A, Younger A. Deltoid ligament injury and repair. Journal of Orthopaedic Surgery (Hong Kong). 2023; 31: 10225536231182345.

[2] Gopinath R, Pigott M, Lindsey B, Finney FT, Holmes JR, Walton DM, *et al*. Medial Ankle Instability: Review of Anatomy, Evaluation, and Treatment. Foot & Ankle Specialist. 2022; 15: 573–578.

[3] Trignano E, Fallico N, Fiorot L, Bolletta A, Maffei M, Ciudad P, *et al*. Flap monitoring with continuous oxygen partial tension measurement in breast reconstructive surgery: A preliminary report. Microsurgery. 2018; 38: 402–406.

[4] Leigheb M, Janicka P, Andorno S, Marcuzzi A, Magnani C, Grassi F. Italian translation, cultural adaptation and validation of the "American Orthopaedic Foot and Ankle Society's (AOFAS) ankle-hindfoot scale". Acta Bio-medica: Atenei Parmensis. 2016; 87: 38–45.

[5] Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical Rating Systems for the Ankle-Hindfoot, Midfoot, Hallux, and Lesser Toes. Foot & Ankle International. 1994; 15: 349-353.

[6] Li X, Yan X, Xie Q, Gu R, Wang Z, Liu F, *et al*. Medial Soft tissue and medial malleolus loss-the posterior tibial artery perforator technique combined with iliac crest autograft to Stabilize the ankle and cover Soft tissue defect: A case Series. Journal of Orthopaedic Surgery (Hong Kong). 2022; 30: 10225536221111588.

[7] Kelahmetoglu O, Mehdizade T, Unal M, Keles MK, Guneren E. Free ALT Perforator Flap in Nonobese Patients: The Recontouring of Soft Tissue Defects Around Foot. Indian Journal of Orthopaedics. 2021; 56: 445–451.

[8] Esmailian M, Ataie M, Ahmadi O, Rastegar S, Adibi A. Sensitivity and specificity of ultrasound in the diagnosis of traumatic ankle injury. Journal of Research in Medical Sciences: the Official Journal of Isfahan University of Medical Sciences. 2021; 26: 14.

[9] Wagner E, Wagner P, Escudero MI, Pacheco F, Salinas D, Godoy-Santos AL, *et al*. Acute Deltoid Injury in Ankle Fractures: A Biomechanical Analysis of Different Repair Constructs. Foot & Ankle International. 2023; 44: 905–912.

[10] Cooper MT. The Role of Deltoid Repair and Arthroscopy in Ankle Fractures. Clinics in Sports Medicine. 2020; 39: 733–743.

[11] Lughi M, Campagna A, Purpura V, Bondioli E. A New Treatment for the Reconstruction of the Medial Compartment of the Ankle: The Combined Use of Biological Materials. Joints. 2021; 7: 228–232.

[12] Shah A, Taupin P. Strategies for extremity reconstruction with exposed bones and tendons using acellular dermal matrices: concept of sequential vascularization. Case Reports in Plastic Surgery & Hand Surgery. 2021; 9: 7–14.

[13] Liu X, Zhang H, Li Y, Chen Y, Deng W, Zhang W. Application of Negative Pressure Wound Therapy in Total Ankle Replacement. The Journal of Foot and Ankle Surgery: Official Publication of the American College of Foot and Ankle Surgeons. 2021; 60: 283–287.

[14] Alfano C, Chiummariello S, Mazzocchi M, Trignano E, Rinaldi S. Use of the reverse flow island sural flap in the replacement of tissue loss involving the distal third of the leg, ankle and heel. Acta Chirurgiae Plasticae. 2006; 48: 10, 12–4.

[15] Yemenlehan Bahesutihan, Fan C, Wang X, Abulaiti Abula, Ren P, Aihemaitijiang Yusufu. Application of free transverse gracilis myocutaneous flap for soft tissue defects of foot and ankle. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi = Zhongguo Xiufu Chongjian Waike Zazhi = Chinese Journal of Reparative and Reconstructive Surgery. 2022; 36: 766–769. (In Chinese)

[16] Wu SP, Zhang FH, Yu FB, Zhou R. Medial malleolus and deltoid ligament reconstruction in open ankle fractures with combination of vascularized fibular head osteo-tendinous flap and free flap transfers. Microsurgery. 2009; 29: 630–635.

[17] Ciudad P, Kaciulyte J, Torto FL, Vargas MI, Bustamante A, Chen HC, *et al*. The profunda artery perforator free flap for lower extremity reconstruction. Microsurgery. 2022; 42: 13–21.

[18] Kim JH, Yoon T, Park JKH, Eun S. Reconstruction of Foot and Ankle Defects Using Free Lateral Arm Flap: A Retrospective Review of Its Versatile Application. BioMed Research International. 2021; 2021: 4128827.

[19] Trignano E, Fallico N, Nitto A, Chen HC. The treatment of composite defect of bone and soft tissues with a combined latissimus dorsi and serratus anterior and rib free flap. Microsurgery. 2013; 33: 173–183.

[20] Noaman HH, Mohamed MA, Faisal A, Soroor YO. Different surgical procedures for reconstruction of soft-tissue defects around the ankle. Injury. 2022; 53: 2657–2665.

[21] Lee JY, Lee HJ, Yang SH, Ryu JH, Kim HT, Lee BH, *et al*. Treatment of Soft Tissue Defects after Minimally Invasive Plate Osteosynthesis in Fractures of the Distal Tibia: Clinical Results after Reverse Sural Artery Flap. Medicina (Kaunas, Lithuania). 2023; 59: 1751.

[22] Eseme EA, Remy K, Mené BL, Walz SN, Madduri S, Oranges CM, *et al*. Sensory and pain outcomes of neurotized skin-grafted free gracilis muscle flaps for lower extremity reconstruction. Journal of Plastic, Reconstructive & Aesthetic Surgery: JPRAS. 2024; 92: 216–224.

[23] Mert A, Cinaroglu S, Keleş H, Aydin M, Çiçek F. Evaluation of Autografts Used in Anterior Cruciate Ligament Reconstruction in Terms of Tensile Strength. Cureus. 2023; 15: e39927.

[24] Ciudad P, Agko M, Date S, Chang WL, Manrique OJ, Huang TCT, *et al*. The radial forearm free flap as a "vascular bridge" for secondary microsurgical head and neck reconstruction in a vessel-depleted neck. Microsurgery. 2018; 38: 651–658.

[25] Sever C, Uygur F, Kulahci Y, Karagoz H, Sahin C. Thoracodorsal artery perforator fasciocutaneous flap: A versatile alternative for coverage of various soft tissue defects. Indian Journal of Plastic Surgery: Official Publication of the Association of Plastic Surgeons of India. 2012; 45: 478–484.

[26] Huff ML, Mansour AM, Raj MS, Allen RJ, Sr, Wallace SJ. Delayed Thoracodorsal Artery Perforator Free Flap for Calcaneal Degloving Injury Reconstruction. Plastic and Reconstructive Surgery. Global Open. 2023; 11: e4880.

[27] Kozusko SD, Liu X, Riccio CA, Chang J, Boyd LC, Kokkalis Z, *et al*. Selecting a free flap for soft tissue coverage in lower extremity reconstruction. Injury. 2019; 50 Suppl 5: S32–S39.

[28] Patel KA, Cabe T, Drakos M. Hamstring Autograft for Lateral Ligament Stabilization. Current Reviews in Musculoskeletal Medicine. 2020; 13: 289–297.

[29] Yadav U, Nemani M, Devgun A, Malik M, Agrawal GK. Iatrogenic Foot Drop After Anterior Cruciate Ligament Reconstruction With Peroneus Longus Tendon Autograft: Report of a Rare Case. Cureus. 2022; 14: e26476.

[30] Rossi MJ. Editorial Commentary: Pedicled Quadriceps Tendon Autograft for Medial Patellofemoral Ligament Reconstruction Eradicates Risk of Saphenous Nerve Injury Seen With Gracilis Autograft. Allograft, When Available, Also Shows Excellent Outcomes. Arthroscopy: the Journal of Arthroscopic & Related Surgery: Official Publication of the Arthroscopy Association of North America and the International Arthroscopy Association. 2024; 40: 446–448.

[31] Moonot P, Dakhode S, Karwande N, Pawar P. Combined Deltoid and Spring Ligament Reconstruction Using the Quadrangular Construct: Our Experience and Review of the Literature. Cureus. 2023; 15: e50361.

[32] Son TT, Dung PTV, Thuy TTH, Chien VH, Phuc LH, Huy LA. One-stage reconstruction of the massive overlying skin and Achilles tendon defects using a free chimeric anterolateral thigh flap with fascia lata. Microsurgery. 2022; 42: 659–667.

[33] Nakata K, Shino K, Horibe S, Natsu-ume T, Mae T, Ochi T. Re-

construction of the lateral ligaments of the ankle using solvent-dried and gamma-irradiated allogeneic fascia lata. The Journal of Bone and Joint Surgery. British Volume. 2000; 82: 579–582.

[34] Rupp MC, Degenhardt H, Winkler PW, Hinz M, Ehmann YJ, Imhoff AB, *et al*. High return to sports and return to work rates after anatomic lateral ankle ligament reconstruction with tendon autograft for isolated chronic lateral ankle instability. Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of the ESSKA. 2022; 30: 3862–3870.

[35] Maruccia M, Fallico N, Cigna E, Ciudad P, Nicoli F, Trignano E, *et al*. Suprafascial versus traditional harvesting technique for free antero lateral thigh flap: A case-control study to assess the best functional and aesthetic result in extremity reconstruction. Microsurgery. 2017; 37: 851–857.

[36] Cigna E, Tarallo M, Bistoni G, Anniboletti T, Trignano E, Tortorelli G, *et al*. Evaluation of polyurethane dressing with ibuprofen in the management of split-thickness skin graft donor sites. In Vivo (Athens, Greece). 2009; 23: 983–986.

[37] Trignano E, Nitto A, Cigna E, Ciudad P, Chen HC. A simple way for salvage of zone IV deep inferior epigastric perforator flap using pre-tie sutures and serial delayed closure. Journal of Plastic, Reconstructive & Aesthetic Surgery: JPRAS. 2012; 65: 273–275.

[38] Park TH. The versatility of tensor fascia lata allografts for soft tissue reconstruction. International Wound Journal. 2023; 20: 784–791.

[39] Trignano E, Serra PL, Grieco F, Rodio M, Rampazzo S, Pili N, *et al*. Heel reconstruction with ALT free flap in a 4-year-old patient after a severe lawnmower injury. A case report. Case Reports in Plastic Surgery & Hand Surgery. 2022; 10: 2157280.