European Journal of Plastic Surgery (2019) 42:523–526
https://doi.org/10.1007/s00238-019-01542-w

CASE REPORT

The use of a Gore-Tex prosthesis to stabilise venous drainage in an amputated distal forearm replantation

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Received: 18 January 2019 / Accepted: 27 May 2019 / Published online: 5 June 2019

Abstract

Venous drainage disorders are one of the common complications after peripheral limb replantation. We report a middle-aged male patient who underwent a macro-amputation of the distal forearm at the wrist as part of an occupational accident. After successful replantation, a postoperative venous drainage disorder develops, which despite multiple revisions and the installation of a wide venous grafts could not be permanently repaired and endangered the preservation of the hand. The use of a Gore-Tex prosthesis allows a sufficient venous drainage and was the last option to preserve the limb. As far as we know, the available sources give no information about the use of Gore-Tex prostheses in venous drainage restoration in a case of hand replantation. The resulting limb drainage was sufficient, exhibiting both stability and minimal complications in healing. Despite significant advances in surgical technique, replanting the amputated hand in the forearm remains a challenge for the reconstructive surgeons' community.

Keywords Gore-Tex prosthesis · Hand amputation · Thrombosis · Vascular graft · Vein graft

Introduction

The basis of successful replantation in cases of micro- and macro-amputation is the restoration of interrupted blood flow. In addition to the reconstruction of the arterial bed, special attention must be paid to the venous drainage system. Venous drainage disturbances in the sense of venous thrombosis represent the most frequent vascular complication [1]. Arterial thrombosis is the second most frequent vascular complication.

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Case

We report a case of a 53-year-old patient, who suffered a right upper extremity macro-amputation in an accident at work involving a chopping machine (Fig. 1). After the acute treatment at the emergency room, the patient was taken directly to an operating theatre. Below the upper arm's tourniquet compression in a bloodless field, the debridement of the amputated limb and the forearm stump was performed, so that the articular surface of the distal radius and about 8 cm of the distal ulna remained at the amputated limb. The bony cut surfaces were relatively smooth, but the soft tissue shell, however, squeezed particularly significantly on both endings. After identification and marking of the muscular or tendinous, vascular and nerve structures on both the stump and the amputated limb, osteosynthesis of the forearm bones was performed, with primary arthrodesis being determined by arthrodesis plate and ulna plating. As a result, the desired shortening of the bony structures by 3 cm could be achieved. Subsequently, the tendinous structures were restored and sutured with Pulvertaft suture (FDS, FDP) or direct suture (FPL) with Ti-Cron (© Covidien, USA) and Prolene (© Ethicon, USA).

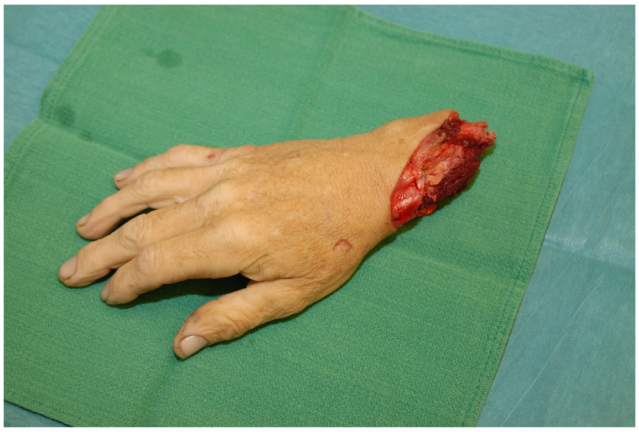

Fig. 1 A 53-year-old patient, suffered a right upper extremity macro-amputation in an accident at work involving a chopping machine

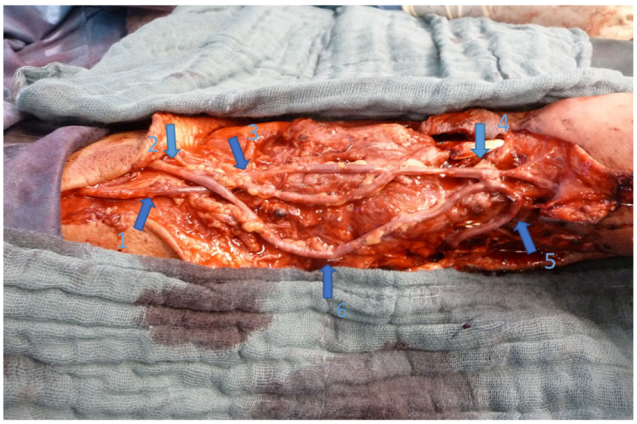

Fig. 2 (1) Basilic vein outflow, (2) cephalic vein outflow, (3) intermediate antebrachial vein outflow, (4) cephalic vein inflow, (5) basilic vein inflow and (6) wide venous grafts network harvested from ipsilateral lower leg

Under the surgical microscope, the arterial inflow was restored, first by anastomosing the ulnar artery and then the radial artery tension-free technique, end-to-end. Both allowed a good inflow into the hand immediately. The reconstruction of the neural structures and extensor tendons was performed parallel to the harvest of the venous grafts (twice in lengths of 15 cm from the ipsilateral lower leg, great saphenous vein). The venous outflow was restored in anatomical routes. Already intraoperatively, the venous grafts showed spasticity in a centralised circulatory position. The administration of papaverine locally improved and stabilised the drainage significantly. Finally, incomplete wound closure was performed, with particular attention paid to covering neurovascular structures. The patient was relocated postoperatively into the ICU with intravenous heparin 20,000 IU/24 h and replanted limb vitality control hourly. Because of venous congestion signs, surgical revision was indicated 9.5 h after the replantation procedure. Both thrombosed venous grafts were reanastomosed with other high-calibre veins. In addition, the palmar aponeurosis was split, all skin sutures removed and the wound area covered with temporary skin cover (Epigard, © Biovision, Germany). In the planned second-look operation 2 days later, the veins and arteries were inconspicuous. On the fourth postoperative day, the venous congestion occurred again, so the venous grafts had to be revised. After thrombectomy, a new venous graft route was created (harvested from the contralateral lower leg dorsalis pedis vein, 15 cm long). 2.5 h later, venous thrombosis occurred again. The senior surgeon reconstructed a venous outflow with wide venous grafts network of dorsalis pedis vein, harvested from ipsilateral lower leg, which consisted of 2 inflows and 3 outflows (20 cm long) (Fig. 2). In the following 14 h, the venous congestion appeared again (Fig. 3). During the intraoperative revision, closure of all outflow venous grafts was present. The decision was made to use a 20-cm long and 5-mm thick Gore-Tex vascular prosthesis (© W.L.Gore & Associates, Inc., USA). The prosthesis was anastomosed between the cephalic vein and the radial vein (Fig. 4), local skin flaps and meshed split thickness skin grafts were used to cover residual defect and Gore-Tex vascular prosthesis (Fig. 5). As a result, a sufficient and constant circulation situation with an average peripheral O_2 saturation of 97% was achieved on the 11th postoperative day. In later days, increasing secretion in the area of the entire wound surface appeared. Microbiologically, *Staphylococcus aureus* and *Aspergillus fumigatus* were isolated. Systematic antibiotic and antifungal therapy as well as intensive wound care were introduced. From the 11th day after the accident, passive occupational therapy was initiated. As part of a routine, on the 31st postoperative day after implantation, an ultrasound examination of the Gore-Tex shunt was performed. The thrombotic occlusion of the artificial prosthesis was not present. A pulse oximetric also showed inconspicuous conditions, which led to an intermediate consolidation of the drain on newly formed veins. Longer term, due to a fistulating infection, the arthrodesis plate had to be removed and vacuum-assisted therapy treatment was applied. The

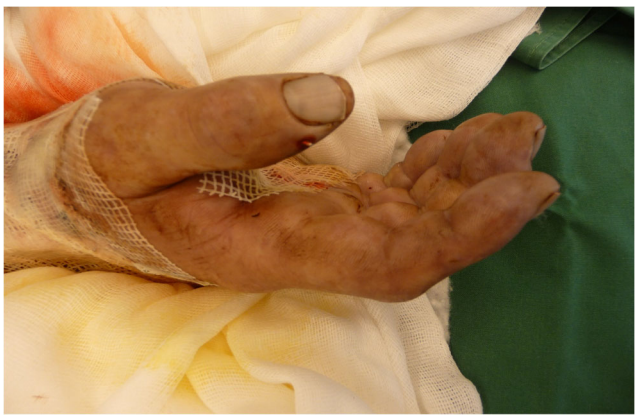

Fig. 3 Signs of venous congestion, initial cyanosis of replanted hand

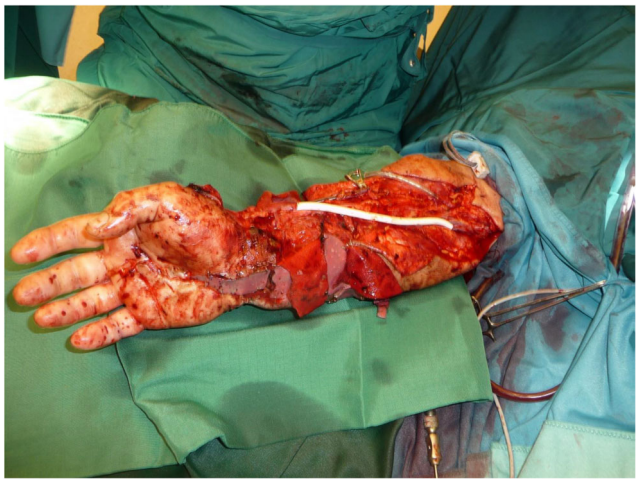

Fig. 4 The prosthesis was anastomosed between the cephalic vein and the radial vein

residual defects were healed secondary and covered by full thickness skin grafts (Fig. 6).

Discussion

If the hand is not significantly crushed by the previous trauma, amputation in the wrist and forearm is an absolute indication of replantation. Hoang [2] reports very good results in replantations of amputations at the wrist and radiocarpal joint level, where patients receive 60–80% of the original range of motion of the joints of the replanted hand compared with the contralateral healthy limb. Although the function of intrinsic muscles is impaired, especially after prolonged ischemia, all patients were able to grasp and pinch grip. When the ischemia exceeds 6 h, the use of temporary vascular shunts is considered to release metabolic toxins from the amputated extremity via transected veins [3, 4]. Early arterial inflow and vein outflow determine the vitality of limb during the replantation. According to available sources, the risk of thrombosis in the

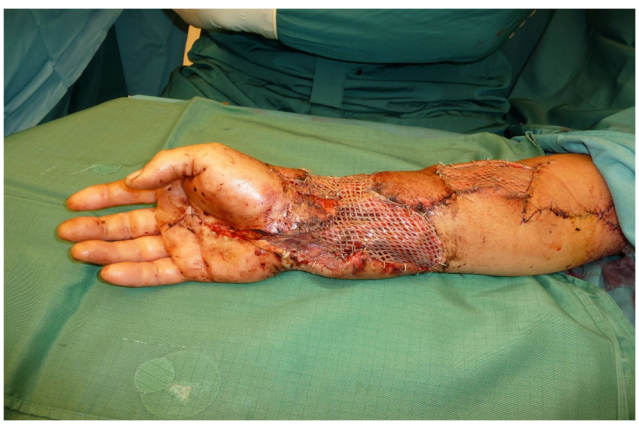

Fig. 5 Local skin flaps and meshed split thickness skin graft were used to cover residual defect and Gore-Tex vascular prosthesis

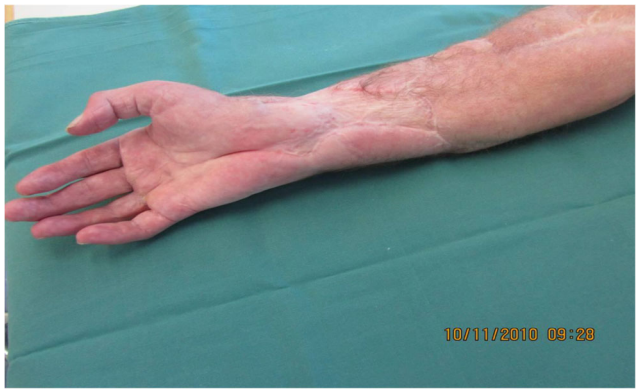

Fig. 6 Due to a fistulating infection, the arthrodesis plate had to be removed and vacuum-assisted therapy treatment was applied. The residual defects were healed secondary and covered by split thickness skin grafts

low-flow venous bed is 4-fold higher than in high-flow arterial bed [5–7]. Unless the equilibrium of vascular flow of the amputated hand is sustainably insufficient, consideration should be given to revision surgery and, if necessary, the use of a venous or arterial autologous graft which has the best long-term flow results. There are several donor sites on the body to obtain an autologous vascular graft. The senior author of this article decided to harvest a great saphenous vein from the ipsilateral lower limb. Despite sufficient anti-coagulation and antithrombotic therapy, repeated replacement of the original vein grafts with new venous grafts and anastomosis to high-calibre veins did not provide sufficient drainage of the limb. Another possibility of reconstruction of venous drainage could be to harvest a voluminous venous graft from the lower limb more proximally. Literary sources also mention the use of arterial autologous grafts from either the contralateral upper limb, radial artery, ulnar artery or the use of other donor blood vessels from the lower limb or chest (descendent branch of circumflex femoral lateral artery or thoracodorsal artery) [8–10]. The advantage of the autologous vascular graft is its good adaptation and a stable vascular wall. The disadvantage is the morbidity of the donor site and loss of natural drainage route. Another option would be temporary provision of venous drainage by draining the amputate into the vein of the contralateral forearm. The senior surgeon then opted for reconstitution of the amputated hand with Gore-Tex prosthesis. As far as we know, the available sources give no information about the use of Gore-Tex prostheses in venous drainage restoration in a case of hand replantation. The resulting limb drainage was sufficient, exhibiting both stability and minimal complications in healing cured by systematic antifungal therapy. Despite significant advances in surgical technique, replanting the amputated hand in the forearm remains a challenge for the reconstructive surgeons' community. The authors believe that the use of Gore-Tex prosthesis is a safe alternative to the reconstruction of venous drainage in hand replantation in the level of wrists and forearms.

Compliance with ethical standards

Conflict of interest Tomas Kempny, Martin Knoz, Bretislav Lipovy, Andreas Priol and Jakub Holoubek declare that they have no conflict of interest.

Ethical approval For this case report, formal consent from a local ethics committee is not required.

Informed consent Patient signed two different consents in which he accepts to share his photos and information of the treatment for scientific purposes.

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