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CASE REPORT

Resurrection of an ALT flap with recombinant tissue plasminogen activator and heparin

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Abstract The authors present the salvage of an anterolateral (ALT) thigh flap, which was congested secondary to venous thrombosis for a period of more than 12 h. This case report details the technical steps that were employed and the evidence base behind them.
Level of Evidence : Level V, therapeutic study.

Keywords Flap salvage · ALT flap · Recombinant tissue plasminogen activator · Heparin

Introduction

Free tissue transfer is now commonplace in many plastic surgery units worldwide in both elective and trauma settings. In experienced microsurgical units, acceptable flap failure rates are <2 % for elective reconstructions and up to 5 % [1] following trauma. Higher failure rates are more common in trauma cases where recipient vessels for microsurgery can be damaged due to the zone of injury [2, 3]. It is well known that venous thrombosis as a cause of flap compromise is far more common than arterial thrombosis [1]. This risk is reduced by sound microsurgical technique, avoiding tension on the flap pedicle and utilising vessels of a good calibre out of the zone of injury [2]. In order to reduce the chances of flap failure early detection and surgical re-exploration is warranted [1]. Early detection is best achieved by regular flap observations using clinical examination. However, in some rare events, the 'free flap in difficulty' can be detected late due to very gradual changes in clinical appearance and also human error.

We present such a case where we salvaged a free fasciocutaneous flap used in a case of lower limb trauma. Though the use of Alteplase (Genentech, San Francisco, USA) in free flap salvage is not new, there is no standardised recipe for how best to use it. Here, we present the recipe we used to help the reader in challenging scenarios such as this.

Alteplase is recombinantly manufactured tissue plasminogen activator (rtPA). When using Alteplase to salvage a free flap, there are two important variables to consider. The first is its concentration and the second is its dwell time. For systemic use, therapeutic levels in the blood circulation are in the region of 0.004 mg/ml (20 mg in 5 L circulating volume). When used for unblocking catheters it is recommended to use 2 mg and allow this to work for at least 30 min before seeing whether it is unblocked. As the catheter is in the systemic circulation a repeat dose is not recommended for 2 h. When salvaging flaps we dilute the 1 mg/ml solution with 4 ml of normal saline to make 5 ml with a concentration of 0.2 mg/ml. This is infused at a rate of 1 ml (0.2 mg)/min and alternated with heparin with a strength of 100 u/ml (5000 units heparin in 50 ml N Saline) also infused at 1 ml (100)u/min.

Case report

A 36-year-old farmer was referred to our unit after tibial nail fixation of a Gustilo 3b Injury. The trauma had been secondary to a crush injury from a bale of hay falling on his lower limb. The distal third of his leg had an open wound with bone

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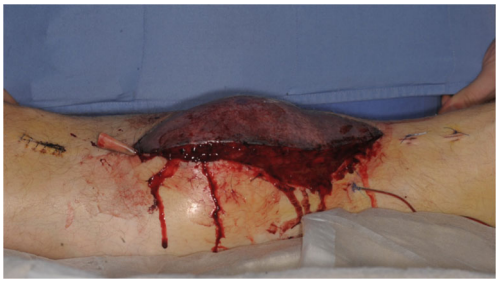

Fig. 1 Sutures and cast released on ward, giving temporary relief to the flap

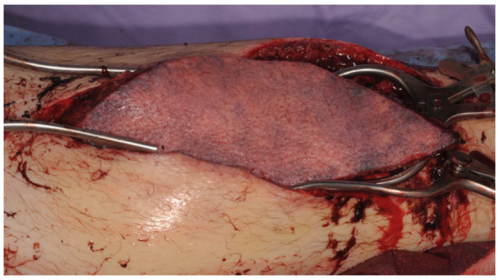

Fig. 3 Significant improvement on table after tPA and heparin and reanastomsosis

exposed. The decision was made to perform an ALT flap to cover the defect. The reconstruction was performed 5 days after the injury and 24 h after the tibial nail. The reconstruction using his contralateral ALT flap was uneventful, and the microsurgical anastomoses were uncomplicated and out of the zone of injury. The flap artery was anastomosed to the posterior tibial artery (end to side), and the two venae comitantes from the flap pedicle were anastomosed to the posterior tibial vein and long saphenous vein (end to end) using a 3-mm coupler.

For the first 48 h, postoperatively, the flap was soft and pale with a good Doppler signal and a 2–3 s capillary refill. However, in the early evening (1900 h) of the third postoperative day, it was noted that although the flap remained soft and the Doppler examination was normal, the capillary refill had become brisk. The doctor who reviewed the patient and made this examination had not realised that the patient had had a change of cast that afternoon, and the procedure had been difficult due to pain. The flap was re-examined the next day 0700 and found to be severely congested with a large haematoma resulting from venous occlusion (Fig. 1).

Pre-operative steps

The tight sutures and cast around the gentleman's limb were released (Fig. 1) to evacuate the haematoma. This bought time whilst theatres were prepared for urgent re-exploration.

Intraoperative and postoperative steps

A 100-ml haematoma was evacuated from around the flap pedicle. The flap veins were disconnected from their recipient veins in the leg, and 7-cm clots were milked out of them. There was still no venous bleeding from the flap veins although the artery was still running (as confirmed by bleeding from the flap dermis and an intraoperative Doppler). The decision was made to use alteplase to dissolve the clot in the microcirculation.

A ligaclip was removed from a proximal branch on the main flap pedicle, which also confirmed that the artery was still patent. The venae comitantes of the branch were re-ligaclipped, and this arterial branch was cannulated with a 24-gauge paediatric cannula. An 8/0 nylon suture was tied around the branch with the cannula inside it to stop the arterial blood leaking from around the sides of the vessel. Five ml of Alteplase with a dose of 0.2 mg/ml was infused at a rate of 1 ml/min through this proximal arterial branch of the main pedicle (Fig. 2). This was alternated with 5 ml of heparinised saline (100u/ml) also infused over 5 min. This cycle was repeated. After a further 10 min, there was still no bleeding from the flap veins. This proximal branch was ligaclipped, and the ligaclip on the distal end of the lateral circumflex femoral vessels was removed. The distal end of the artery was cannulated with a paediatric 24-gauge cannula, and the venae comitantes were ligaclipped as before. A further 3 cycles of alteplase and heparin were infused over 30–40 min. After this step, the flap veins started to bleed, and the flap was allowed to bleed out for 10 min before revision anastomoses. This was to

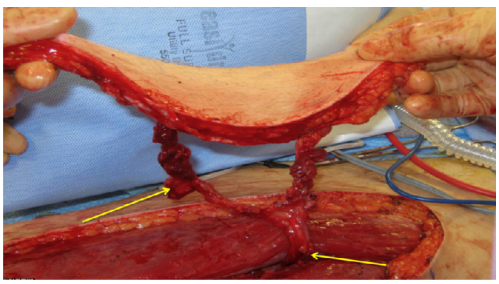

Fig. 2 *Yellow arrows* show where the tPA was infused through the flap. Photo taken from original case showing anatomy of the ALT flap with two perforators

Fig. 4 Only day 3 and fixed staining has significantly receded flap is soft, normal capillary refill without evidence of any flap demarcation

Table 1 Studies that used tPa

Study	Number of patients	Types of flaps	Type of thrombosis	Dose of tPa	Outcomes
Casey et al. 2007	12	–	1 arterial 11 venous	2 mg	1 failure 11 successfully salvaged
Ayhan et al. 2009	1	DIEAP	–	2 mg	Successfully salvaged
Chang et al. 2011	33	–	–	2.5 mg	28 successfully salvaged 5 failed
Ihler et al. 2013	3	Free radial forearm flap	3 venous	4 mg	All successfully salvaged

ensure that as little tPA as possible reached the systemic circulation.

Once the flap veins were bleeding normally, 5000 IU of IV heparin was administered systemically. The flap veins were anastomosed end to end to the previously unused posterior tibial vena comitantes and long saphenous vein which had been flushed with Hepsal. A 2.5- and 3-mm coupler were used, respectively. Significant improvement in the flap colour was noted on table (Fig. 3). The patient then returned to the ward for elevation and close monitoring (Fig. 4). The patient was discharged to the rehabilitation unit on postoperative day 5 with no evidence of flap loss.

Discussion

Although flap salvage techniques are documented in the literature [4–7], we feel that these simple reproducible steps emphasising the diluted concentration of tPA and the long dwell times adopted in this case are transferrable to many other cases of 'free flaps in difficulty'. This case also highlighted that salvage is still feasible at such a late presentation and that the plastic surgeon should not give up even in such dramatic scenarios where positive outcomes appear hopeless (Fig. 1). Authors have also reported the use of subcutaneous tPA in DIEP and TRAM salvage for venous congestion [8, 9]. The use of subcutaneous tPA could possibly reduce the degree of major fat necrosis secondary to venous thrombosis [8, 9].

Venous congestion in free tissue transfer can be attributed to a number of factors such as intrinsic venous anatomy, venous thrombosis, haematoma and pedicle torsion [7]. In this scenario, possible change of cast resulting in pain could have occluded the venous outflow causing the haematoma, which consequently led to venous thrombosis. Given the irreversible nature of microcirculatory changes in venous insufficiency, it needs to be recognised as soon as possible [4], and emergent surgical exploration is the gold standard of care [4].

tPA is a second generation thrombolytic agent with several advantages: systemic side-effects are minimal, it is relatively clot selective, has no antigenic effect, dissolves the clot within 10 min and has fewer bleeding complications. On analysis of the literature it is clear that is no consensus on the amount of tPA used (Table 1) [8, 10–12]. The average amount used was 2.0 mg, but 2.5 mg and 4.0 mg has also been used. In this case, we used 5.0 mg.

In determining whether a flap is salvageable, the composition of the flap and the timing of surgical re-exploration for the free flap in difficulty are crucial. Muscle flaps with shorter ischaemia times will not do as well as fasciocutaneous flaps. Winterton et al. identified that if re-exploration takes place within the first 24 h post-op, the flap is more likely to survive [13]. We feel that the combination of diluted tPA and heparinised saline (100 u/ml) with the relatively prolonged dwell times resurrected this flap from near certain death. Further studies are needed to determine whether tPA and heparin is more effective than tPA alone. Furthermore, there is no standard dosage for these therapies, and large multicentre studies are difficult to conduct in these relatively rare emergencies. We therefore feel that this is one instance where the reporting of anecdotal evidence may be of benefit to the plastic surgeon.

Compliance with ethical standards

Ethical standards For this retrospective study, formal consent from a local ethics committee is not required.

Conflicts of interest Dariush Nikkhah, Ben Green, Stamatis Sapountzis, Onur Gilleard, Amanpreet Sidhu and Adam Blackburn declare that they have no conflict of interest.

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Patient consent Patient provided written consent prior his inclusion in the study. Additional consent was obtained for the use of his images.

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