Symmetrical peripheral gangrene reconstruction after lower limb amputation

Ann. Ital. Chir., 2020 91, 4: 432-436
pii: S0003469X20033205

Sandro Rizzato*, Eva Kohhischeen*, Paolo Marchica*, Giuseppe Masciopinto*, Vincenzo Vindigni*, Cesare Tiengo*, Giampiero Avruscio**, Franco Bassetto*

Padua University Hospital, Padua, Italy
**Department of Neuroscience, Clinic of Plastic Surgery*
***Department of Cardiac, Thoracic and Vascular Sciences, Unit of Angiology*

Symmetrical peripheral gangrene reconstruction after lower limb amputation

Symmetrical peripheral gangrene (SPG) is a complication of septicemia, characterized by progressive skin lesions, which can result in wide necrosis of all the extremities. Severe necrosis is often responsible of disfiguring consequences. It is important to limit the amputation and to provide a stable and functional soft tissue coverage of the stumps. Limited amputation and free flap reconstruction may help to prevent tissue loss and to provide an effective prosthetization and a prompt rehabilitation. We present a clinical case of a 60-year-old male admitted in our department for lower limbs necrosis due to SPG after a pneumococcal infection. The patient underwent bilateral forefeet amputation and microsurgical reconstruction with antero-lateral thigh flap was performed on the left stump. Vascular complications determined a progressive necrosis of the flap and the failure of the reconstruction. A careful analysis of the local and systemic inflammatory vascular and coagulative issues following the SPG has been performed to explain the failure of the microsurgery. Although the opinion of several authors is divided about the use of free tissue transfer, we believe that microsurgical reconstruction remains the first choice of treatment due to the reduced morbidity and early rehabilitation it provides.

KEY WORDS: Amputation, Free flaps, Free tissue transfer, Limb salvage, Microsurgery salvage, Prosthesis, Sepsis, Septicaemia, Symmetrical peripheral gangrene

Background

Symmetrical peripheral gangrene (SPG) is a rare and severe condition where symmetric ischaemia of the extremities occurs without arterial vessel obstruction [1]. Several mechanisms are involved in its pathogenesis: disseminated intravascular coagulation (DIC), hemodynamic impairment, septicaemia, vasoconstrictors administration to support circulation, asplenia, immunosuppression and increased sympathetic tone [2,3]. SPG is clinically characterized by erythematous and purpuric skin lesions that represent the first sign of the circulation impairment. Subsequent modifications consist in ischemic discoloration of the skin which appears pale and cold and finally development of symmetric cutaneous and deep tissues necrosis involving both the extremities [4]. Early surgical debridement of devitalized tissue is not indicated. Indeed, ischemic and subsequent necrotic areas have to be completely demarcated before proceeding to the amputation and related stump capping [2]. It is well known that total or partial loss of the extremities, both the uppers and lowers, determines not only physical but also psychological issues and it represents a significant reconstructive challenge to ensure the patient the best achievable quality of life. Aims of surgical treatment are to limit the level of amputation, preserving the length of the stump as much as possible,

Pervenuto in Redazione Aprile 2020. Accettato per la pubblicazione Maggio 2020
Correspondence to: Sandro Rizzato, University of Padua, Department of Neurosciences, Via Nicolò Giustiniani 2, 35128 Padova, Italy (e-mail: rizzatosdr@gmail.com)

and to provide stable and functional tissue coverage in order to allow an early prosthetization and rehabilitation [5]. The microsurgical reconstruction is a suitable option to accomplish a good reconstruction, but its application is technically demanding and not free from problems, complications, and failures [6]. Aim of this work is to present a failure case of microsurgical reconstruction in a patient with bilateral forefoot necrosis and subsequent amputation, after development of SPG due to pneumococcal infection. Free tissue transfer resulted complicated and unsuccessful and possible etiology of failure is discussed, based on the evidences from the literature.

Case Report

A 60-year-old male, with history of tonsillectomy, adenoidectomy in young age and splenectomy in 2012 after a ski accident, presented to our Hospital complaining respiratory symptoms by the end of February 2016. Admitting diagnosis was pneumonitis caused by S. pneumoniae and the patient was treated in Internal Medicine Department with antibiotic therapy and oxygen supplementation. Subsequent worsening of general conditions and development of sepsis and septic shock associated with DIC required additional support in Intensive Care Unit (ICU), where the patient received inotropic and vasopressor medicaments, invasive mechanical ventilation and continued antibiotic therapy. During admittance in ICU, bilateral erythematous lesions of the forefeet occurred. Afterwards, both the forefeet became pale and cold and full thickness necrosis involving soft tissues and bones took place, assuming the form of peripheral symmetric dry gangrene (SPG). General conditions improved with resolution of pneumonia and systemic flogosis and patient was discharged from ICU and transferred to Internal Medicine. Nevertheless, bilateral dry gangrene caused the partial loss of the lower limb extremities. In order to save as much tissue as possible, to demarcate the necrotic areas and limit the loss of tissues, from April

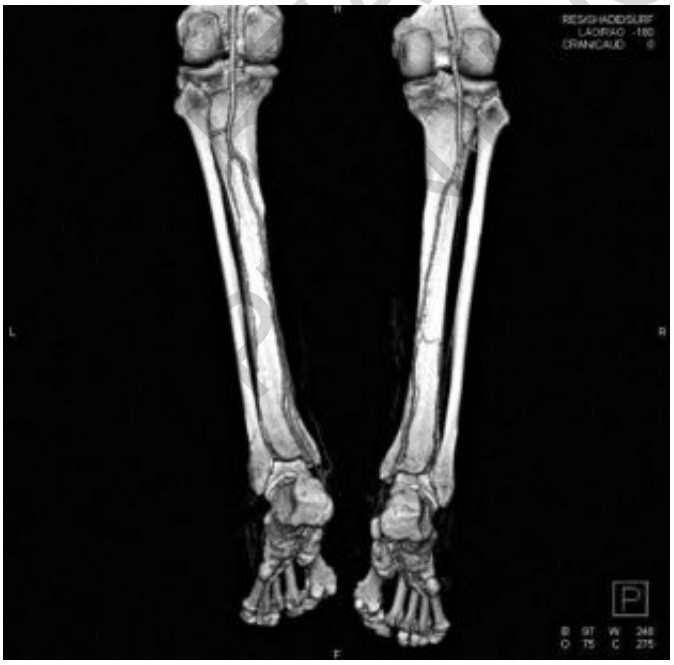

Fig. 1: Preoperative CTA 3D reconstruction.

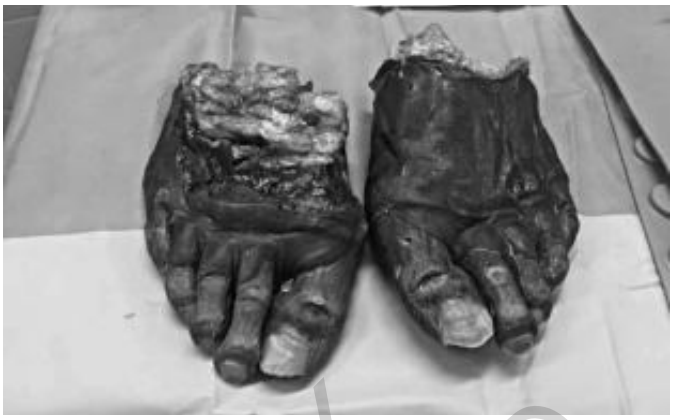

Fig. 2: Amputated forefeet with complete dry necrosis.

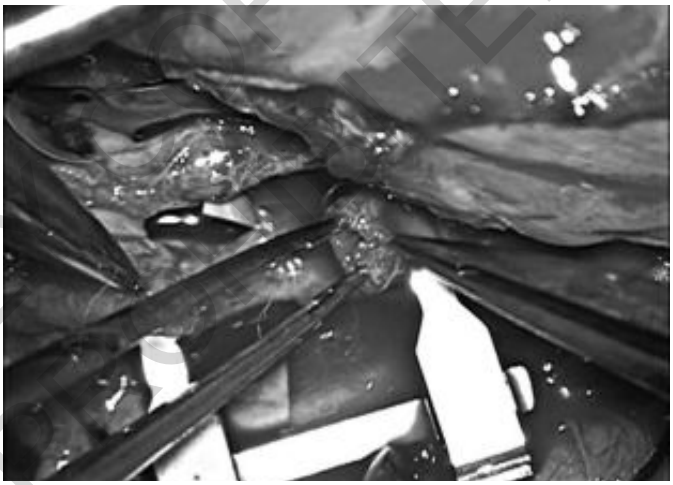

Fig. 3: : Intra-operative microscopic image showing the malacic and friable intimal sheet of anterior tibial artery.

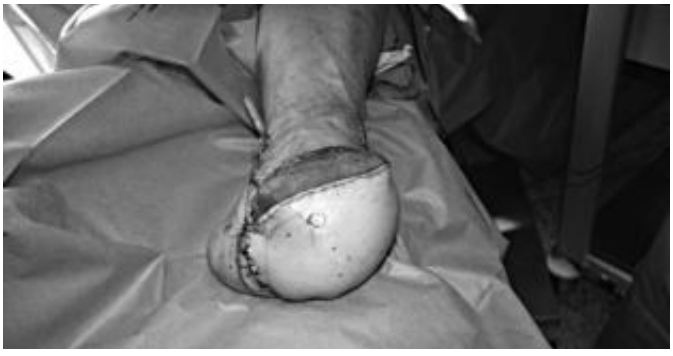

Fig. 4:: Inset and reshaped microsurgical ALT flap to cover the left forefoot stump.

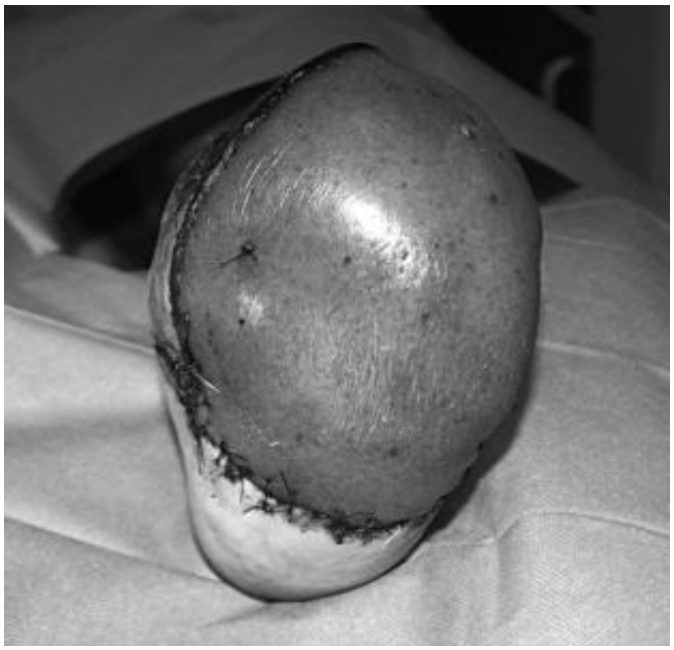

Fig. 5: Venous congestion that lead to failure of free flap reconstruction.

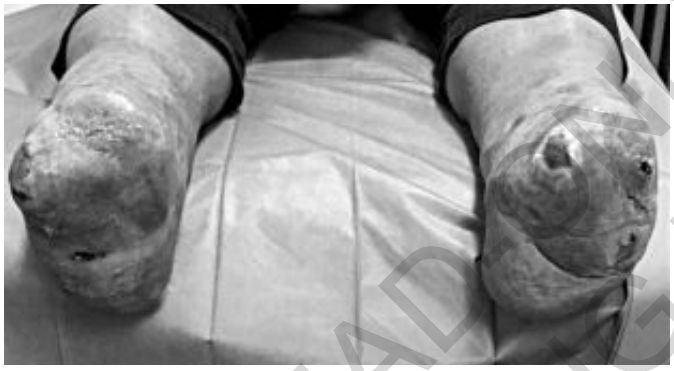

Fig. 6: : 3-years follow-up: after ALT flap removal, tissue coverage of both stumps was obtained with dermal substitute and skin grafts; as showed in the picture, complete healing has not been achieved yet, due to improper coverage provided by skin grafts.

2017 to September 2017, three cycles (each cycle of 30 sessions) of hyperbaric oxygen therapy (total of 90 sessions) and infusion therapy with prostanoids (E1 Prostaglandin/Alprostadil) were administered to the patient. As a consequence of the treatment, the hypertrophic development of a collateral vessel of dorsalis pedis artery was obtained with the nourishment improvement and the definitive demarcation of devitalized tissue, thus allowing to perform the definitive amputation and the reconstructive path.

In October 2017 the patient presented to our Plastic Surgery Unit to schedule reconstructive surgery. A multidisciplinary team discussed the case after performing preoperative CTA (Computerized Tomography Angiography) which evidenced a complete patent iliofemoral axis up to the three leg vessels (posterior tibial, anterior tibial and peroneal artery) (Fig. 1).

Complete blood count test and serological investigation did not reveal any significant anomalies. Platelet value was 750,000/microL, as a mild thrombocytosis. No pre- or peri-operative pharmacological protocol was applied with antiplatelet agents. Preoperative microbiological swab sample revealed colonization of multisensible P. aeruginosa.

Surgery consisted in bilateral Lisfranc (tarsometatarsal) amputation of the forefeet (Fig. 2) and bilateral application of negative pressure wound therapy device with instillation or iNPWT (V.A.C. UltaTM Kinetic Concepts Inc., San Antonio, TX), in order to promote granulation and decrease bacterial colonization of Pseudomonas spp. Three weeks later iNPWT treatment, a microsurgical Antero-Lateral Thigh (ALT) flap was performed to left stump capping. During the surgical free tissue transfer procedure, despite a good arterial flow confirmed by hand-held doppler probe, the chosen recipient vessel (anterior tibial artery) showed a friable intimal sheet, vessel spasms and repeated thrombotic events (Fig. 3). Thus, a different recipient artery was selected for end-to-end anastomosis. The posterior tibial artery presented a suitable calibre and optimal flow but yet the intimal sheet was found malacic. Nevertheless, the arterial anastomosis was accomplished and two venae comitantes were anastomosed with the recipient venous vessels (Fig. 4). The right foot stump was treated with further debridement and positioning of NPWT (ActiV.A.C.TM Kinetic Concepts Inc., San Antonio, TX) without instillation.

By the end of the second postoperative day, the flap showed developing local signs of arterial complications, probably due to thrombotic issues, that lead the ALT flap to progressive and complete necrosis (Fig. 5) and on the 5th postoperative day the entire flap was removed. In order to accomplish a better coverage than the simple skin graft, a dermal substitute Integra® Dermal Regeneration Template (Integra LifeSciences, Plainsboro, NJ) was implanted on both foot stumps. Three weeks later, almost total coverage was obtained by performing a meshed skin graft on the engrafted dermal substitute. Finally, almost three months after the amputation, the patient reached to maintain the upright position with to the help of crutches. To date, three-years follow-up the patient walks without the help of any devices, using only custom-made orthopaedic prosthetic shoes. However, the grafted areas of both the stumps present unstable scars with dystrophic skin and repeated ulcerations. Indeed, the continuous contact between the prosthesis and the fragile cap of the stumps determines pressures sores and painful wounds (Fig. 6).

Discussion

The symmetric peripheral gangrene (SPG), first described by Hutchinson in 1891 [7], is considered one of the worst

complications of sepsis and up to the 50% of the patients surviving from this severe infective issue undergo amputation of affected extremities.

The pathogenetic factors contribute alone or together when present simultaneously to the damage of the endothelium. It is estimated that DIC represents the main responsible of SPG (85% cases of SPG). As regards bacteria, S. pneumoniae in adults and N. meningitidis in children, have been found as the major responsible microbiological agents of SPG, due to their exotoxins or endotoxins production. Immunosuppression certainly promotes the onset of these infections. Congenital or acquired asplenia concurs in develop SPG due to protean mechanisms such as increased deposition of circulating immune complexes, immunodeficiency and thrombocytosis as well. Sympathetic tone may be upregulated by the use of drugs for circulation and hemodynamic support (mainly norepinephrine and dopamine), or because further acquired conditions (pheochromocytoma, other neuroactive drugs, etc.) [2,3].

The aforementioned factors concur to develope an inflammatory process determining endothelial damage of the small arterial vessels and capillaries, due to the action of bacterial endotoxins and exotoxins which trigger a DIC that finally cause thrombosis, ischemia and necrosis until dry gangrene [2]. Immune complexes may start or contribute to DIC process as well. Concurring hypotension and hypoperfusion may worsen the already jeopardized oxygenation of the tissues, especially the extremities that result the most involved district [3].

Clinical signs are usually characterized by the appearance of erythematous-purpuric skin lesions and petechial rash, paleness and cyanosis of the involved areas. Afterwards they evolve into haemorrhagic blisters and progressive thickness necrosis, with confluent grey, blue or violet spots of devitalized tissue, turning into bigger black stains, once the necrosis has occurred [3]. Patients comply burning pain until the nervous fibers are shattered by the process.

Histopathological examination showed a systemic vasculitis of the small vessels and microcirculation with capillary dermic thrombosis, swollen endothelial cells, vasodilatations and leakage of red blood cells. Vasculitis and its consequences may be observed up to several months (from 4 to 7) after the onset of SPG [8].

To date, there are not any strategies to prevent SPG. The only effective treatment remains the debridement and the amputation of devitalized tissues after the general condition of the patient are stable, once the necrosis is completely demarcated [2]. However, an optimal reconstruction is pivotal to obtain an effective prosthetization and a prompt rehabilitation. Such a target needs to perform an adequate amputation, gaining a suitable stump length, and to choose the best tissue coverage technique to create a stump cap resistant to continuous pressure and ensuring a stable and durable coverage [5].

Full thickness skin grafts do not have the necessary features to provide stability, strength and endurance of the stump in its interaction with the prosthesis. Local skin flaps, thought they may provide a better coverage, usually present signs of tissue impairment, due to the proximity to the area affected by SPG [8]. Therefore, the best tissue coverage is achievable through microsurgical reconstruction, according to the reconstructive elevator theory [9], by free tissue transfer procedures which may provide the most suitable stump cap quality [10,11]. Nevertheless, the microsurgical option is not free from complications and risk of failure [5,6]. Indeed, SPG histopathological modifications are responsible of a poor quality of the vessels of both the recipient site and the flap, resulting in friable and malacic intimal sheets. Moreover, thought the end-to-side anastomosis is preferable to the end-to-end, in case of intimal sheet damage as occurs in SPG, the latter represents the best choice to perform the flap insetting, due to the risk reduction of intraoperative thrombosis. However, performing an end-to-end anastomosis determines the exclusion of one of the three vascular axes of the leg, thus an increased risk of worsening the distal ischemia [6].

Thrombocytopenia occurs in the acute phase of SPG, due to the increased platelet consumption. Afterwards the bone marrow provides a quick response to the platelets depletion with a rebound effect of secondary thrombocytosis. In patients with congenital or acquired asplenia, the bone marrow answer leads to an increased number of circulating platelets that results higher than in normal patients, thus causing a more severe thrombocytosis [12] and, together with the endothelial damage, it determines a hypercoagulability condition. Hence it represents a further obstacle to microsurgery [13].

The use of anticoagulant or platelet antiaggregant drugs in prevention and management of intraoperative thrombosis during microsurgery does not find any support in literature. Several protocols have been proposed but, to date, their administration remains a choice of each surgeon [12].

Systemic effects of SPG do no end with the resolution of the acute phase. Indeed, up to 4-7 months after the onset of the syndrome, the inflammatory response persists and continues causing microscopic injuries to the intimal sheets of the small vessels. Hence, the time required for necrosis to demarcate does not match with the end of the systemic inflammation [6], thus the reconstructive microsurgical pathway may fail, as happened in our case.

Based on these evidences, some authors prefer a more conservative approach for the reconstructive surgery, thus limiting the microsurgery to a few selected cases or either after failure of previous options. Other surgeons, despite the systemic inflammation, the vasculitis and the coagulative issues, claim that free tissue transfer is not a contraindication and still represents the best surgical treatment and reconstructive option to face the sequelae of SPG. The potential failure of the free flaps is rather attributed to technical difficulties [5,10,11,14].

Conclusion

In our case it has not been possible to identify a specific cause to explain the failure of the microsurgical treatment. To date, many risk factors, such as the aforementioned vascular inflammatory changes, the endothelial damage, the hypercoagulability and the secondary thrombocytosis and their persistence after the acute phase of SPG, may be responsible of the failure and capable to jeopardize the reconstructive outcome. Furthermore, technical difficulties may represent an additional factor. However, we believe that the use of free tissue transfers and microsurgical procedures remains the best surgical option in management the reconstruction after SPG and its consequences such as the amputations, and in providing the basis for a prompt rehabilitation of the patient.

Riassunto

La gangrena periferica simmetrica (GPS) è una complicanza della setticemia, caratterizzata da lesioni cutanee progressive che possono esitare in una necrosi estesa di tutte le estremità. La necrosi severa è spesso responsabile di conseguenze sfiguranti. È dunque importante limitare le amputazioni e fornire una copertura stabile e funzionale dei monconi con dei tessuti molli. Le amputazioni limitate e la ricostruzione con lembi liberi possono essere d'aiuto nel prevenire la perdita dei tessuti e nel fornire una protesizzazione efficace e una pronta riabilitazione.

Presentiamo un caso clinico di un uomo di 60 anni ricoverato presso la nostra UOC di Chirurgia Plastica per necrosi degli arti inferiori a seguito di una GPS da infezione pneumococcica. Il paziente è stato sottoposto ad una amputazione bilaterale degli avampiedi e ad una ricostruzione microchirurgica con un lembo anterolaterale di coscia a carico del moncone del piede sinistro. Le complicanze vascolari hanno causato una progressiva necrosi del lembo e il fallimento della ricostruzione. È stata eseguita un'attenta analisi dei problemi infiammatori, vascolari e coagulativi locali e sistemici per spiegare il fallimento della microchirurgia. Nonostante le opinioni di diversi autori restino divise riguardo l'utilizzo dei lembi liberi, crediamo che la ricostruzione microchirurgica rimanga la prima scelta di trattamento a causa della ridotta morbidità e della precoce riabilitazione che è in grado di offrire.

References

1. Ruffin N, Vasa CV, Breakstone S, et al.: *Symmetrical peripheral gangrene of bilateral feet and unilateral hand after administration of vasopressors during septic shock*. BMJ Case Rep, 2018 Feb 7; pii: bcr-2017-223602.

2. Shimbo K, Yokota K, Miyamoto J, et al.: *Symmetrical peripheral gangrene caused by septic shock*. Case Reports Plast Surg Hand Surg, 2015; 2(3-4):53-6.

3. Johansen K, Hansen ST Jr: *Symmetrical peripheral gangrene (purpura fulminans) complicating pneumococcal sepsis.* Am J Surg, 1993; 165(5):642-45.

4. Shenoy R, Agarwal N, Goneppanavar U, et al.: *Symmetrical peripheral gangrene. A case report and brief review*. Indian J Surg, 2013; 75(Suppl 1):163-65.

5. Raveendran SS, Mosahebi A, Ramakrishnan VV: *Early free tissue transfer following gangrene of the feet.* Br J Plast Surg, 2005; 58(5):692-94.

6. MacLennan SE, Kitzmiller WJ, Yakuboff KP: *Free-tissue transfer for limb salvage in Purpura fulminans*. Plast Reconstr Surg, 200; 107(6):1437-442.

7. Hutchinson J: *Notes of Uncommon Cases.* Br Med J, 1891; 2(1592): 8-9.

8. Potokar TS, Oliver DW, Ross Russell R, et al.: *Meningococcal septicaemia and plastic surgery. A strategy for management*. Br J Plast Surg, 2000; 53(2):142-48.

9. Gottlieb LJ, Krieger LM: *From the reconstructive ladder to the reconstructive elevator*. Plast Reconstr Surg, 1994; 93(7):1503-504.

10. Duteille F, Thibault F, Perrot P, et al.: *Salvaging limbs in cases of severe purpura fulminans: Advantages of free flaps*. Plast Reconstr Surg, 2006; 118(3):681-85; discussion 686-87.

11. Jester A, Waag KL, Germann G, et al.: *Sequential microsurgical flap reconstruction following purpura fulminans during infancy and childhood*. J Reconstr Microsurg, 2002; 18(1):17-22.

12. Senchenkov A, Lemaine V, Tran NV: *Management of perioperative microvascular thrombotic complications. The use of multiagent anticoagulation algorithm in 395 consecutive free flaps.* Journal of Plastic, Reconstructive and Aesthetic Surgery, 68, 1293-1303. J Plast Reconstr Aesthet Surg, 2015; 68(9):1293-2303.

13. Cho EH, Bauder AR, Centkowski S, et al.: *Preoperative platelet count predicts lower extremity free flap thrombosis: A multi-institutional experience.* Plast Reconstr Surg, 2017; 139(1):220-30.

14. Lu J, Elmarsafi T, Lakhiani C, et al.: *Septic shock following prostate biopsy: aggressive limb salvage for extremities after pressor-induced ischemic gangrene*. Plast Reconstr Surg Glob Open, 2017; 5(9):e1430.