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Research Paper

Risk Factors of Venous Congestion After Reverse Sural Artery Flap

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ABSTRACT

Background: In recent decades, the reverse sural artery flap (RSAF) has become popular for reconstructing soft tissue defects in the distal third of the tibia, ankle, or heel. Previously published studies have reported limited observations of the associated complications and related factors.

Objectives: This cross-sectional study was conducted to determine the risk factors and their correlation with RSAF outcomes.

Methods: The study included patients referred to our department with soft tissue defects of the distal tibia, ankle, or heel treated using RSAF from 2019 to 2022. Clinical and outpatient records were investigated to collect the data. Qualitative data were reported using frequencies and percentages, and quantitative data were reported using Mean±SD.

Results: Flap congestion was reported in 71.8% of the 39 patients with variable severity. Smoking, drug addiction, late referral, concomitant fractures, and soft tissue defects were associated with venous congestion at the repair site.

Conclusion: Flap congestion is common after an RSAF. By controlling the risk factors associated with this complication, such as smoking cessation and faster referral to a surgeon skilled in reconstructing soft tissue defects, flap congestion can be reduced, thus reducing the possibility of treatment failure.

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Introduction

Reconstruction of the soft tissue defects around the ankle remains challenging because of the particular anatomy and the possibility of exposure to bone, tendon, or device [1, 2]. Reverse sural artery flap (RSAF) is commonly used to cover the soft tissue defects of the distal third of the leg, ankle, and foot, which has gained popularity among surgeons in recent years (Figure 1) [3, 4]. This flap is placed on the middle raphe between the medial and lateral heads of the gastrocnemius muscle proximally and posteriorly to the tip of the fibula distally (Figure 2). The types of RSAF include fasciocutaneous, adipofacial, and myocutaneous flaps [5]. The key benefit of this technique is that it is feasible in a minimal-resource center as it does not require microsurgical facilities (Figure 3).

The complication rate of RSAF varies among studies and previously published research is limited regarding the rates of complications and associated risk factors. Similar to any other flap, venous congestion can be observed in the RSAF. This complication is highlighted in cases of RSAF, in which the flap's pedicle is passed through the subcutaneous tissue. According to the GU classification, venous congestion can vary from absence of congestion to severe congestion (Figures 4, 5, and 6) [6]. Venous congestion should be diagnosed and treated promptly after surgery, otherwise, it can lead to flap failure [7].

This study aimed to evaluate different risk factors and their relationship with flap venous congestion as the most common complication of the RSAF reconstructive method.

Methods

We included patients with soft tissue defects of the distal tibial ankle or heel who were admitted to our department from 2019 to 2022 and underwent RSAF. Patients with inadequate follow-up and missing data or those who did not sign the informed consent upon admission were excluded from the study. The clinical records of these patients were reviewed to collect data needed to determine the incidence of venous congestion of the flap and its related factors.

One surgeon operated on all patients (Figures 7, 8 and 9). The formula proposed by Cochran was used to calculate the adequacy of the number of patients included. Patient demographic data, including age, sex, occupation, comorbidities, medications used, smoking status, drug use, and alcohol use, were reviewed and collected. In addition, the surface area of the flap, primary admission versus patients referred from remote hospitals, the time between soft tissue defect development and reconstructive surgery, hospitalization length, and incidence of flap venous congestion at the reconstructed site were recorded.

Data analysis was performed using SPSS software, version 26. Qualitative data were reported using frequency and percentage, and quantitative data using Mean±SD. To analyze the data, Spearman's rho correlation coefficient and Mann-Whitney U test were used, and $P<0.05$ was determined as the significance level in statistical tests.

Results

A total of 39 patients were identified through a comprehensive investigation of the clinical records at our hospital, adhering to the specified inclusion and exclusion criteria. The etiology of soft tissue defects in these patients could be attributed to either primary open fracture or secondary open reduction and internal fixation of ankle fractures. Among these defects, the most prevalent locations were the distal tibia (69%), followed by the heel (17%) and the dorsal aspect of the foot (14%).

Figure 1. Preoperative picture of the defect

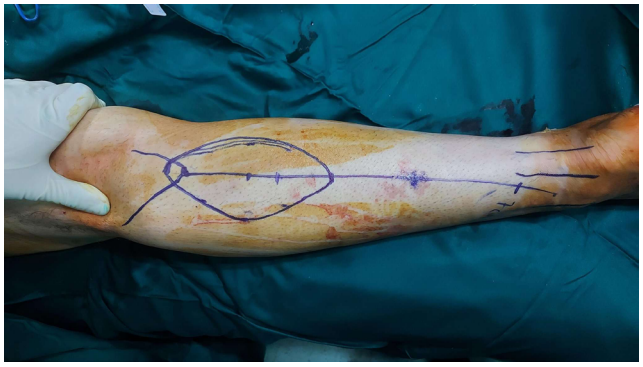

Figure 2. Reverse sural flap design

All collected variables were complete, without any missing data. The background characteristics of the patients are summarized in Table 1. The mean age of the patients was 36.18±16.06 years, and the majority (97.4%) were male. The prevalence of smoking, drug addiction, and alcohol use among patients was 56.4%, 38.4%, and 12.8%, respectively. Interestingly, a substantial proportion of the patients (71.8%) were referred from a remote hospital.

The characteristics of the soft tissue defects are listed in Table 2. Specifically, the left side was affected in 20.50% of cases, and fractures were reported in 64.10% of patients, with open fractures documented in 56.4% of these cases. The mean surface area of the flap was 107.84±55.97 cm^2. The average time interval between the occurrence of the defect and reconstructive surgery was 27.32±27.82 days. Following reconstructive surgery, patients had an average hospitalization duration of 7.44±9.41 days.

The degree of flap congestion after the reconstructive surgery in the evaluated patients is shown in Table 3. Flap congestion was not observed in 11 patients (28.2%), whereas the remaining patients (n=28, 71.8%) experienced varying flap congestion.

Correlation analysis was conducted to investigate the potential relationships between background data and the incidence of flap congestion in patients. The results revealed significant positive correlations between smoking (P=0.003), drug addiction (P=0.009), late referral (P=0.007), concomitant fractures (P=0.012), and the occurrence of flap congestion. In contrast, no significant relationships were found between age, sex, level of education, time until surgery, surface area, surgery time, and the incidence of flap congestion after RSAF.

Discussion

Flap congestion after reverse sural flap surgery may occur early or late. Mechanical factors, such as hematoma formation and the compressive effect on the flap pedicle, are the main causes. Prompt diagnosis and intervention are critical. Techniques, such as leech therapy, venous supercharging, and revision surgeries can effectively address varying degrees of congestion [8-10]. Understanding the risk factors in RSAF can aid in the prevention of flap congestion leading to reducing flap failure [11]. Congestion of the flap in the absence of proper and timely treatment can cause partial or complete necrosis of the

Table 1. Background factors of the patients

Background Characteristics	Mean±SD/ No. (%)	P
Age (y)	36.18±16.06	0.82
Gender (male)	38(97.4)	0.821
Body mass index (kg/m^2)	23.40±4.12	0.007
High education	6(15.4)	0.311
Smoking	22(56.4)	0.003
Drug addiction	15(38.4)	0.009
Alcohol consumption	5(12.8)	0.081

Figure 3. Postoperative picture.

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flap [12, 8]. The present study was conducted to investigate the incidence of venous congestion in RSAFs used to reconstruct soft tissue defects of the distal tibia, ankle, or heel and to determine the associated risk factors. The results showed that 71.8% of the evaluated patients developed flap venous congestion of various severities. In patients with low degrees of flap congestion, leech therapy was used; in more severe cases, skin grafting was performed after debridement, and in two cases with very severe flap congestion, free flaps were performed. By investigating the underlying factors and incidence of congestion in RSAF, it was found that smoking, drug addiction, late referral, and the simultaneous presence of fractures were associated with increased venous congestion. Different degrees of flap congestion may also be due to a combination of these four risk factors and the small sample size.

In this regard, several studies have been conducted to investigate the outcomes of RSAF in soft tissue reconstructive surgeries of the distal tibia, ankle, and heel. According to previous studies, the prevalence of venous congestion at the repair site reported in these investigations ranged from 3.05% to 75.3% [13-15]. Our study highlights the high prevalence of venous congestion in RSAF patients, with fractures emerging as a critical risk factor due to vascular compromise.

A systematic review study investigated the risk factors of necrosis incidence in RSAF [14]. In this study, smoking was the only suggested risk factor for partial necrosis of the RSAF. Due to the limitations of the reviewed articles regarding the venous congestion incidence determination, Daar et al. made no definitive statements and recommended that researchers in this field report and investigate the incidence of flap venous congestion in the patients treated with RSAF [14]. In this regard, the present study investigated and reported the incidence of venous congestion, its severity, and risk factors for venous congestion at the soft tissue re-

Figure 4. Moderate venous congestion of RSAF

RSAF: Reverse sural artery flap.

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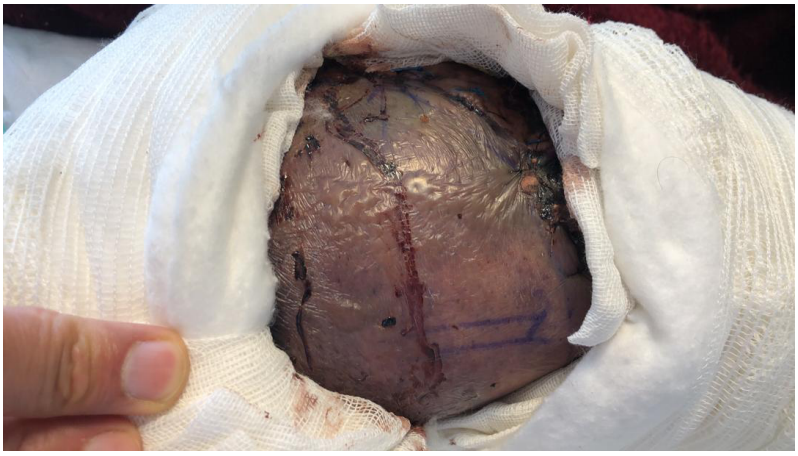

Figure 5. Severe venous congestion of RSAF

Figure 6. Mild venous congestion of RSAF
RSAF: Reverse sural artery flap.

Figure 7. Distal flap dissection

Figure 8. Elevate flap from the donor site

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Figure 9. The flap was passed through the subcutaneous tissue

pair site using RSAF. The findings of the present study indicated a significant incidence of venous congestion and determined smoking, drug addiction, late referral of patients, and the simultaneous presence of fractures. Thus, by controlling the suggested risk factors, that is, cessation of smoking, drug abuse, and early referral of patients with soft tissue defects in the distal lower limbs to a skilled surgeon in the field of reconstruction of soft tissue defects, the rate of flap congestion can be decreased, which could reduce the probability of treatment failure. It is also recommended to employ appropriate methods to reduce flap congestion, such as offloading with the Ilizarov technique, leech therapy, and heparin therapy. Furthermore, patients with these risk factors should be monitored at least every hour for 48 hours after surgery [8, 13, 16].

Optimizing flap design and preserving vascularity are essential for reducing congestion. Adjustments, such as a wider pedicle base and careful dissection to minimize compression, can improve outcomes [17, 18]. Subcutaneous tunneling techniques should also be evaluated for their impact on venous drainage [19]. While RSAF is effective, alternative methods, such as perforator flaps and free tissue transfer, offer additional options for specific cases. These approaches should be considered based on the patient's condition and resource availability.

Table 2. Factors associated with soft tissue defects in the examined patients

Associated Factors	Mean±SD/ No. (%)	P
Defect location (left)	8(20.5)	0.505
Surface area of flap (cm^2)	107.84±55.97	0.728
Early referral	11(28.2)	0.007
Concomitant fracture	25(64.1)	0.012
Open fracture	22(56.4)	0.644
Time to flap surgery (d)	27.32±27.82	0.361
Surgery time (minutes)	113.72±49.2	0.891
Time from surgery to discharge (d)	9.41±7.44	0.161

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Table 3. The degree of flap congestion in the examined patients

The Degree of Flap Congestion	No. (%)
No congestion	11(28.2)
Low	10(25.6)
Medium	11(28.2)
Severe	5(12.8)
Very severe	2(5.1)

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Conclusion

Flap congestion is common after an RSAF. By controlling the risk factors of this complication, such as smoking cessation and faster referral to a surgeon skilled in reconstructing soft tissue defects, flap congestion can be reduced, thus reducing the possibility of treatment failure.

The most important limitation of our study was its retrospective design, which made the data prone to publication bias. Another limitation of this study was the number of samples included, which provided results with an accuracy of 10%. The data analyzed in this study were collected from a single treatment center. In addition, sufficient data concerning the outcomes of reconstructive surgery in terms of the incidence of partial or complete necrosis were unavailable, which also limited the results of our study. Another limitation was the sex distribution of the patients, which mainly consisted of men, making the results of this study inapplicable to all patients undergoing reconstructive surgery of the soft tissue of the distal tibia. More research with larger sample sizes must be conducted, along with adjustments for risk factors that did not demonstrate significant effects in our study, such as sex and age.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Research Committee of the Shahid Beheshti University of Medical Sciences, Tehran, Iran (Code: IR.SBMU.MSP.REC.1401.543), and informed consent was obtained before the collection of data from participants.

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Authors' contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interception of the results and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

Conflict of interest

The authors declared no conflict of interest.

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