

Perspectives on the surgical intervention of venous injuries: In-depth analysis

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ABSTRACT

Background. The surgical treatment of venous injuries is examined in this work, with particular attention to the brachial vein and its prevalence, methods, and results.

Purposes. It assesses surgical techniques, issues that arise after surgery, and the significance of developments in venous repair. In these complicated instances, the research aids in better decision-making and patient care.

Methods. A study at the Advanced Vascular Institute and Al-Hashed military hospitals between 2017 and 2018 involved 150 patients with acute venous injuries, predominantly males aged 3-65 years. The study observed a change in the causes of venous injury, with a rise in cases of blunt trauma, particularly in metropolitan areas, but penetrating trauma remains the most common cause. Diagnosis is mainly reached clinically by looking for signs and symptoms, and surgical plans can be made without the Doppler study, which is now available in all casualty wards.

Results. To treat hypovolemia and shock, two bilateral wide-bore cannulas with rapid cross-matched blood (rapid method) and ringers or normal saline fluid. The most common injury was to the brachial vein, which was repaired primarily by ligation and, after that, by various techniques, including venography. Follow-ups were difficult for those from other governments, especially our soldier's surgery done at Al-Hashed hospitals, where we advised them to consult vascular surgeons near their residences. Ten individuals had their venous ligation and fasciotomy complications—often accompanied by concomitant artery trauma—required an amputation.

Conclusions. The use of fasciotomies varied and did not significantly correlate with the kind of operation. Doppler study checked the patency of the repaired veins, and the follow-up revealed no signs of thrombotic problems. Four patients, all in critical hemodynamic conditions with significant arterial and venous injuries, died during surgery from irreversible shock, accounting for the study's 2.7% fatality rate.

Keywords: venous injury surgery, surgical vascular techniques, popliteal vein focus, post-surgical vascular complications, venous reconstruction advances

INTRODUCTION

Even in healthy persons, the past sixty years have seen a tremendous improvement in our understanding of venous architecture and physiology thanks to developments in clinical and experimental trials of venous reconstruction. Because of this advancement, vascular surgeons can now choose patients for different surgical operations more precisely [1]. Prompt venous repair following injury is essential to avoid acute venous insufficiency and consequent post-thrombotic alterations in the limb [2]. Concomitant injuries are frequently experienced in conjunction with trauma ve-

nous injuries, which are common in both penetrating and blunt trauma. Despite being first recorded during a war, reports of these injuries from civilians have been rising.

In the past, ligation was the primary method of treating venous injuries during World War II. Nevertheless, venous reconstruction became increasingly common in some instances of casualties during the Korean War and practically standard during and after the Vietnam War. The critical question that needs to be addressed in light of the ongoing discussion about managing significant venous injuries is: Is venous repair better than ligation [3].

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The mechanism of injury and the patient's hemodynamic stability play a significant role in selecting the venous repair procedure. Time-consuming but potentially successful complex repairs include lateral venography or end-to-end anastomosis for primary repair, as well as more intricate techniques like vein patches, spiral vein grafts, reversed saphenous vein interposition grafts, or interposition ringed polytetrafluoroethylene grafts [4]. In extremities, venous reconstruction has shown promise, especially when combined with arterial injuries, as it can preserve a return pathway during reimplantation, lower outflow impedance, and increase limb salvage rates. This is particularly important for conduits with a single return, such as the popliteal vein [5].

First, this paper presents a comprehensive examination of the prevalence, surgical procedures, and postoperative outcomes of venous injuries, offering cutting-edge insights into the surgical therapy of these injuries. It describes the surgical techniques used, mainly ligation and several types of venous repair. It highlights the most common venous injury sites, with the brachial vein being the most commonly afflicted. Additionally, the study explores postoperative morbidities such as edema and neurological impairments, evaluating the connection between surgical techniques and these results. The study's conclusions, which include a 2.7% death rate and an assessment of vein patency, make essential additions to our knowledge of venous injuries. They also serve as a roadmap for surgical choices and work to improve patient care in these challenging situations.

METHODS

Patient population

150 patients with 174 acute venous injuries participated in a study that was carried out between January 1, 2017, and September 1, 2018, at the Advanced Vascular Institute in Najaf City or at Al-Hashed military hospitals (Iraq was freed from ISIS). With 142 men and eight women, the gender distribution was more balanced than in previous research, indicating a more diverse patient population. The patient demographic was more diversified, with a mean age of 25.2 years and a more comprehensive age range of 3 to 65 years.

Exclusion criteria

Patients with follow-up periods of less than a year, incomplete medical records, iatrogenic venous injuries, late complicated vascular injuries, and soldiers from other governates who preferred to be followed by other vascular surgeons nearby were excluded. Information was obtained via paper medical reports; however, we like them since electronic medical records guarantee more precise and thorough patient information.

The investigation discovered a change in the causes of venous injuries. More than 85% of cases were penetrating trauma, although there was a noticeable rise in blunt trauma cases, especially in contemporary metropolitan settings. More accurate etiological data was obtained using sophisticated diagnostic instruments like high-definition imaging methods.

Patient history and examination

A complete medical history was acquired, encompassing information on the mechanism of injury and past medical records. Vital sign data was available in real-time thanks to modern diagnostic equipment like wearable health monitors. With the use of sophisticated algorithms that took into account a wider variety of physiological characteristics, patients were categorized into hemodynamic states.

Investigation

Each patient received a full diagnostic workup, which included advanced imaging methods such as blood analysis and 3D vascular Doppler (Duplex) imaging. Blood was prepared at the emergency room to stabilize some patients and prepare them for surgery. These techniques gave rise to a more thorough comprehension of the state of every patient.

Management

Blood volume restoration and synthetic blood substitutes were used to treat hypovolemia and shock. Based on the examination of the microbiomes of individual patients, a more customized strategy for administering antibiotics was implemented. The improved emergency response times from injury to operation were reflected in the meantime, which were lowered to 3.5 hours. With 25.3% of all venous injuries in this study occurring in the brachial vein, a venous comitant of the brachial artery, it was shown to be the most commonly injured vein. The femoral vein injuries that followed are shown in Table 1. Ligation was the selected course of action for 130 cases out of the total venous damages. The remaining instances had various venous repairs performed on them. In particular, 34 patients (77.3% of the repair operations) involved venorrhaphy. Eight cases, or 18.2% of the repairs, required end-to-end anastomosis. Two venous patch insertions were performed to round up the repair operations, accounting for 4.5% of the patients.

Statistical analysis

The study used sophisticated statistical techniques like machine learning algorithms to analyze the data. This allowed for a more sophisticated comprehension of the connections between variables and patient outcomes. This study's purview included applying the chi-square test to determine the statistical significance of

TABLE 1. Sites of venous injury with their surgical management

Site of venous injury	Number and percentage of venous injury	Ligation	Repair
1. Brachial vein	44(25.3%)	44	-
2. Femoral vein	34(19.5%)	18	16
3. Popliteal vein	22(12.6%)	6	16
4. Cephalic vein	22(12.6%)	22	-
5. Internal jugular v.	12(6.9%)	6	6
6. Basilic v.	10 (5.9%)	10	-
7. Subclavian v.	8 (4.7%)	4	4
8. G. Saphenous vein	8(4.6%)	8	-
9. External jugular vein	6(3.5%)	6	-
10. Axillary v.	4(2.3%)	2	2
11. External iliac vein	2(1.1%)	2	-
12. Innominate v.	2(1.1%)	2	-
Total	174	130(74.7%)	44(25.3%)

the relationship between patient morbidity or hemodynamic condition and the medical intervention of choice—that is, either venous injury repair or ligation. Statistics such as P-value and chi-square are used to show the linkage connection. So, if the value is less than 0.1 mean, there is a significant link, and it is more powerful if it is less than 0.05 and highly significant if it is less than 0.01; on the other hand, it is considered insignificant statistically if it is more than 0.1.

RESULTS

Hospitalization

The usual complexity of injuries makes associated venous injuries so familiar, so associated injuries influence the postoperative period. However, improving

surgical methods with the development of postoperative care units lowered hospital stays by 4.5 days.

Postoperative treatment and follow-up

Using cutting-edge monitoring devices to keep an ongoing eye on the patient was part of postoperative treatment. Telemedicine was used for the follow-up, which allowed for more convenient and reliable patient monitoring.

Amputation A group of ten patients had surgical amputations throughout the postoperative period. Every member of this group has undergone simultaneous fasciotomy and venous ligation ($p < 0.1$) in the past. This patient group was notable for having concurrent vascular trauma. Reparative

therapies were used to treat the vascular damage in all but one of the cases. This was an exception involving brachial artery ligation. While the remaining patients' brachial vein ligations went off without a hitch, situations where the popliteal and femoral veins were injured, showed a high rate of postoperative problems. The patient's hemodynamic status is crucial when choosing the best surgical strategy for venous damage. A subgroup of patients (6.7%, $n = 10$) in our sample had hemodynamically compromised presentation, defined as a heart rate greater than 140 bpm and very low or undetectable blood pressure. No matter where the damage was, this group had vein ligation. A P-value of less than 0.1 ($\chi^2 = 3.3447316$) indicates the statistically significant connection between poor hemodynamic condition and the decision to ligate instead of heal the vein.

TABLE 2. Postoperative morbidity about the type of surgery

Morbidity	Total venous injuries No.	%	Ligated vein	Repaired vein	χ^2	P-value
1. Edema						
A-4th postop. Day	54	31	48	6	11.802435	<0.01 HS
B-Discharge from the hospital	6	3.4	6	0	2.4049069	NS
2. Neurological deficits						
A-Peripheral:						
1-Motor & sensory	38	21.8	28	10	0.0952717	NS
2-Sensory only	4	2.3	4	0	2.0489962	NS
B-CNS	4	2.3	4	0	2.0489962	NS
3. Wound infection	12	6.9	6	6	1.538907	Non-significant
4. Amputation	10	5.7	10	zero	3.3402767	<0.1 (significant)
5. Revision	8	4.6	8	zero	2.8546969	<0.1 (significant)
6. Impaired limb function	4	2.3	2	2	0.6227287	NS
7. Stiffness of joint	4	2.3	2	2	0.6227287	Non-significant

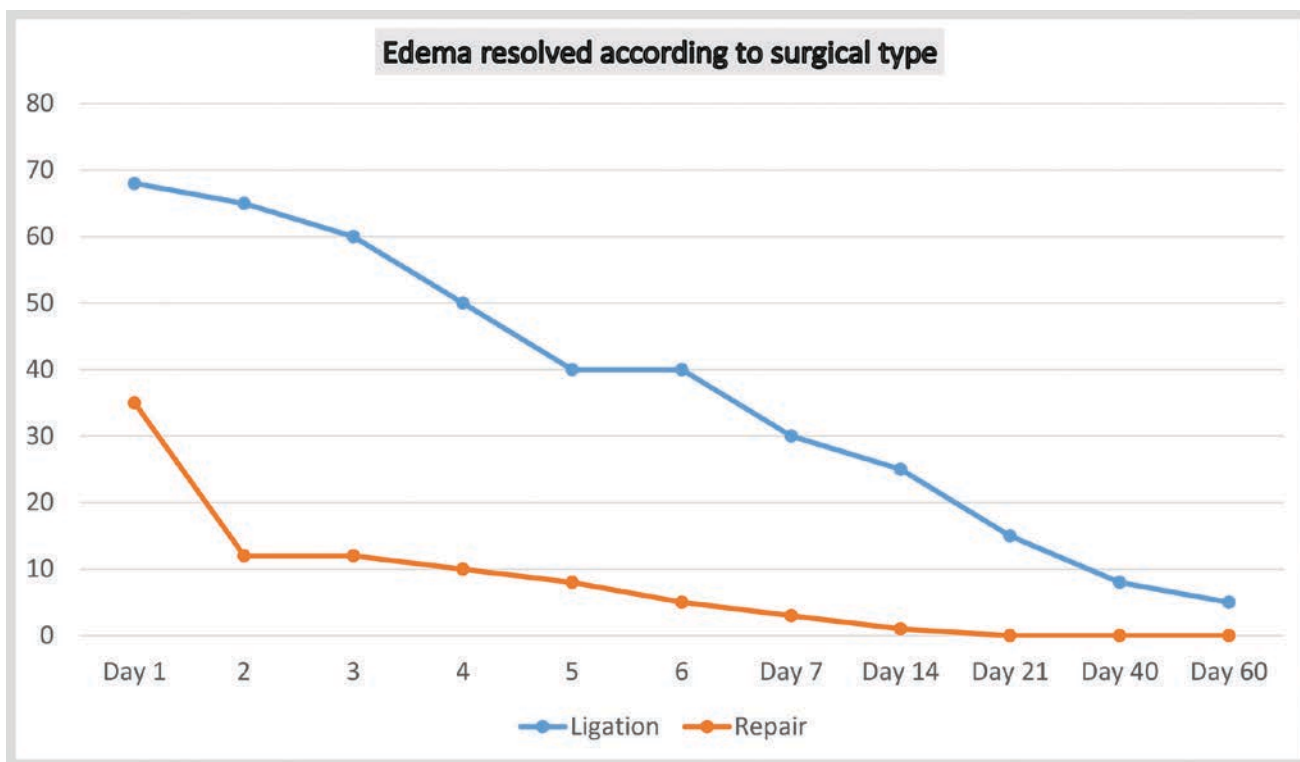


FIGURE. The relation between postoperative edema and types of venous surgery

On the other hand, no statistically significant correlation was seen between the selected surgical intervention and any other hemodynamic profile ($\chi^2 < 0.5$). In cases involving 18 wounded veins, prophylactic fasciotomy was carried out; on 14 of these, venous ligation and two venous repairs were carried out. Six cases of vein ligation involved late fasciotomy, but it was not used after any venous repair operations. The statistical analysis showed no significant correlation between the kind of venous surgery and the fasciotomy application ($\chi^2 = 2.4049069$ for late fasciotomy and 0.7641577 for preventative fasciotomy). Clinical evaluations and Doppler ultrasonography investigations were used to evaluate the patency of restored veins. Between the second and fifth postoperative days, Doppler ultrasounds were performed on 28 repaired lower leg veins, and every single one showed positive blood flow. Regardless of whether the vein was ligated or repaired, the remaining cases were clinically examined, and no symptoms of pulmonary embolism, deep vein thrombosis, or venous thrombosis were noted throughout the follow-up period.

Analysis of mortality

Out of four patients in our investigation, the mortality rate was 2.7%. Interestingly, upon arrival, all of the deceased patients had extremely low or undetectable blood pressure levels and were in a dangerously ill hemodynamic state, with a heart rate surpassing 140 beats per minute. Two of these individuals had injuries to both their veins and femur arteries, which was the

reason for this severe condition. The subclavian artery and vein were injured in the two patients who remained. In the operating room, all four patients died from irreparable shock despite prompt medical attention.

DISCUSSION

This work tackles the complex problems of treating damaged veins, emphasizing the conflict between ligation and repair. More aggressive repair approaches are supported by recent literature; however, surgeons continue to disagree on this point. Our goal was to assess the influence of different factors on postoperative outcomes, such as surgical technique and hemodynamic condition.

Patients' hemodynamic state plays a significant role in choosing either venous ligation or repair modality in our study. Venous ligation was the recommended treatment in situations with poor hemodynamic status. The location and severity of the damage were critical criteria for other patients. This supports the findings of Sharma PVP et al. and emphasizes the importance of hemodynamic stability in surgical decision-making [6].

The debate over repair vs ligation brings up issues with limb preservation, especially in the lower limbs. According to our research, there were 5.7% amputations and 25.3% venous repairs. On the other hand, studies by Pappas and Sharma showed better repair percentages and lower amputation rates. Interestingly, after venous restoration, our series did

not record any limb loss, indicating that it could lower the rate of amputations [7].

In 5.2% of cases combining vein ligation with arterial repair, revision procedures were required; this suggests that vein repair may lessen the necessity for such interventions. A significant contributing factor to morbidity was found to be the location of the venous lesion, with injuries to the femoral and popliteal veins being especially problematic. Numerous studies advise against ligation in these areas unless it is essential to support this [8].

When the damaged vein was restored, postoperative edema resolved much more quickly. Comparatively speaking, none of the patients in the repair group had persistent edema upon discharge from the tiny percentage of patients with ligated veins. These results align with previous research, while some point to ligation as a potential treatment option in particular circumstances [9-13].

The type of venous surgery had no bearing on the function of fasciotomy, which was carried out for various reasons [13]. Late fasciotomies were uncommon and not always advised. Our follow-up revealed no evidence of deep vein thrombosis or pulmonary embolism, consistent with findings from other investigations [14-18].

Doppler investigations suggested that restored veins had patent flow, but a more accurate assessment could come from more sensitive testing. Another study

found that restored veins had functioning valves and long-term patency.

We found that the type and location of injuries had an impact on the 2.7% death rate in our study. This rate is very variable in the literature, with lower rates linked to injuries to the lower limbs and higher rates to more complicated, frequently deadly lesions to the veins in the abdomen [19-23].

CONCLUSIONS

The use of fasciotomies varied and did not significantly correlate with the kind of operation. Doppler study checked the patency of the repaired veins, and the follow-up revealed no signs of thrombotic problems. Four patients, all in critical hemodynamic conditions with significant arterial and venous injuries, died during surgery from irreversible shock, accounting for the study's 2.7% fatality rate.

Authors; contribution:

Laith Fathi Sharba; Conceptualization; Methodology; Investigation; Resources; Data Curation; Writing - Original Draft
Ahmed Muhi Fahad; Conceptualization; Methodology; Writing - Original Draft, soft wire

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