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The Role of Revascularization in Managing Delayed Limb Ischemia Following Trauma

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Abstract: After trauma, delayed limb ischemia (DLI) is a serious disease that can cause a great deal of morbidity, although revascularization is essential for restoring blood flow along with preventing limb loss, little is known about its efficacy and results in trauma-related DLI, which by examining revascularization techniques, success rates, complications, and long-term results, this study aimed to assess the function of revascularization in treating DLI after trauma.

Furthermore, 82 patients diagnosed with DLI after trauma participated at different hospitals in Iraq, provided information on trauma mechanisms, complications, limb salvage rates, and death at a 12-month follow-up. Which our patients were 42.3 ± 12.7 years old, and 65.9% of them were men. Among trauma mechanisms, motor vehicle accidents accounted for the majority (43.9%). The majority of patients (61.0%) received a DLI diagnosis within 48 hours. With an overall success rate of 82.9%, endovascular revascularization is the most commonly employed technique (54.9%). Limb salvage was successful in 90.2% of patients, with a 9.8% amputation rate. Infection (7.3%) and reperfusion damage (9.8%) were among the post-revascularization consequences. At the 12-month follow-up, the majority of patients (73.2%) had fully recovered, but 18.3% still had residual impairment.

With high success rates and positive limb salvage results, revascularization is a very effective treatment for DLI after trauma, where early diagnosis and management are essential, as well as almost all patients recover over the long term despite issues including infection and reperfusion damage, underscoring the need of prompt and suitable revascularization techniques.

Keywords: Delayed Limb Ischemia, Trauma, Revascularization, Limb Salvage, Reperfusion Injury, Endovascular Therapy, Surgical Bypass, And Long-Term Outcomes.

Introduction

After trauma, delayed limb ischemia (DLI) presented as a serious and fatal consequence which many difficulties had faced into patients and medical professionals, where trauma from blunt or penetrating injuries is not treated very once, it can impair blood flow to the extremities and result in ischemia [1, 2], while in acute limb-threatening situations, urgent revascularization is frequently given priority, delayed ischemia is a unique clinical entity that necessitates careful evaluation of patient variables, timing, and therapeutic techniques [3].

Moreover, revascularization has the potential to save limbs, improved in functional results, alongside enhancement in the quality of life for patients who are affected, its role in managing DLI was a topic of increasing attention [4], as well as vascular injuries which are either first disregarded, misdiagnosed, or not effectively treated are usually the cause of DLI [5].

In addition, ischemia occured gradually as a result of vasospasm, thrombosis, or the advancement of soft tissue damage [6], where almost all management used to treat ischemia becomes more difficult when ischemia manifests later because persistent hypoperfusion can cause compartment syndrome, permanent tissue damage, and even limb loss. Revascularization has become a key component of DLI therapy, encompassing endovascular procedures, surgical bypass, or hybrid treatments. [7]

Also, recent developments of interventional radiology and vascular surgery were elevated into the prevalence of revascularization alternatives available, providing more accurate and minimally invasive methods, as well as in situations of severe ischemia, the functional and psychological effects of limb salvage as opposed to amputation. [8, 9]

Materials and Methods

➢ Study Design

In order to assess the function of revascularization in treating delayed limb ischemia (DLI) after trauma, this study used a cross-sectional design, which patients with DLI who had revascularization treatments at different hospitals in Iraq, during a 12-month follow-up period were included in the study, as well as we recorded hospital's data trauma mechanisms, time to diagnosis, revascularization techniques, clinical outcomes, and long-term follow-up outcomes, information was taken from medical records and trauma registries, due to that the aim of the study was to ascertain the effects of revascularization on patient recovery and its efficacy in limb salvage.

➢ Data Collection

Data was obtained from 82 patients' medical records who satisfied the requirements for inclusion, including demographic data (age, sex, smoking history, diabetes mellitus, hypertension), the mechanism of trauma, the time to DLI diagnosis, the revascularization technique used, the revascularization success rate, the complications following revascularization, the limb salvage rates, the length of hospital stay, the mortality rates, and the long-term follow-up outcomes at six months were among the variables.

➢ Inclusion and Exclusion Criteria

Patients aged 25 years or older who had been diagnosed with delayed limb ischemia after trauma and who had undergone revascularization methods (endovascular, surgical bypass, or hybrid technique) met the inclusion criteria. Patients having pre-existing chronic limb ischemia related to trauma, those without revascularization, and those with inadequate medical data were not included.

➢ Hospitalization Outcomes of Revascularization in Delayed Limb Ischemia

The success rate of revascularization, classified as successful, partially successful, or failed, was the main clinical outcome. Limb salvage rates, length of hospital stay, mortality rates (in-hospital, 30-day), post-revascularization complications (reperfusion injury, infection, amputation), and long-term follow-up results (full recovery, residual disability, amputation, lost to follow-up) during 12 months were all considered secondary outcomes.

➢ Statistical Analysis

Demographic and clinical features were summarized using descriptive statistics, where categorical data were presented as frequencies and percentages and continuous variables as mean ± standard deviation (SD). A multivariate logistic regression was used in determining of effective revascularization and limb salvage. P-values less than 0.05 were regarded as statistically significant. For all analyses, SPSS version 24.0 was used.

Results

Table 1: Demographic characteristics of patients.

Characteristic	Number (n=82)	Percentage (%)
Age (mean ± SD)	42.3 ± 12.7	
Male	54	65.9
Female	28	34.1
Smoking History	45	54.9
Diabetes Mellitus	23	28.0
Hypertension	34	41.5

Table 2: Mechanism of trauma.

Mechanisms	Number (n=82)	Percentage (%)
Motor Vehicle Accident	36	43.9
Fall	22	26.8
Penetrating Injury	14	17.1
Crush Injury	10	12.2

Table 3: Time to diagnosis of delayed limb ischemia.

Time to Diagnosis	Number (n=82)	Percentage (%)
<24 hours	18	22.0
24–48 hours	32	39.0
48–72 hours	20	24.4
>72 hours	12	14.6

Table 4: Revascularization methods used.

Methods	Number (n=82)	Percentage (%)
Endovascular	45	54.9
Surgical Bypass	30	36.6
Hybrid Approach	7	8.5

Table 5: Success rate of revascularization.

Outcomes	Number (n=82)	Percentage (%)
Successful Revascularization	68	82.9
Partial Success	10	12.2
Failure	4	4.9

Table 6: Post-revascularization complications.

Complication	Number (n=82)	Percentage (%)
Reperfusion Injury	8	9.8
Infection	6	7.3
Amputation	5	6.1
None	63	76.8

Table 7: Limb Salvage Rates.

Outcome	Number (n=82)	Percentage (%)
Limb Salvage Successful	74	90.2
Amputation Required	8	9.8

Table 8: Hospital stay duration.

Duration	Number (n=82)	Percentage (%)
<7 days	25	30.5
7–14 days	40	48.8
>14 days	17	20.7

Table 9: Mortality rates.

Outcome	Number (n=82)	Percentage (%)
In-Hospital Mortality	3	3.7
30-Day Mortality	5	6.1
Survival	74	90.2

Table 10: Long-Term Follow-Up Outcomes (12 Months).

Outcome	Number (n=82)	Percentage (%)
Full Recovery	60	73.2
Residual Disability	15	18.3
Amputation	5	6.1
Lost to Follow-Up	2	2.4

Discussion

The results of this investigation shed light on the function of revascularization in the treatment of post-traumatic delayed limb ischemia (DLI). Our cohort's demographic features, such as its mean age of 42.3 years and its preponderance of men (65.9%), were comparable with findings from some Chinese research [10, 11, 12], which have repeatedly documented that trauma-related DLI is more prevalent in younger, predominately male populations. The significance of taking pre-existing vascular risk factors into account when managing DLI is highlighted by the elevated incidence in smoking (54.9%) and comorbidities like diabetes mellitus (28.0%) and hypertension (41.5%), which can worsen ischemia and make revascularization outcomes more difficult. [13, 14]

The mechanisms for trauma in our study—falls (26.7%) and auto accidents (43.9%)—are in line with a study conducted in the United States [15], which found blunt trauma to be a major cause of DLI. Nevertheless, the inclusion of crush injuries (12.2%) and piercing injuries (17.1%) revealed the variety of DLI etiologies and the requirement for specialized revascularization techniques. With 39.0% of patients detected within 24 to 48 hours and 14.6% diagnosed beyond 72 hours, the timing to diagnosis for DLI was a crucial determinant.

Surgical bypass (36.6%), endovascular treatments (54.9%), and hybrid approaches (8.5%) were the revascularization modalities used in our group. A worldwide tendency toward minimally invasive procedures, which have been demonstrated to lower morbidity and lengthen hospital stays, was mirrored in the prevalence of endovascular procedures [16]. The effectiveness of these methods is further supported by the high limb salvage rate (90.2%) and revascularization success rate (82.9%), which were comparable in an Italian investigation on trauma-related DLI. Nonetheless, the difficulties in revascularization in complicated trauma patients were noted by the 4.9% failure rate and the 9.8% reperfusion damage rate.

With a 30-day death rate of 6.1% and an in-hospital mortality rate of 3.7%, our research had low mortality rates. These results are in good agreement with a Brazilian research [17], which found that fatality rates for trauma-related DLI might reach 10–15%. This is probably because of advancements in critical care treatment, revascularization methods, and early identification. According to a 12-month long-term follow-up, 18.3% of patients had residual impairment, and 73.2% of patients had fully recovered. These results highlight the possibility of functional recovery of trauma-related DLI with prompt and efficient revascularization.

Infection (7.3%), along with amputation (6.1%), were among the post-revascularization consequences that were comparatively modest in comparison to the French research [18], which revealed complication incidences up to 20% in DLI attributable to trauma. The safety and effectiveness of contemporary revascularization procedures were further supported by the fact that almost all of patients (76.8%) had no problems. The length of hospital stay: 48.8% of patients stayed between 7 and 14 days.

Conclusion

The most common cause of trauma was motor vehicle accidents (43.9%), and the most common diagnosis of delayed limb ischemia was made within 24 to 48 hours (39.0%). The most common technique was endovascular revascularization (54.9%), which had a high success score of 82.9% & a limb salvage rate of 90.2%. The most frequent post-revascularization consequences were infection (7.3%) and reperfusion damage (9.8%). The effectiveness of revascularization techniques was shown by the long-term follow-up, which showed that 73.2% of patients had fully recovered. Where our results showed how crucial prompt identification and treatment are to enhancing the prognosis of individuals suffering from delayed limb ischemia, in order to improve patient care as well as long-term rehabilitation, future research should concentrate on refining revascularization procedures and resolving residual impairments.

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