Predictive factors for postrevascularization compartment syndrome in acute lower limb ischemia

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Background

Following revascularization treatments for acute limb ischemia, postischemic compartment syndrome (CS), a surgical emergency brought on by elevated intracompartmental pressure in a lower extremity, develops acute limb ischemia. The muscles in the extremities may become edematous during surgical revascularization, such as embolectomy or artery bypass, as a result of fluid extravasation or inflammatory reactions following an ischemia-reperfusion insult, leading to a fast rise in intracompartmental pressure.

Objectives

In patients with nontraumatic acute ischemia of the lower extremities, are to evaluate the risk variables for postrevascularization CS.

Patients and methods

The 50 patients for this study were chose n at random from the emergency hospital at Mansoura University's Department of Vascular Surgery.

Results

The most important predictors of the CS were paralysis, Rutherford classification IIB, and intraoperative insufficient backflow. Significant risk factors for CS were atrial fibrillation, emboli, thrombosis, Rutherford classification IIA, ischemia time (h), and positive fluid balance in the first 24 h.

Conclusion

The most important predictors of the CS in postrevascularization of acute lower limb ischemia, as shown by the regression analysis, is paralysis, Rutherford classification IIB, and intraoperative insufficient backflow.

Keywords:
Predictive factors of acute compartment syndrome, acute compartment syndrome, compartment syndrome

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Introduction

Following revascularization treatments for acute limb ischemia (ALI), postischemic compartment syndrome (CS), a surgical emergency brought on by elevated intracompartmental pressure (ICP) in a lower extremity, develops ALI. The muscles of the extremities may become edematous during surgical revascularization, such as embolectomy or artery bypass, as a result of fluid extravasation or inflammatory reactions in response to an ischemia-reperfusion damage. This causes the ICP to rise quickly [1,2]. Localized ischemia of intracompartmental tissues, such as muscles and nerves, is caused by CS [1,3]. Particularly following revascularization of a lower extremity with a prolonged ischemia duration of more than 6 h, these processes manifest themselves quickly [3,4]. As a result, delayed diagnosis of CS may result in permanent ischemia of the muscles and nerves in the extremity, leaving the limb paralyzed or even lost [5]. The likelihood of complete limb recovery will be maximized by early diagnosis and care of CS.

Farrow *et al*. [6] realized in 2011 that high rates of CS were connected to vigorous fluid resuscitation or a positive fluid balance volume. The severity of ischemia, location, number, and level of affected arteries, as well as the etiology of ischemia (such as emboli, thrombosis, vasospastic limb, arterial dissection, and aneurysm with distal embolization) [7–9], as well as occupation and serum creatine kinase (CK) levels, are additional factors that increase the risk of CS, according to basic scientific theory [1,10]. The low sensitivity and low positive predictive value of clinical criteria for screening CS [1,11], the varying approaches and shaky reliability of ICP measurements [12,13], the rapid progression of CS, and the high morbidity and mortality of delayed diagnosis of CS make CS difficult to diagnose with a

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high level of suspicion. In order to help physicians with the diagnosis, early identification, and prevention of CS, as well as the avoidance of consequences from delayed fasciotomy, the authors undertook this study to discover the predictive characteristics connected with CS.

In individuals who are cognizant, clinical diagnosis is frequently not too difficult. A significant degree of suspicion should be raised in the presence of a pertinent trauma, a tight calf, and an excessive amount of discomfort relative to the trauma. The diagnosis is more likely if the serum creatine phosphokinase and creatinine levels are high. However, the diagnosis is simple to overlook in people who are unconscious. Every patient who poses a danger should be treated with extreme suspicion, and the calf should be checked often. CS can be diagnosed with great benefit using ICP measurements [14].

In our study, we aim to evaluate the risk variables for postrevascularization CS in patients with nontraumatic acute ischemia of the lower extremities.

Patients and methods

Technical design: this was a prospective randomized study that was performed on 50 cases from the Department of Vascular Surgery, emergency hospital, Mansoura University between 2017 and 2022.

Inclusion criteria: this study included all adult patients aged greater than 18 years with nontraumatic ALI with viable limbs (Rutherford classification I, IIA, and IIB).

Exclusion criteria: patients who had severe vascular damage or irreversible limb ischemia were excluded from the trial, and those who were unable to agree to interventional procedures could not receive revascularization operations.

Operative design

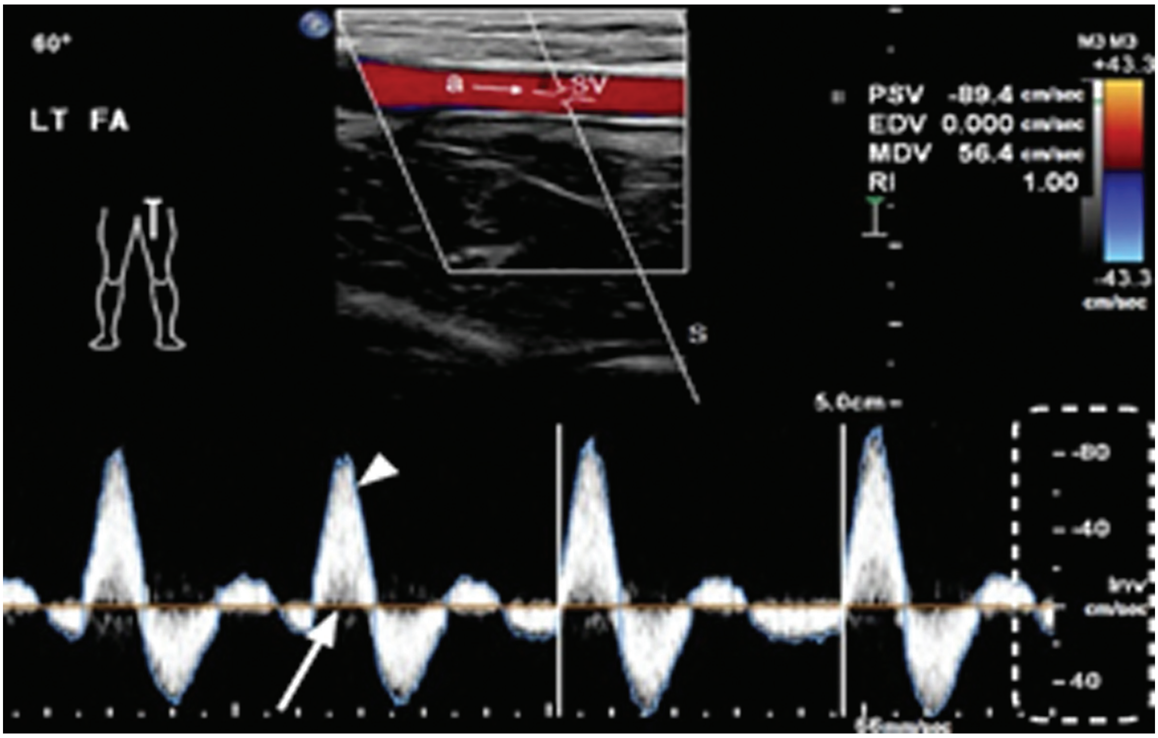
All patients included in the study were subjected to the following:

The patients that are included are exposed to taking a thorough history to cover the length of the ischemia, its etiology, and the hospital's diagnosis. Date of hospital admittance. Thorough clinical evaluation of vital indicators, and symptoms of (pallor, cyanosis, jaundice, and lymph node enlargement). The traditional signs and symptoms of the six Ps were evaluated for adequate selection criteria for ALI diagnosis.

Evaluation of distal arterial flow using SD3 vascular ultrasonic pocket Doppler

Investigations: complete blood picture, renal function test, serum CK levels: as a sign of rhabdomyolysis and skeletal muscle damage (earlier research found that a CK level of more than 4000 U/l was indicative of CS). An elevated CK level alone is not pathognomonic for

Figure 1



Color and pulsed-wave Doppler sonograms of normal lower extremity arteries with parameters.

CS. Profile of the liver test serum albumin, bilirubin, gamma-glutamyl transferase, serum aspartate and alanine aminotransferases International Normalization Ratio (INR). Total lipids, serum total cholesterol, serum high-density lipoprotein (HDL) cholesterol, total cholesterol to HDL ratio, serum triglycerides, serum phospholipids, low-density lipoprotein, very-low-density lipoprotein, and HDL are all included in the lipid profile and coagulation pattern (INR, activate partial thromboplastin time (APTT), platelets, and fibrinogen).

Imaging

Duplex on lower extremity vessels

For ALI assessment, duplex ultrasonography is the initial imaging method of choice which is very helpful for monitoring the success of revascularization treatments (Fig. 1).

Computed tomography angiography

Computed tomography angiography showed a sensitivity and specificity of 96 and 98%, respectively. Iodinated contrast agents are typically contraindicated in individuals with glomerular filtration rates less than 60 ml/min because they can exacerbate renal failure.

Magnetic resonance angiography

Compared with digital subtraction angiography, gadolinium-enhanced magnetic resonance angiography offers good sensitivity (93–100%) and specificity (93–100%) digital substraction angiography (DSA). However, patients with ALI could find it difficult to stay for lengthy imaging sessions. Patients with a nonimmediately threatened limb are only eligible for computed tomography angiography and magnetic resonance angiography.

Surgical technique

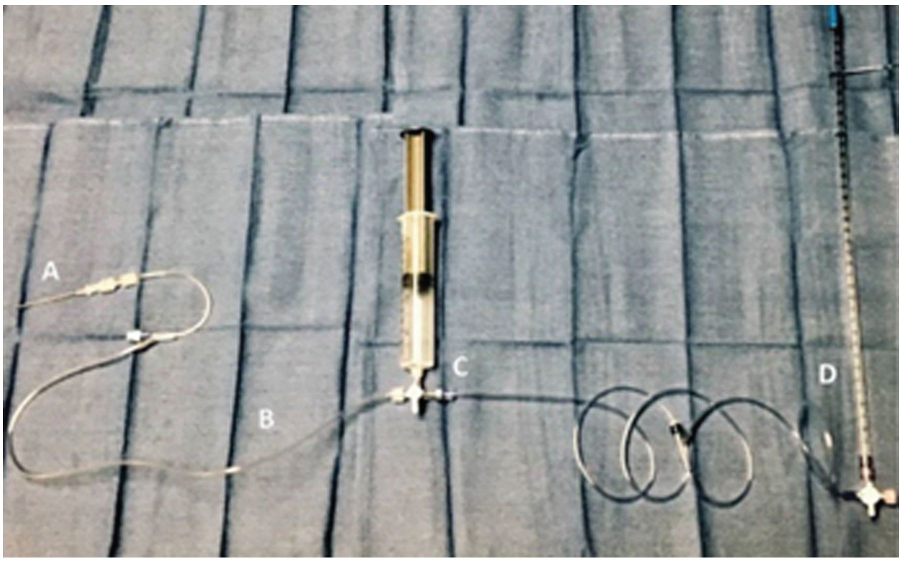
Patients with nontraumatic ALI and functional limbs underwent revascularization. Patients with ALI owing to emboli may have had thrombectomy utilizing vacuum-assisted thrombectomy. Until blood flow was restored and the thrombus load was decreased, intermittent angiography and vacuum-assisted thrombectomy were used.

Patients whose thrombectomy treatments had failed had a surgical bypass. Blood flow was restored to the common femoral artery (CFA), profunda femoris, and superficial femoral artery using an aorto-femoral bypass procedure.

Ischemic time was assessed and recorded as the period of time between the commencement of ALI and the revascularization procedure. After the revascularization surgery, all patients are rigorously watched for clinical signs of CS over the first 24 h. Using the Whitesides technique, the ICP of postrevascularized limbs was assessed immediately following surgery, 8 h later, and at the onset of CS.

A needle, syringe, three-way stopcock, plastic intravenous (i.v.) tubing, regular saline, and a mercury manometer33 are among the medical materials used in the Whitesides technique, which

Figure 2



Whitesides method of compartment pressure monitoring.

was first documented in the 1970s. These components are put together as a device that requires a needle to be placed into the muscle compartment in order to transmit the pressure thereby i.v. tubing to a manometer, where it may be read in millimeters of mercury (mmHg) (Fig. 2).

IV tubing is attached to a side-port needle (a) (b). This is attached to a mercury manometer by a three-way stopcock (c), which is attached to a syringe (d). The needle is put into the problematic compartment, and the manometer measures the pressure there. If a side-port needle is not available, a normal beveled needle may be utilized.

The tenseness of the compartment together with discomfort upon passive stretching, movements of muscle groups that passed through the same compartment, or peripheral nerve abnormalities (paresis or paresthesia) referring to the same compartment were the clinical criteria for the diagnosis of CS. Patients were placed in the CS group if they met the study's clinical diagnostic criteria for CS. All patients in the CS group had an emergency fasciotomy after having their ICP assessed.

Fasciotomy operations were always rigorously guided by the clinical criteria without relying on ICP since there was a high index of suspicion of CS when the clinical diagnostic criteria were present (Fig. 3).

On the other hand, a preventive fasciotomy is indicated by an absolute ICP greater than 30 mmHg without the clinical criterion, and an emergency fasciotomy is carried out in the operating room 31.

Figure 3

Prophylactic fasciotomy.

The non-CS group of patients contained those who did not meet the clinical criteria for CS. The most reliable and precise method for measuring ICP in a clinical setting was an 18-G bevel-tipped needle with a digital transducer manometer.

All compartments of the leg, including the anterior, lateral, superficial posterior, and deep posterior compartments, were measured for ICP (Fig. 4). The study excluded new-onset high-risk patients who were unable to undergo revascularization surgery due to medical comorbidities that were not well managed and failure of revascularization. To reduce the severity of the ischemic condition, systemic heparinization and hydration were administered. Amputation was done if the limb could no longer be saved in order to avoid consequences like pain and infection. Vascular testing, a conclusive ALI diagnosis, surgical intervention, and preoperative care, including ICP measures, were all completed.

CS clinical criteria were used to separate the patients into the CS and non-CS groups, independent of ICP. In this study, CS-related predictive parameters were taken into account. The following factors were taken into consideration: ischemic time, age, previous history of ALI in a lower extremity, peripheral arterial disease, preoperative hypotension, intraoperative insufficient backflow in arteries distal to the occlusion level, positive fluid balance volume in the first 24 h following the revascularization procedure, the severity of ischemia (according to the Rutherford classification), level of occlusion, number of occluded vessels, etiology of ischemia, and these were noted and put through analysis.

Administrative considerations: the ethics committee of the vascular surgery division, emergency hospital, Mansoura University, granted official clearance. The Institutional Research granted formal approval. Approval from the medical school's ethics committee (Institutional Research Board IRB Code MD 18.11.102).

Ethical consideration

The medical research ethics committee of the Faculty of Medicine at Mansoura University in Egypt submitted the study protocol for approval. Each research participant was asked for their signed agreement after confidentiality was guaranteed.

Data management and statistical analysis

Using SPSS, version 20, data input, processing, and statistical analysis were completed (Statistical Package

Figure 4

ICP was measured using an 18-G bevel-tipped needle with Whitesides method. ICP, intracompartmental pressure.

for the Social Sciences, New Orchard Road, Armonk, New York 10504-1722; US). The Kruskal–Wallis, Wilcoxon, χ^2, logistic regression analysis, and Spearman's correlation tests of significance were applied. According to the kind of data (parametric and nonparametric) collected for each variable, data were presented, and an appropriate analysis was carried out. *P* values of 0.05 or below 5% were regarded as statistically significant.

P value: significance level: nonsignificant if *P* value greater than 0.05, 0.05 or lower: significant, highly significant at *P* value of 0.01.

Descriptive statistics: for parametric numerical data, we use mean, SD, and range; for nonparametric numerical data, we use median and interquartile range. Proportion and frequency of nonnumerical information.

Analytical statistics: the statistical significance of a difference in a nonparametric variable between more than two research groups were evaluated using the Kruskal–Wallis test. Analysis of variance in one direction for variables with continuous normal distribution. After an analysis of variance, post-hoc analysis was carried out using the Mann–Whitney *U* test and the Tukey test.

Results

In Tables 1–14 we analyzed the data of our study which was performed on 50 cases selected from the Department of Vascular Surgery, emergency hospital, Mansoura University.

Table 1 shows that the mean age of the non-CS group was 61.7 years and that in the CS group was 64.29 years. 57.6% of the non-CS group and 52.9% of the CS group were males. There were nonsignificant differences between the non-CS group and CS group regarding age and sex (*P*=0.277 and 0.754, respectively).

Table 2 shows that there was a statistically significant difference between both groups regarding the history of atrial fibrillation (*P*=0.033). However, there were nonsignificant differences between both groups regarding other medical histories as hypertension (HTN), diabetes mellitus (DM), ischemic heart disease, cerebrovascular disease, smoking, and ALI (*P*>0.05).

Table 3 shows that the presence of emboli as a cause of ischemia was significantly higher in the non-CS group (*P*=0.020). However, thrombosis was significantly higher in the CS group (*P*=0.020).

Table 4 shows that paralysis as a presenting symptom was significantly higher in the CS group (*P*<0.001). There were nonsignificant differences between both groups regarding other presenting symptoms such as claudication, pain, pulseless, pallor, paresthesia, and poikilothermia (*P*>0.05).

Table 5 shows that there were nonsignificant differences between both groups regarding the level of occlusion as aorta-iliac arteries or femoral-popliteal arteries (*P*=0.980).

Table 6 shows that there was a nonsignificant difference between both groups regarding the number of occluded vessels (*P*=0.365).

Table 7 shows that there was a significant difference between both groups regarding Rutherford classification (*P*=0.007).

Table 1 Demographic characteristics of the studied sample

	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Age (years)	61.70±7.605	64.29±8.476	0.277
Sex			
Male	19 (57.6)	9 (52.9)	0.754
Female	14 (42.4)	8 (47.1)	

Data is expressed as mean and SD or as percentage and frequency.CS, compartment syndrome.*P* value is significant when less than 0.05.

Table 8 shows that serum CK was significantly higher in the CS group (*P*<0.001).

Table 9 shows that the ischemic time was significantly higher in the CS group (*P*=0.003).

Table 10 shows that the preoperative hypotension was significantly higher in the CS group (*P*=0.013). Also, the intraoperative inadequate backflow was significantly higher in the CS group (*P*<0.001). The positive fluid balance in the first 24 h was significantly higher in the non-CS group (*P*=0.037).

Table 11 shows that there was a nonsignificant difference between both groups regarding the ICP immediately after revascularization (*P*=0.371). However, the ICP was significantly higher in the CS group after 8 h (*P*<0.001).

Table 12 shows that the CS manifestations such as tenseness, pain on stretching or motion, paresis, and paresthesia were significantly higher in the CS group (*P*<0.001).

Table 13 shows that according to the regression analysis, the paralysis, Rutherford classification IIB and intraoperative inadequate backflow were the most significant predictors of the CS in the current study (*P*<0.001). Atrial fibrillation, emboli, thrombosis, Rutherford classification IIA, ischemic time (h) and positive fluid balance in the first 24 h were significant predictors of CS in this study

Table 2 Medical history of the studied patients

	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Hypertension	27 (81.8)	14 (82.4)	0.963
Diabetes mellitus	10 (30.3)	7 (41.2)	0.442
Atrial fibrillation	16 (48.5)	3 (17.6)	**0.033**
Ischemic heart disease	10 (30.3)	6 (35.3)	0.720
Cerebrovascular disease	5 (15.2)	2 (11.8)	0.744
Smoking	24 (72.7)	10 (58.8)	0.318
Previous history of ALI	12 (36.4)	7 (41.2)	0.740

Data is expressed as percentage and frequency. ALI, acute limb ischemia; CS, compartment syndrome. *P* value is significant when less than 0.05.

Table 3 Cause of ischemia of the studied patients

Cause of ischemia	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Emboli	23 (69.7)	6 (35.3)	0.020
Thrombosis	10 (30.3)	11 (64.7)	

Data is expressed as percentage and frequency.CS, compartment syndrome.*P* is significant when less than 0.05.

Table 4 Presenting symptoms of the studied patients

Symptoms	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Claudication	29 (87.9)	13 (76.5)	0.297
Pain	24 (72.7%)	12 (70.6)	0.873
Pulseless	27 (81.8)	16 (94.1)	0.235
Pallor	19 (57.6)	13 (76.5)	0.187
Paresthesia	11 (33.3)	5 (29.4)	0.778
Poikilothermia	17 (51.5)	5 (29.4)	0.136
Paralysis	3 (9.1)	15 (88.2)	Ë **0.001**

Data is expressed as percentage and frequency.CS, compartment syndrome.*P* is significant when less than 0.05. Bold: highly significant.

Table 5 Level of occlusion of the studied patients

Level of occlusion	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Aorta-iliac arteries	2 (6.1)	1 (5.9)	0.980
Femoral-popliteal arteries	31 (93.9)	16 (94.1)	

Data is expressed as percentage and frequency.CS, compartment syndrome.*P* is significant when less than 0.05.

Table 6 Number of occluded vessels of the studied patients:

	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Number of occluded vessels	1.39±0.496	1.53±0.514	0.365

Data is expressed as mean and SD.CS, compartment syndrome.*P* is significant when less than 0.05.

Table 7 Rutherford classification of the studied patients

Rutherford classification	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
I: viable	14 (42.4)	0	0.007
IIA: marginally threatened	16 (48.5)	14 (82.4)	
IIB: immediately threatened	3 (9.1)	3 (17.6)	

Data is expressed as percentage and frequency.CS, compartment syndrome.*P* is significant when less than 0.05.

Table 8 Serum creatine kinase of the studied patients

	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Serum creatine kinase	1383±400	11556±5262	Ë 0.001

Data is expressed as mean and SD.CS, compartment syndrome.*P* is significant when less than 0.05.

Table 9 Ischemic time (h) of the studied patients

	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Ischemic time (h)	38.36±23.428	65.29±36.055	0.003

Data is expressed as mean and SD.CS, compartment syndrome.*P* is significant when less than 0.05.

(*P*=0.041, 0.023, 0.023, 0.018, 0.006, and 0.041, respectively).

Table 14 shows that according to the regression analysis, age, sex, HTN, DM, ischemic heart disease, cerebrovascular disease, smoking, previous history of ALI, claudication, pain, pulseless, pallor,

Table 10 Preoperative hypotension, intraoperative inadequate backflow, and positive fluid balance in the first 24 h of the studied patients

	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Preoperative hypotension	0	3 (17.6)	0.013
Intraoperative inadequate backflow	3 (9.1)	11 (64.7)	<0.001
Positive fluid balance in the first 24 h	13 (39.4)	12 (70.6)	0.037

Data is expressed as percentage and frequency.CS, compartment syndrome.*P* is significant when less than 0.05.

Table 11 Intracompartmental pressure follow-up of the studied patients

Intracompartmental pressure	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Immediately after revascularization	13.15±5.767	11.59 ±5.874	0.371
After 8 h	10.97±4.902	29.94 ±4.423	<**0.001**

Data is expressed as mean and SD.CS, compartment syndrome. *P* is significant when less than 0.05. Bold: highly significant.

Table 12 Compartment syndrome manifestations of the studied patients

	Non-CS group (*N*=33)	CS group (*N*=17)	*P*
Tenseness	0	17 (100.0)	<0.001
Pain on stretching or motion	0	15 (88.2)	<0.001
Paresis	0	13 (76.5)	<0.001
Paresthesia	0	12 (70.6)	<0.001

Data is expressed as percentage and frequency.CS, compartment syndrome.*P* is significant when less than 0.05.

Table 13 Regression analysis for significant predictors of compartment syndrome in this study

	R^2 (%)	*B*	*P*
Atrial fibrillation	12.8	0.23	0.041
Emboli	14.3	4.2	0.023
Thrombosis	14.3	0.24	0.023
Paralysis	66.8	75.0	<0.001
Rutherford classification IIA	18.8	0.14	0.018
Rutherford classification IIB	66.8	75.0	<0.001
Ischemic time (h)	4.2	1.03	0.006
Intraoperative inadequate backflow	40.1	18.3	<0.001
Positive fluid balance in the first 24 h	11.8	3.7	0.041

CS, compartment syndrome.*P* is significant when less than 0.05.

Table 14 Regression analysis for insignificant predictors of compartment syndrome in this study

	P
Age (years)	0.272
Sex	0.755
Hypertension	0.963
Diabetes mellitus	0.444
Ischemic heart disease	0.720
Cerebrovascular disease	0.744
Smoking	0.321
Previous history of ALI	0.740
Claudication	0.305
Pain	0.873
Pulseless	0.260
Pallor	0.193
Paresthesia	0.778
Poikilothermia	0.141
Level of occlusion	0.123
Number of occluded vessels	0.363
Rutherford classification I	0.998
Serum creatine kinase	0.942
Preoperative hypotension	0.999

ALI, acute limb ischemia; CS, compartment syndrome.*P* is significant when less than 0.05.

paresthesia, poikilothermia, level of occlusion, number of occluded vessels, Rutherford classification I, serum creatine.

Discussion

A closed fascial gap is what gives rise to the surgical emergency known as acute limb compartment syndrome (LCS). When ICP is raised, capillary perfusion is decreased below the amount required for tissue viability. Effective diagnosis and treatment of this condition are still difficult to achieve [15].

Reduced tissue perfusion can cause permanent necrosis, which can cause functional disability, limb loss, and, in extreme circumstances, death. The most common time for acute LCS to develop is after a traumatic incident, yet in up to 30% of cases, there is no sign of a fracture [16]. Thermal injuries (particularly those that are circumferential), lithotomy placement during surgery, and tight casts or wraps are other conditions that might result in acute extremities CS [17].

Nephrotic syndrome, rhabdomyolysis, bleeding problems, and iatrogenic causes, such as an unintentional pressured intravenous or extravenous infusion of a substance, have also been linked to acute LCS. Acute extremities CS can also be brought on by infections, particularly those caused by Streptococcus spp. Therefore, a patient with acute extremities CS might be seen by nearly any doctor [16].

The limbs are covered in a thick fascial layer that compartmentalizes the skeletal muscle groups and the neurovascular bundles that support them. Since this fascial membrane is rigid, an increase in ICP might decrease capillary blood flow, which could eventually result in arteriolar compression and, if decompression is delayed, muscle and nerve ischemia, muscle infarction, and nerve damage [18].

The most effective technique for sufficient compartment decompression is open fasciotomy, which involves incising both skin and fascia. ICP measurement methods offer benefits and drawbacks, whereas the pressure threshold that requires fasciotomy is debatable [16].

Delay in diagnosis is the key factor in a bad result from LCS following injury. The diagnosis may be diagnosed early and the effects may be reduced with continuous ICP monitoring [19].

Therefore, the purpose of this study was to evaluate the risk variables for postrevascularization CS in people who had nontraumatic ALI.

The 50 patients for this study were chosen at random from the emergency hospital at Mansoura University's Department of Vascular Surgery.

The non-CS group in this research had a mean age of 61.7 years, whereas the CS group had a mean age of 64.29 years. Males made up 52.9% of the CS group and 57.6% of the non-CS group. Regarding age and sex, there were no appreciable differences between the non-CS group and CS group (P=0.277 and 0.754, respectively).

The study's patients' medical histories revealed a statistically significant difference between the two groups with relation to a history of atrial fibrillation (P=0.033). Regarding other medical conditions such HTN, DM, ischemic heart disease, cerebrovascular disease, smoking, and ALI, there were no statistically significant differences between the two groups ($P>0.05$).

In contrast to our findings, a study by Orrapin and colleagues that sought to identify predictive factors for CS found no statistically significant difference between the CS group and the non-CS group in terms of the patients' demographic and clinical data (cardiovascular disease, atrial fibrillation, hypertension, coronary artery disease, congestive heart failure, rheumatic heart disease with multiple sclerosis, peripheral arterial disease, non–cardiovascular disease).

Regarding the degree of occlusion or the quantity of occluded arteries, there were no statistically significant differences between the two groups in our study (*P*=0.980 and 0.365, respectively).

In agreement with our findings, Orrapin and colleagues reported no statistically significant difference in the amount of occlusion between the CS group and the non-CS group.

In this investigation, the non-CS group had substantially more emboli as a contributing factor to ischemia (*P*=0.020). The thrombosis rate, however, was noticeably greater in the CS group (*P*=0.020).

Contrary to our findings, Orrapin and colleagues found no evidence of a difference between the CS group and the non-CS group in terms of the etiology of acute arterial occlusion as emboli or thrombosis.

In this investigation, the CS group had substantially greater levels of tenseness, discomfort with stretching or motion, paresis, and paresthesia (*P*=0.001). The CS group had considerably more paralysis as a presenting symptom (*P*=0.001). Regarding other presenting symptoms such claudication, pain, pulselessness, pallor, paresthesia, and poikilothermia, there were no statistically significant differences between the two groups (*P*>0.05).

Contrary to our findings, Lin and Samora conducted a comprehensive study of ACS of the extremities and found that of the 165 patients whose symptoms were documented, pain was most frequently reported by 146 (88%) individuals. Following this, there were 53 (32% of cases) of paresthesia/abnormal sensations, 47 (28% of swelling), 43 (26% of paralysis), 21 (13% of pulselessness), and 19 (12% of pallor) [20].

With regard to the ICP immediately following revascularization, there was no statistically significant difference between the two groups in this research (*P*=0.371). After 8 h, however, the ICP in the CS group was considerably higher (*P*=0.001).

In a research by Orrapin and colleagues, all patients in the CS group had an ICP greater than 30 mmHg in at least one of four compartments, which is one of the diagnostic criteria for CS. The ICP was less than 30 mmHg in all individuals in the non-CS group who did not exhibit the symptoms and indications of CS. When compared with the non-CS group, the ICP in each compartment of the CS group was noticeably higher (*P*=0.001). In the CS group, the anterior compartment had the greatest mean ICP (38 mmHg). The deep and superficial posterior compartments' mean ICP in the CS group did not surpass the absolute ICP threshold (28.6 and 26.6 mmHg, respectively).

Regarding Rutherford's categorization, there was a significant difference between the two groups in our study (*P*=0.007). The CS group had considerably more serum CK (*P*=0.001) than the control group. In the CS group, the ischemia time was substantially longer (*P*=0.003). In the CS group, the preoperative hypotension was substantially worse (*P*=0.013). In addition, the CS group had considerably more intraoperative insufficient backflow (*P*=0.001) than the control group. The non-CS group had a considerably greater positive fluid balance throughout the first 24 h (*P*=0.037).

The paralysis, Rutherford classification IIB, and intraoperative insufficient backflow were this study's most significant predictors of the CS (*P*=0.001) according to the regression analysis. In the present investigation, significant predictors of CS were atrial fibrillation, emboli, thrombosis, Rutherford classification IIA, ischemia duration (h), and positive fluid balance in the first 24 h (*P*=0.041, 0.023, 0.018, 0.006, and 0.041, respectively).According to some of our findings, Orrapin and colleagues identified four variables as statistically significant predictors of CS: insufficient backflow, favorable fluid balance, advanced-stage acute arterial occlusion, and high serum CK level. Eighty percent of the patients' in the CS group had inadequate intraoperative blood flow returning from the distal run-off arteries. The CS group's (4324 ml) positive fluid balance volume over the first 48 h was substantially higher than that of the non-CS group (1223 ml). Rutherford class IIB was assigned to each patient in the CS group. The difference between the CK levels in the CS group and the non-CS group was considerable (20 683 and 911 U/l, respectively).

In addition, when blood CK levels in CS were evaluated [12], only maximal CK demonstrated a sufficient connection with CS. Maximum CK levels greater than 4000 U/l were the ideal cut thresholds. When all three factors were missing, zero of six patients had CS according to the model with CK levels larger than 4000 U/l, chloride levels greater than 104 mg/dl, and blood urea nitrogen levels less than 10 mg/dl. There were 36, 80, and 100% more patients with CS when one, two, or three factors were present. The sensitivity, specificity, positive and negative prediction values, and overall accuracy were all 0.85, 0.87, 0.76, 0.92, and 0.86, respectively, when the cut point was two or more of these three variables being positive.

According to the regression analysis of our results, age, sex, HTN, DM, ischemic heart disease, cerebrovascular disease, smoking, previous history of ALI, claudication, pain, pulseless, pallor, paresthesia, poikilothermia, level of occlusion, number of occluded vessels, Rutherford classification I, serum CK and preoperative hypotension were insignificant predictors of the CS in this study ($P>0.05$).

The connection between CS and young age in a research by Orrapin and colleagues could not be assessed in our investigation since all patients in the CS and non-CS groups were older than 45 years. Number of patients had a background with ALI. The cause of arterial occlusion, the number of blocked arteries, the patient's employment, and the kind of revascularization operation were all not reliable predictors of CS.

Conclusion

In conclusion, LCS occurs when raised ICP causes tissue ischemia. It is a potentially limb-threatening and life-threatening problem after revascularization of the acute ischemic limbs. A high index of clinical suspicion is required to diagnose this pathologic process. For early detection, it is necessary to educate those taking care of patients at risk, especially in the early symptoms and signs. In our study, According to the regression analysis, the paralysis, Rutherford classification IIB and intraoperative inadequate backflow were the most significant predictors of the CS. Atrial fibrillation, emboli, thrombosis, Rutherford classification IIA, ischemic time (h) and positive fluid balance in the first 24 h were also predictors of CS but less statistically significant. Monitoring of ICP should be routine, particularly in patients in whom subjective clinical assessment is not available, i.e., in unconscious, sedated, and uncooperative patients. Delay in diagnosis or treatment of LCS can result in significant morbidity for the patient.

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Conflicts of interest

There are no conflicts of interest.

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