

Research Article

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Results of Surgical Treatment of Elderly and Senile Patients With Acute Ischemia of the Lower Extremities of Embologenic Origin

I.P. Mikhailov¹, V.A. Arustamyan¹ ✉, S.I. Rey¹, M.S. Mikerova²

Department of Vascular Surgery

¹ N.V. Sklifosovsky Research Institute for Emergency Medicine

3, Bolshaya Sukharevskaya Sq., Moscow, 129090, Russian Federation

² I.M. Sechenov First Moscow Medical University, F.F. Erisman Institute of Public Health

8, bldg. 2, Trubetskaya Str., Moscow, 119991, Russian Federation

✉ **Contacts:** Vladislav A. Arustamyan, Junior Researcher, Department of Vascular Surgery of the N.V. Sklifosovsky Research Institute for Emergency Medicine.

Email: arust_vlad@mail.ru

BACKGROUND Today, one of the urgent problems of emergency vascular surgery is the high mortality rate in acute ischemia of the lower extremities in elderly and senile patients.

AIM OF STUDY To evaluate the incidence of complications in elderly and senile patients with acute ischemia of the lower extremities of embologenic origin.

MATERIAL AND METHODS As an object of study, three groups of elderly and senile patients admitted with a clinical picture of acute ischemia of the lower extremities were studied. Group I – patients who underwent reconstructive interventions in the scope of the so-called proximal reconstruction; group II – patients who, for the purpose of complete revascularization, underwent extended reconstructive interventions using an additional surgical approach; group III – patients who underwent a “classic” embolectomy.

RESULTS Good results were statistically significantly more common in group II. Satisfactory and poor results were observed in group III. Amputations were statistically significantly more common in group III. In 69.6% of cases, the use of plasmapheresis and infusion therapy prevented the development of acute renal injury.

CONCLUSION Performing extended arterial reconstructions, including using an additional surgical approach, makes it possible to more fully restore the main blood flow in the ischemic limb and thereby completely restore the main blood flow in the ischemic limb and reduce the degree of ischemia, as well as reduce the severity of the manifestation and course of the post-ischemic syndrome.

Keywords: acute ischemia of the lower extremities, embolism of the arteries of the lower extremities, acute renal injury, reconstructive interventions in acute ischemia of the lower extremities

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Affiliations

Igor P. Mikhailov	Doctor of Medical Sciences, Professor, Scientific Supervisor of the Department of Vascular Surgery, N.V. Sklifosovsky Research Institute for Emergency Medicine of the Moscow Health Department; https://orcid.org/0000-0003-0265-8685 , mikhailovip@sklif.mos.ru; 40%, development of the concept and design of the study, analysis of the obtained data, editing
Vladislav A. Arustamyan	Junior Researcher, Department of Vascular Surgery, N.V. Sklifosovsky Research Institute for Emergency Medicine of the Moscow Health Department; https://orcid.org/0000-0003-0520-0573 , arust_vlad@mail.ru; 30%, collection of material, analysis of the received data, preparation of the text
Sergey I. Rey	Candidate of Medical Sciences, Senior Researcher at the Department of Emergency Surgery, Endoscopy and Intensive Care, N.V. Sklifosovsky Research Institute for Emergency Medicine of the Moscow Health Department; https://orcid.org/0000-0001-7802-2283 , reysi@sklif.mos.ru; 30%, collection of material, analysis of the received data, preparation of the text
Maria S. Mikerova	Associate Professor of the N.A. Semashko Department of Public Health of the F.F. Erisman Institute of Public Health, I.M. Sechenov First Moscow Medical University; https://orcid.org/0000-0003-2718-1895 , mikerova_m_s@staff.sechenov.ru; 10%, statistical processing of the material

AKI - acute kidney injury
 ALLI - acute lower limbs ischemia
 CPK - creatine phosphokinase
 RRT - renal replacement therapy

Acute lower limb ischemia (ALLI) continues to be the most common urgent pathology of the cardiovascular system, which, according to various sources, occupies from 43 to 60% of cases in the structure of emergency vascular pathology [1, 2].

The Transatlantic Intersociety Conciliation Document (TASC) defines ALE as “a sudden decrease in perfusion of an extremity leading to an established or potential threat to its viability” [3]. ALLI occurs when the duration of its accompanying symptoms is less than 2 weeks. The main amputation rate for ALLI is reported to be 10–15% [3, 4], while the associated 30-day mortality is 15–25% [5]. Thus, in the latest reviews [6, 7] conducted in the UK (*Hospital episode statistics*) it was shown that the number of patients hospitalized with ALLI reaches 1.5 cases per 10,000 population annually.

Aim of study: to assess the incidence of complications in elderly and senile patients with ALLI of embologenic origin.

MATERIAL AND METHODS

In the Department of Emergency Vascular Surgery of N.V. Sklifosovsky Research Institute for Emergency Medicine, an analysis was made of the results of surgical treatment of 387 elderly and senile patients with ALLI caused by embolism of the arteries of the lower extremities for the period from 2014 to 2020.

The mean age of the patients was 74.1 ± 8.2 years. There were 160 men (41.3%), their average age was 72.5 years. There were 227 women (58.7%), their average age was 74.6 ± 6.7 years. The distribution of patients by sex and age is presented in Table 1.

Table 1

Distribution of patients by gender and age

Gender	Age group, years									
	60–65		66–70		71–75		over 75		Total	
	%	n	%	n	%	n	%	n	%	n
Men	51.5	52	58.3	21	54.9	28	29.6	59	41.3	160
Women	48.5	49	41.7	15	45.1	23	70.4	140	58.7	227
Total	100	101	100	36	100	51	100	199	100	387

Depending on the extent of the operation, all patients were divided into three groups.

Group I ($n = 121$) — patients who underwent embolectomy in addition to reconstructive surgery from one surgical approach. Surgical correction was carried out in the volume of the so-called proximal reconstructive operation in the minimum possible volume for regression of ischemia.

Group II ($n = 74$) — patients who underwent extended reconstructive interventions using an additional surgical approach in order to complete revascularization.

Both groups made up the studied category of patients. As a comparison group (Group III, $n = 192$), patients with embolism of the arteries of the lower extremities and the same age group were selected. Surgical revascularization in this group of patients was performed only by "classical" embolectomy, without performing reconstructive operations.

The degree of ALLI was assessed in accordance with the classification of I.I. Zatevakhin (2002), presented in the draft national guidelines for the diagnosis and treatment of diseases of the arteries of the lower extremities (2019).

The distribution of patients according to the degree of ischemia in groups is presented in Table 2.

Table 2

Distribution of patients according to the degree of ischemia in groups

Degree of limb ischemia (according to I.I. Zatevakhin)	I group		II group		III group	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
2A degree	19	15.7	23	31.1	47	24.5
2B degree	101	83.5	36	48.6	138	71.9
2C degree	1	0.8	15	20.3	7	3.6
Total	121	100	74	100	192	100

Notes : all three groups statistically significantly differ from each other in the degree of limb ischemia ($p=0.042$)

In the first 6 hours from the moment of admission to the hospital, 286 patients (73.9%) were operated on, 101 patients (26.0%) were operated on within the period from 7 hours to several days. They needed to perform additional research methods for differential diagnosis, at the same time anticoagulant, angiotropic, infusion therapy was started. During the observation period, ischemia did not progress.

From the moment of acute ischemia to the restoration of the main blood flow, patients were distributed as follows: no more than 6 hours, 129 patients (33%); from 8 to 12 hours, 16 (4%); and more than 12 hours, 241 (63%).

The timing of the operation from the onset of acute ischemia to the restoration of the main blood flow is shown in Fig. 1.

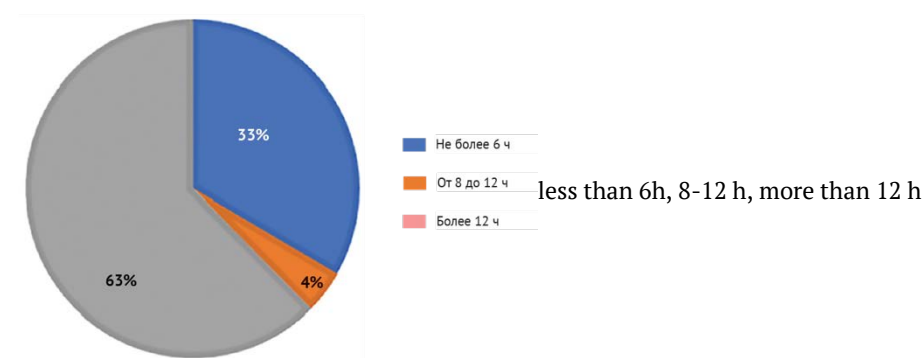


Fig. 1. The timing of the operation from the moment of acute ischemia to the restoration of the main blood flow

Note: the timing of the operation was statistically significantly different ($p<0.05$)

Depending on the extent of the operation, all patients were divided into three groups.

Group I ($n = 121$) — patients who underwent embolectomy in addition to reconstructive surgery from one surgical approach. Surgical correction was carried out in the volume of the so-called proximal reconstructive operation in the minimum possible volume for regression of ischemia.

Group II ($n = 74$) — patients who underwent extended reconstructive interventions using additional surgical access in order to complete revascularization.

Both groups made up the studied category of patients. As a comparison group (Group III, $n = 192$), patients with embolism of the arteries of the lower extremities and the same age group were selected. Surgical revascularization in this group of patients was performed only by "classical" embolectomy, without performing reconstructive operations. In these patients, a transverse arteriotomy was used during the operation, followed by suturing of the artery with a continuous twist suture.

Results were considered good if there was a complete restoration of limb function; Satisfactory were cases when there was a pronounced decrease in the degree of ischemia of the limb with its transition to a lower level or the level of upcoming amputation decreased. The results were considered poor when there was no decrease in ischemia or retrombosis of the reconstructed area of the arterial bed developed with the progression of acute limb ischemia.

Repeated embolisms in the main arteries of the lower extremities were observed in 45 patients (11.6%).

In 289 patients (74.7%), embolism was diagnosed in atherosclerotically altered arterial bed. the superficial femoral artery was also analyzed, which was important when planning a reconstructive operation.

The state of the superficial femoral artery in patients with ALLI is shown in Fig. 2.

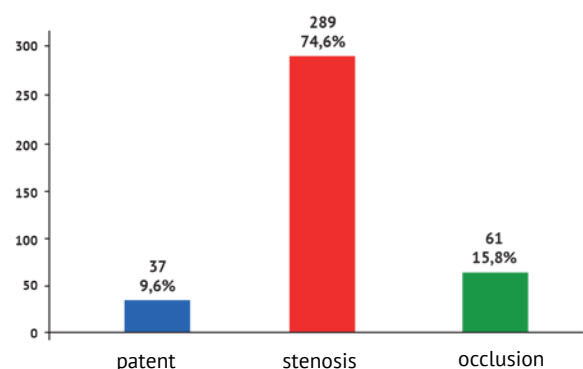


Fig. 2. The state of the superficial femoral artery in patients with acute ischemia of the lower extremities

All patients underwent ultrasound duplex scanning of the arteries of the lower extremities upon admission. Angiographic examination was performed in 94 patients (24.3%). Hybrid radiation methods were performed in 84 patients (21.7%).

Predictors of the development of postischemic syndrome, the degree of damage to skeletal muscles were studied, indications for renal replacement therapy in the development of postischemic syndrome in the postoperative period were determined. To assess the degree of damage to the skeletal muscles of the limb, the activity of the enzyme creatine phosphokinase (CPK) was evaluated.

The distribution of patients according to the development of post-ischemic syndrome and acute kidney injury (AKI) is presented in Table 3.

Table 3

Distribution of patients according to the development of post-ischemic syndrome and acute renal injury

	Groups, n (%)			p-value
	I	II	III	
Post-ischemic edema (local manifestation)	11 (9.09)	6 (8.11)	9 (4.69)	0.276
Post-ischemic syndrome (laboratory)	42 (34.71)	24 (32.43)	3 (2.81)	0.001
Acute kidney injury	1 (0.83)	1 (1.35)	5 (2.6)	0.49

Notes: Groups I and II are statistically significantly different from group III ($p=0.0001$). At the same time, there are no statistically significant differences between groups I and II ($p=0.92$)

The earliest indicators of rhabdomyolysis, which begin to rise in 6 hours, are blood myoglobin and CPK levels. In our study, we evaluated the dynamics of CPK.

One of the criteria for carrying out methods of extracorporeal hemocorrection was an increase in the level of CPK $>10,000$ U/l.

In 14 patients (54%), after the first session of plasmapheresis, a 1.5-fold decrease in CPK or more was noted. In 9 cases (35%), due to persistent high CPK numbers, repeated plasmapheresis was required.

In 91 cases (23.5%), therapy was carried out according to the method of forced diuresis.

The statistical analysis of the obtained data was carried out on a personal computer using *MS EXCEL* and *IBM SPSS 23* application packages.

The distribution parameters (mean value, standard deviation, frequency analysis) were calculated for all studied indicators in each group.

Statistical analysis of the obtained data was carried out on a personal computer using the *IBM SPSS 23* program. The data were checked for compliance with the normal distribution using the Shapiro–Wilk test. The quantitative data is presented as $M \pm \sigma$.

Differences between the studied groups were checked using the Mann–Whitney test, and when analyzing the dynamics, using the Friedman test. The indicators presented in the nominative scale were evaluated using frequency analysis using the Pearson's Chi-squared test. For the convenience of comparative visualization, quantitative indicators in the studied groups and subgroups are presented in the form of “Box & Whisker Plot”. All obtained differences were considered at a significance level not higher than 0.05.

RESULTS

As a result of a comparative analysis between the groups, statistically significant differences were found in all indicators, except for the mortality rate. Good results were statistically significantly more common in group II. Satisfactory and poor results were common in group III. Amputations were statistically significantly more common in group III.

The results of a comparative analysis of surgical treatment between groups are presented in Table 4.

Table 4

Results of a comparative analysis of surgical treatment between groups

Indicators	Groups, n (%)			Chi-square	p-value
	I	II	III		
Good	94 (77.69)	58 (78.38)	68 (35.42)	71.35	0.001
Satisfactory	18 (14.88)	14 (18.92)	81 (42.19)	31.458	0.001
Poor	9 (7.44%)	2 (2.70)	43 (22.40)	23.477	0.001
Amputations	9 (7.44)	2 (2.70)	26 (13.54)	8.175	0.017
Mortality	4 (3.31)	1 (1.35)	13 (6.77)	4.256	0.12

Note: groups are statistically significantly different at $p < 0.05$

In 26 patients (6.71%), the post-ischemic syndrome had a local character and was manifested only by post-ischemic edema and a less pronounced increase in enzymes, ischemia markers (CPK). Not all patients after the restoration of the main blood flow developed a post-ischemic syndrome with an increase in enzymes. In total, in our study, post-ischemic syndrome developed in 33% of cases (129 cases).

Of the 18 patients who died, 7 (38.8%) had AKI. In 5 cases (38.5%) in group III, which was also due to late terms of ischemia, a higher incidence of rethrombosis in the early hours after surgery and "insufficient" to stop and prevent the progression of acute ischemia by restoring the main blood flow.

Plasmapheresis was required in 23 cases (6%). In 7 patients (1.8%) with developed AKI, hemodiafiltration sessions were performed for 24 hours. One patient with AKI did not require renal replacement therapy (RRT).

In 14 patients (54%), after the first session of plasmapheresis, a 1.5-fold decrease in CPK was noted. In 9 cases (35%), due to persistent high CPK, repeated plasmapheresis was required. There were no statistically significant differences between groups (Table 5).

Table 5

Comparative analysis between groups on the need for plasmapheresis

	Groups, n (%)		
	I (n =121)	II (n =74)	III (n =192)
Plasmapheresis, n (%)	7 (5.78)	9 (12.1)	7 (3.64)
Repeated plasmapheresis, n (%)	2 (1.65)	3 (4.05)	4 (2.08)

The dynamics of the increase in the level of CPK is shown in Fig. 3.

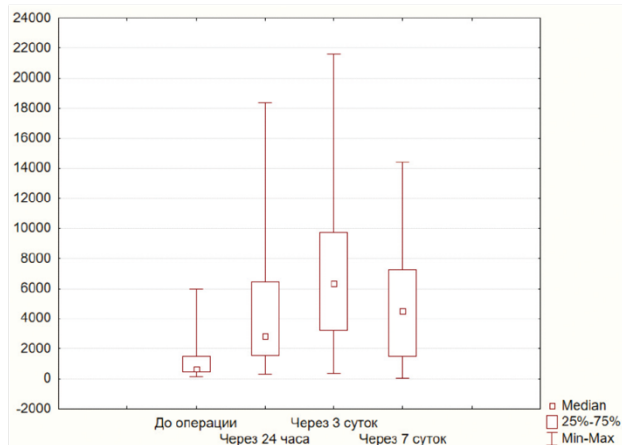


Fig. 3. The dynamics of increasing the level of creatine phosphokinase

In the period from 24 hours to 3 days after the restoration of the main blood flow in the ischemic limb, reperfusion injury of skeletal muscles reaches a maximum 24 hours after the operation (see Fig. 3). The picture of reperfusion damage to skeletal muscles is most pronounced in patients with a high degree and long periods of ischemia. Further, there is a decrease in CPK with the achievement of normal values by the 7th day after the restoration of blood flow in the limb.

DISCUSSION

Despite the improvement of instrumental diagnostic methods, the detailed studied and proven technique of revascularization operations, mortality in acute arterial insufficiency of the lower extremities remains high. According to domestic and foreign sources, the development of acute limb ischemia leads to disability in 10–15% of patients, while mortality remains at the same level of 15–25% [8].

Determination of indications and contraindications for revascularization operations in stroke of embologenic origin in elderly and senile patients is one of the most important issues, therefore, when developing indications for surgical treatment, the following factors were taken into account: overall operability of patients based on the results of assessing cardiac and other risk factors, the severity of limb ischemia, evaluation of the distal vascular bed and soft tissue viability of the ischemic limb.

There are different opinions regarding the processes occurring after the restoration of blood flow in ischemic tissues. Thus, a number of authors believe that successful revascularization is accompanied by an improvement in the supply of ischemic tissues with oxygen already on the 1st day [9], while others, on the contrary, believe that an increased supply of oxygen to tissues occurs against the background of a decrease in the ability to utilize it, and the restoration of blood circulation is characterized by inadequate transport function of oxygen in the lower extremities included in the bloodstream [10]. 1–2% of them develop AKI, requiring RRT (dialysis, hemodiafiltration) [11]. The term “acute kidney injury” (AKI), which has replaced the concept of acute kidney failure since 2004, was proposed by the International Committee for Improving Kidney Disease Improving Global *Outcomes* (KDIGO), and began to be used by nephrologists and resuscitators around the world [12, 13].

There are generally accepted indications for the immediate initiation of RRT in patients with AKI (Table 6) [14–16].

Indications for initiation of RRT are presented in Table 6.

Table 6

Indications for initiation of renal replacement therapy

Category	Characteristic
Absolute indications for starting renal replacement therapy	
Hyperkalemia	≥ 6.5 mmol / l and (or) changes in the electrocardiogram
Severe hyperhydration	Resistant edema (especially pulmonary, cerebral) in patients with acute kidney injury
Azotemia	Plasma urea level ≥ 30 mmol/l
Acidosis	$\text{pH} \leq 7.15$
Oligoanuria	Urine output < 200 ml/12 hours or anuria
Uremic complications	Encephalopathy, pericarditis, neuro- and myopathy
Hypermagnesemia	≥ 4 mmol/l and/or anuria/absence of deep tendon reflexes
Exogenous poisoning	Elimination of dialyzable poison
Severe and/or rapidly progressive acute kidney injury	Stage 3 acute kidney injury
Relative indications for initiation of renal replacement therapy	
Stage 2 acute kidney injury in critically ill patients with multiple organ dysfunction	

CONCLUSION

Thus, the best results of surgical treatment of elderly and senile patients were noted in the group of patients (I and II) who underwent reconstructive surgery. Extended reconstructive interventions using additional surgical approaches performed in patients with long-term ischemia and thrombosis of the distal arterial bed showed high efficiency. Knowledge of the dynamics of the course (increase) of rhabdomyolysis markers, therapy in a specialized intensive care unit, as well as the use of renal replacement therapy techniques can improve the results of surgical treatment of elderly and senile patients with acute ischemia of the lower extremities of embologenic origin.

1. In case of embolism of the main arteries of the lower extremities, the general condition and senile age of patients are not a contraindication to performing reconstructive interventions, and while minimizing the volume and duration of the operation, they can save the limb and improve the quality of life in this category of patients.

2. Performing extended arterial reconstructions, including using an additional surgical approach, makes it possible to restore the main blood flow better in the ischemic limb and thereby completely restore the main blood flow in the ischemic limb and reduce the degree of ischemia, as well as reduce the severity of the manifestation and course post-ischemic syndrome.

3. "Classic" embolectomy is not indicated for atherosclerotic lesions of the arterial bed.

4. In 69.6% of cases, the use of plasmapheresis and infusion therapy prevents the development of acute renal injury.

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