Acta Scientific MEDICAL SCIENCES (ISSN: 2582-0931)

Volume 9 Issue 1 January 2025

Research Article

Clinical and Hemodynamic Aspects of the Use of Lumbar Sympathectomy in Patients with Critical İschemia of the Lower Extremities

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DOI: 10.31080/ASMS.2025.09.1995

Received: November 08, 2024

Published: December 18, 2024

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Abstract

Objective: To study the clinical and hemodynamic aspects of the use of lumbar sympathectomy in patients with critical ischaemia of the lower extremities.

Material and Methods of Research: The study was carried out in 99 patients with CLI (III-IV degrees of ischemia according to the Fontaine-Pokrovsky classification) The etiological factor for the development of CLI in 67 (67.7%) patients was obliterating atherosclerosis, in 32 (32.3%) patients – thromboangiitis obliterans. In 34 (35.4%) patients, critical ischemia of the III deqree was diagnosed, in 65 (65.6%) patients - in the IV degree. In 48 patients, complex surgical treatment was carried out without the use of any method of indirect revascularization (control group), In 51 patients, lumbar sympathectomy (the main group) was performed. To diagnose and assess the effectiveness of treatment, a clinical study, rheovasography, Doppler ultrasound, multispiral computer-tomographic angiography were carried out, oxygen saturation of the skin, indicators of regional arterial and venous blood flow were studied.

Results of the Study: In the patients of the study group, in comparison with the control group, the short-term results on the Rutherford scale et.al significantly improved, the frequency of major and minor amputations decreased (15.7%), and the frequency of maintaining the supporting function of the limb increased (92.2%) during the hospital stay, The frequency of rehospitalization decreases (69.6% - $\chi2 = 2.470$, $p > 0.05$, $r = 0.2$) and major amputations (26.1% - $\chi2 = 5.920$, $p < 0.05$, $r = 0.4$) and the number of patients with the preservation of the supporting function of the limb increases (73.9% - $\chi2 = 5.920$, $p <0.05$, $r = 0.4$) within 6 months. up to 5 years. In the patients of the study group, in comparison with the baseline ones, after treatment, the indicators of RI, SOS, VAI standing and lying down, POVPG significantly improved ($t = 3.75$, $p > 0.001$; $t = 2.01$, $p < 0.05$; $t = 2.93$,$p < 0.01$; $t = 2.01$,$p < 0.05$; $t = 2.44$, $p < 0.05$) other than RSPG ($t = 1.83$, $p > 0.05$).

Conclusion: Stimulation of peripheral circulation in patients with critical ischaemia of the lower extremities during lumbar sympathectomy is a prognostic criterion for optimizing the immediate and long-term results of surgical treatment.

Keywords: Obliterating Arterial Disease; Critical Ischaemia of the Lower Extremities; Lumbar Sympathectomy; Stimulation of Regional Blood Flow

Introduction

Chronic obliterative arterial disease of the lower extremities (COADLE) affects approximately 3% of the general population. Among these cases, critical limb ischemia (CLI) occurs in 35-65% of patients, and the prevalence of COADLE rises to 5% in individuals over 50 years of age [1]. Delayed diagnosis of COADLE and the lack of comprehensive treatment can lead to the progression of chronic ischemia, ultimately resulting in CLI within 5 to 7 years. If revascularization of the affected limb is not performed, 25% of patients may die within one year, and this figure increases to 60% within five years [2,3].

Reconstructive, endovascular, and hybrid procedures improve the outcomes of direct revascularization in patients with critical limb ischemia (CLI) [4,5]. However, in cases of distal stenosis or occlusion of the arteries, the absence of suitable "outflow pathways" may hinder the achievement of desired results [6-9]. In such instances, indirect revascularization procedures, including lumbar sympathectomy, are employed in clinical practice to stimulate regional blood flow [10,11].

Lumbar sympathectomy improves skin and muscle blood flow, stimulates circulation in bone tissue, and demonstrates a clinical effect in patients with stages II-III-IV of chronic ischemia [12-14]. The efficacy of lumbar sympathectomy is notably high in cases of distal arterial occlusion [15,16]. In 50% of patients with thromboangiitis obliterans, lumbar sympathectomy is performed [17] and in 81.6-88% of cases a positive effect is observed [18]. In cases of atherosclerotic stenosis or occlusion of distal segment arteries, the use of lumbar sympathectomy results in 60-80% of patients achieving good or satisfactory outcomes [19].

Objective of the Study

The aim of the study is to investigate the clinical and hemodynamic aspects of lumbar sympathectomy in patients with critical limb ischemia.

Materials and Methods

The study was conducted on 99 patients with critical limb ischemia (stages III-IV according to the Fontaine-Pokrovsky classification) who were hospitalized in the vascular surgery department of the Scientific Center for Surgery named after Academician M.A. Topchubashov. The etiological factor for the development of critical limb ischemia (CLI) in 67 patients (67.7%) was obliterative atherosclerosis, while 32 patients (32.3%) had obliterative thromboangiitis. Among the patients, 34 (35.4%) were diagnosed with critical ischemia of stage III, and 65 (65.6%) had stage IV. A total of 48 patients underwent comprehensive surgical treatment without the use of any indirect revascularization methods (control group), while lumbar sympathectomy was performed in 51 patients (main group). The levels of arterial stenosis and occlusion are presented in diagrams 1 and 2.

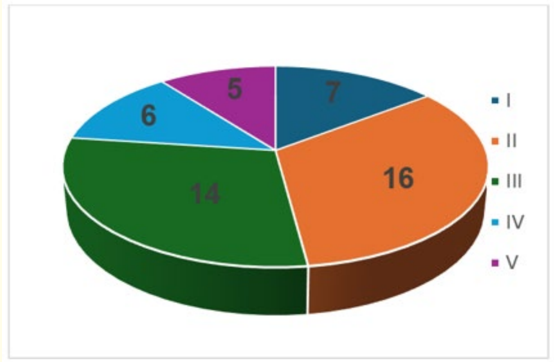

Diagram 1: Tht level of arterial stenoocclusion in patients of the control group.

Note: I – femoropopliteal segment – 7 patients; II – popliteal-tibial segment – 16 patients; III – tibial-foot segment – 14 patients; IV – arteries of the foot – 6 patients; V – multistorey steno-occlusion – 5 patients.

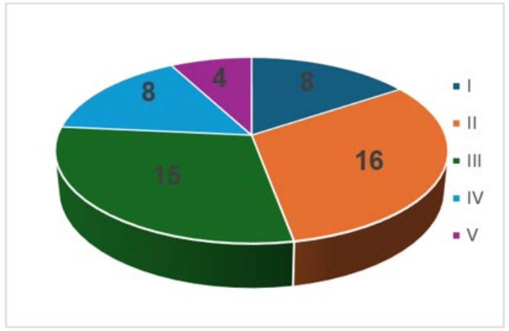

Diagram 2: The level of arterial angina occlusion in patients of the main group.

Note: I – femoropopliteal segment – 8 patients; II – popliteal-tibial segment – 16 patients; III – tibial-foot segment – 5 patients; IV – arteries of the foot – 8 patients; V – multistorey steno-occlusion – 4 patients.

To diagnose and evaluate the effectiveness of treatment, clinical examinations, rheovasography, ultrasound Dopplerography, and multi-slice computed tomography angiography were performed. Skin oxygen saturation, as well as regional arterial and venous blood flow parameters, were assessed, including the venous-arterial index (VAI) in standing and lying positions, the regional systolic pressure gradient (RSPG), and the post-occlusive venous pressure gradient (POVPG) using the methods of B.S. Sukhovatykh and A.Yu. Orlova [20].

The immediate outcomes were assessed using the Rutherford classification [21], focusing on the incidence of minor and major amputations during hospitalization due to worsening critical ischemia, as well as the preservation of limb support function. Long-term outcomes (from 6 months to 6 years) included the rates of recurrent hospitalization, major amputations, and the maintenance of limb support function. The collected data were compared with similar indicators from 48 practically healthy individuals (the “reference” group).

The research results were processed on a personal computer using Excel 2010 and analyzed with the SPSS Statistics software. The following statistical measures were calculated: mean ± standard error (M ± m), t, p, and χ^2 values, p, r). Differences were considered statistically significant at a p-value of less than $p < 0.05$.

Results and Discussion

Analysis of the obtained results indicated that in the control group, significant, moderate, and slight improvements on the Rutherford scale (R.B., *et al.*) were observed in 21 patients (43.7%). The clinical status remained unchanged in 7 patients (14.6%), while slight, moderate, and significant deteriorations were noted in 20 patients (41.7%) (Table 1). In the main group, significant, moderate, and slight improvements on the Rutherford scale were observed in 33 patients (64.7%). The clinical status remained unchanged in 5 patients (9.8%), and slight, moderate, and significant deteriorations were noted in 13 patients (25.5%) (Table 1).

Group of patients Coming outcomes	**Control group n = 48**	**Core Group n = 51**
Significant improvement	5(10,4%)	10(19.6%)
Moderate improvement	9(18,7%)	13(25.5%0
Minor improvement	7(14,6%)	10(19.6%)
No change	7(14,6%)	5(9.8%)
Slight deterioration	6(12.5%)	5(9.8%)
Moderate deterioration	6(12.5%)	4(7.8%)
Significant deterioration	8(16.7%)	4(7.8%)

Table 1: Immediate results of treatment of patients with chronic critical ischaemia of the lower extremities according to the Rutherford R.B., *et al*.

The correlation and statistical analysis revealed that the dependence of immediate outcomes on the treatment method was not statistically significant; however, a weak correlation was observed between these factors ($\chi^2 = 1.625$; $p > 0.05$; $r = 0.3$). Due to worsening critical ischemia in the control group, 14 patients (29.2%) underwent minor and major amputations, while 40 patients (83.3%) maintained limb support function. In contrast, in the main group, 8 patients (15.7%) underwent minor and major amputations, and limb support function was preserved in 47 patients (92.2%).

In the control group, 43 patients and in the main group, 46 patients were studied for various indicators of long-term outcomes over periods ranging from 6 months to 5 years. In the control group, rates of recurrent hospitalization, major amputations, and preservation of limb support function were observed in 83.7%, 51.2%, and 48.8% of cases, respectively. In the main group, these rates were 69.6%, 26.1%, and 73.9%, respectively (Table 2).

Group of patients Remote outcomes	**Control group n = 43**	**Core Group n = 46**
Readmissions	36(83.7%)	32(69.6%)
Major amputations	22(51.2%)	12(26,1%)
Preservation of the support function of the limb	21(48.8%)	34(73.9%)

Table 2: Long-term results of treatment of patients with chronic critical ischaemia of the lower extremities, depending on the method, within 6 months. up to 5 years.

Correlation and statistical analysis showed that the dependence of readmission on the method of treatment was not significant (χ2 = 2.470, p > 0.05, r = 0.2), although there was a weak corrective relationship between these factors (Table 3).

Group of patients Outcomes Treatment		Control group	Core Group	χ^2pr
Readmissions	Hospitalized	36	32	$\chi^2 = 2.470$ $p > 0.05$ $r = 0.2$
	Not hospitalized	7	14	
Major amputations	Performed	22	12	$\chi^2 = 5.920$ $p <0.05$ $r = 0.4$
	Not fulfilled	21	34	
Preservation of the support function of the limb	Saved	21	34	$\chi^2 = 5.920$ $p <0.05$ $r = 0.4$
	Not saved	22	12	

Table 3: Dependence of long-term results of treatment of patients with chronic critical limb ischaemia from the treatment method.

The frequency of major amputations and preservation of limb support function was significantly associated with the treatment method ($\chi^2 = 5.920$, $p < 0.05$, $r = 0.4$ for both). In the main group, these indicators significantly decreased.

We also analyzed changes in regional blood flow (arterial and venous) in patients with critical limb ischemia in both groups. Upon admission to the clinic, patients in the control group showed significant reductions in the Rİ and skin oxygen saturation compared to the "reference" group, with decreases of 53.2% (t = 4.71, p < 0.001) and 45.7% (t = 4.59, p < 0.001), respectively. After treatment, the Rİ and skin oxygen saturation increased non significantly by 3.4% (t = 0.36, p > 0.05) and 5.5% (t = 0.42, p > 0.05), respectively (Table 4).

Group Patients Indicators	Reference Group n = 48	Control group n = 48		Core Group n = 51	
		Before treatment	After treatment	Before treatment	After treatment
Rheographic Index (unit)	0.62 ± 0.04	0.29 ± 0.02	0.30 ± 0.02 t = 0.36 p > 0.05	0.28 ± 0.02	0.43 ± 0.03 t = 3.75 p > 0.001
Oxygen saturation of the skin (mmHg)	96.4 ± 8.4	52.3 ± 4.7	55.2 ± 5.0 t = 0.42 p > 0.05	51.3 ± 4.4	62.7 ± 5.3 t = 2.01 p < 0.05
Standing venous arterial index (%)	41.9 ± 3.1	79.0 ± 6.4	68.7 ± t = 1.25 p > 0.05	77/5 ± 6.3	54.7 ± 4.7 t = 2.93 p < 0.01

Venous arterial index lying down, (%)	21.2 ± 1.7	44.3 ± 3.4	41.3 ± 4.1 t = 0.56 p > 0.05	40.8 ± 3.4	32.2 ± 2.6 t = 2.01 p < 0.05
Regional systolic pressure gradient (unit)	1	1.79 ± 0.14	1.75 ± 0.15 t = 0.20 p > 0.05	1.83 ± 0.14	1.50 ± 0.12 t = 1.83 p > 0.05
Postocclusive venous pressure gradient (unit)	1.98 ± 0.17	3.20 ± 0.27	2.92 ± 0.22 t = 0.80 p > 0.05	3.49 ± 0,26	2.66 ± 0.22 t = 2.44 p < 0.05

Table 4: Dynamics of hemodynamic parameters in patients with chronic Lower limb critical ischaemia (M ± m; t, p).

Upon admission to the clinic, this group of patients showed significant increases in the venous-arterial index (VAI) in both standing and lying positions, as well as the regional systolic pressure gradient (RSPG) and post-occlusive venous pressure gradient (POVPG) compared to the "reference" group, with increases of 26.2% (t = 1.98, p < 0.05), 88.5% (t = 4.52, p < 0.001), 108.9% (t = 6.08, p < 0.001), and 61.6% (t = 3.81, p < 0.001), respectively. After treatment, these same indicators decreased non significantly by 8.7% (t = 1.25, p > 0.05), 6.8% (t = 0.56, p > 0.05), 2.3% (t = 0.20, p > 0.05), and 8.3% (t = 0.83, p > 0.05).

In patients who underwent lumbar sympathectomy, upon admission to the clinic, the Rİ and skin oxygen saturation significantly decreased compared to the "reference" group, with reductions of 54.8% (t = 4.7, p < 0.001) and 46.8% (t = 4.76, p < 0.001), respectively. After treatment, the Rİ and skin oxygen saturation increased significantly by 53.6% (t = 3.76, p < 0.001) and 22.2% (t = 2.01, p < 0.01), respectively.

Upon admission to the clinic, this group of patients showed significant increases in the venous-arterial index (VAI) in both standing and lying positions, as well as the regional systolic pressure gradient (RSPG) and post-occlusive venous pressure gradient (POVPG) compared to the "reference" group, with increases of 84.9% (t = 5.07, p < 0.001), 82.5% (t = 5.15, p < 0.001), 83.0% (t = 2.24, p < 0.05), and 76.3% (t = 4.87, p < 0.001), respectively. After treatment, these indicators, except for the RSPG, significantly decreased by 29.4% (t = 2.93, p < 0.01), 21.1% (t = 2.01, p < 0.05), 18.1% (t = 1.83, p > 0.05), and 23.8% (t = 2.44, p < 0.05), respectively.

Conservative and surgical treatment of patients with critical limb ischemia remains an unresolved issue in angiology and vascular surgery. Direct revascularization methods (reconstructive, endovascular, and hybrid procedures) are effective when suitable "outflow pathways" are present in the distal segment of the arteries [5,6,8]. In the absence of these "outflow pathways," indirect revascularization methods are employed, among which lumbar sympathectomy plays a significant role [11-13,15-19]. Our research [14,16] demonstrates that in patients with critical limb ischemia, lumbar sympathectomy stimulates peripheral circulation by significantly increasing the rheographic index and skin oxygen saturation, while reducing the venous-arterial index (VAI) in both standing and lying positions, as well as the post-occlusive venous pressure gradient (POVPG). These factors contribute to improved immediate and long-term outcomes. This study further confirms the effectiveness of lumbar sympathectomy in patients with critical limb ischemia due to distal stenosis and occlusion of arteries of atherosclerotic and thromboangiitic etiology.

Conclusion

In patients with critical limb ischemia due to distal stenosis and occlusion of arteries, when direct revascularization is not feasible, lumbar sympathectomy is an effective and statistically supported method of indirect revascularization.

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