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Original Article

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Amputation of the lower leg with a new modification: Surgical approach, clinical results and comparative analysis

Abstract

Aim: To describe in detail the methodology of lower one-third calf amputation using a newly modified technique, to present the clinical outcomes, and to compare this approach with classical amputation methods.

Materials and Methods: A retrospective analysis was conducted on 850 patients who underwent lower one-third calf amputation at the Scientific Surgery Center between 2021 and 2025. Among them, 450 patients (52.9%) underwent classical amputation and were included in the control group, while 400 patients (47.1%) underwent amputation using the newly proposed modification and were included in the study group. Functional and quality-of-life outcomes were assessed using the Short Form-36 Health Survey (SF-36), EuroQol-5 Dimension (EQ-5D), and Prosthesis Evaluation Questionnaire (PEQ).

Results: Patients treated with the new modification demonstrated significantly better functional outcomes compared to those treated with classical methods. According to SF-36 and EQ-5D assessments, physical functioning, mobility, and pain indicators were significantly improved in the study group. PEQ results showed that 83% of patients reported comfortable prosthetic fitting and absence of discomfort during daily use. Overall, the new technique provided superior rehabilitation potential and improved prosthetic compatibility.

Conclusion: The newly proposed modification of lower one-third calf amputation demonstrated clear advantages over classical techniques. Patients treated with this method showed improved stump stability, better prosthetic compatibility, reduced pain intensity, and enhanced functional and social adaptation. According to SF-36, EQ-5D, and PEQ assessments, the new technique resulted in superior rehabilitation outcomes and higher quality-of-life indicators. These findings indicate that this modification is an effective and functionally oriented surgical approach that significantly improves postoperative outcomes and prosthetic potential.

Keywords: Calf amputation, new modification, osteomyoplastic technique, phantom pain, prosthetics, rehabilitation, spinal anesthesia

INTRODUCTION

Calf amputation remains a radical but often life-saving surgical procedure performed in patients with severe peripheral arterial disease, diabetic micro- and macroangiopathies, trauma, and malignant neoplasms (1). Classical amputation techniques are frequently associated with delayed wound healing, stump instability, prosthetic difficulties, and the development of phantom pain. Consequently, the development of functionally effective and patient-oriented surgical approaches is of growing importance (2).

In modern surgical practice, amputation is not only aimed at removing a non-viable limb segment but also at ensuring optimal conditions for postoperative rehabilitation, prosthetic fitting, and social reintegration. Therefore, stump shape, stability, load-bearing capacity, and compatibility with prosthetic devices are decisive factors influencing long-term outcomes.

Purpose of the Study

The aim of this study was to describe in detail the surgical technique of a newly modified lower one-third calf amputation, to evaluate its clinical outcomes, and to compare its effectiveness with classical amputation methods.

The study was conducted using anonymized patient data. Ethical principles were observed in accordance with Order No. 137 of the Ministry of Health of the Republic of Azerbaijan dated 29.12.2011.

MATERIAL AND METHODS

This study was reviewed and approved by the Ethics Committee of the Scientific Surgery Center named after Academician M.A. Topchubashov (Approval No. 2025-04, dated 01.07.2025).

A retrospective analysis was performed on 850 patients who underwent lower one-third calf amputation between 2021 and 2025. Of these patients, 520 were male and 330 were female (Figure 1).

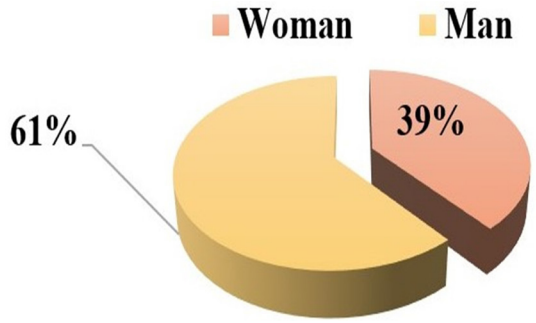

Figure 1. Distribution of patients by gender

Among them, 450 patients (52.9%) underwent classical amputation and were assigned to the control group, while 400 patients (47.1%) underwent surgery using the newly proposed modified technique and were included in the study group (Figure 2).

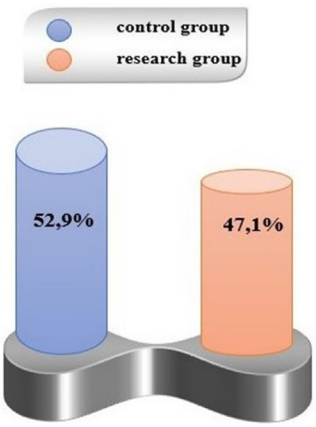

Figure 2. Percentage of patients in the control and study groups

The mean age of the patients was 68.0 ± 13.1 years, mean body weight was 88.2 ± 21.8 kg, and mean height was 168.0 ± 5.01 cm (Table 1).

Table 1. Grouping of patients by age and weight

Indicators	n
Number of patients	850
Average age	68.0 ± 13.1 years
Average weight	88.2 ± 21.8 kg
Average height	168.0 ± 5.01 cm

At the same time, the majority of patients presented with multiple concomitant pathologies. These included hypertension, coronary heart disease (CHD), a history of coronary angioplasty and coronary artery bypass grafting (CABG), and hepatitis C. Additionally, several patients had syphilis, diabetes mellitus with associated micro- and macroangiopathies, and diabetic nephropathy.

Neurological and cardiovascular comorbidities included post-ischemic stroke, atrial fibrillation and flutter, heart failure with reduced ejection fraction (EF = 32.4 ± 3.2%), left ventricular hypokinesia, and global akinesia. Gastrointestinal conditions such as ischemic heart disease (IHD), gastric and duodenal ulcers, and gastric erosions were also frequently observed. The distribution of comorbidities is detailed in Table 2.

Table 2. Comorbidities in all patients

Diseases	n	%
Hypertension	570	67.06%
CHD, post-coronary angioplasty; Coronary artery bypass grafting	289	34%
Hepatitis C	88	10.35%
Syphilis	19	2.23%
Diabetes mellitus	612	72%
Post-ischemic stroke	31	3.65%
Atrial fibrillation and flutter	531	62.47%
Heart failure	387	45.53%
Chronic renal failure	21	2.47%
Gastroduodenal ulcer	223	26.24%
Gastric erosion	386	45.41%

The patients underwent appropriate examinations, including Doppler ultrasonography (USG), electrocardiography (ECG), echocardiography (ECHO), and chest X-ray. General, biochemical, and coagulation parameters of the blood were analyzed. The concentrations of troponin and B-type natriuretic peptide (BNP), as well as blood gas composition and acid–base balance, were monitored.

In 625 (73.53%) patients, the troponin concentration was 323.3 ± 52.1 pg/mL; in 187 (22%) patients, the B-type natriuretic peptide (BNP) level was 1225.13 ± 101.2 pg/mL. In their medical history, 391 patients (46%) were taking antiplatelet drugs (Trombas, clopidogrel, Cardiomagnyl, Aspirin Cardio, Plavix), and 765

patients (90%) were taking non-steroidal anti-inflammatory drugs (diclofenac, Ofdol, ketonal, Blokium B12). A total of 119 patients (14%) were septic and had liver and kidney failure.

A total of 612 patients (72%) were preoperatively prepared in the intensive care unit for 2–5 days with blood and blood substitutes, plasma, albumin, and broad-spectrum antibiotics; cardioprotective and hepatoprotective agents were administered intravenously. Oral administration of antiplatelet agents was discontinued and replaced with enoxaparin (Clexane) 40 mg.

The operation was performed under intubation anesthesia in 51 patients (6%) and under spinal anesthesia in 799 patients (94%). The duration of the operation was 82.3 ± 22.6 minutes. Preoperatively, patients were administered promedol 20 mg intravenously for premedication. Bupivacaine (2.76 μg/kg) was administered into the spinal canal at levels L2–L3.

Hemodynamic parameters, central venous pressure, and hourly urine output were strictly monitored. During the operation, when hemodynamic disturbances were observed, norepinephrine was infused at a rate of 0.03 μg/kg/min.

A lethal outcome was observed in 9.76% of patients. The causes of death included septic condition (3.76%) and multiorgan failure (pulmonary, cardiac, hepatic, and renal failure); coronary thrombosis (3.17%); and acute coronary syndrome and acute myocardial infarction (2.82%).

Statistical Analysis

Quantitative data were expressed as mean ± standard deviation (SD). Intergroup comparisons were performed using Student's t-test. Categorical variables were analyzed using the chi-square test. A p-value < 0.05 was considered statistically significant.

Surgical Techniques

The staged amputation of the calf using the new technique is shown in Figure 3. During the surgical procedure, the amputation area is first marked, and the osteotomy level is carefully determined (a).

A long posterior flap is then created using the Flap Planning technique, which ensures better blood supply and elasticity in the region of the stump (b). This step provides optimal soft tissue coverage of the stump and promotes improved wound healing. Subsequently, osteotomy is performed at the appropriate level, with both the tibia and fibula cut and their edges smoothed (c). Partial preservation of the periosteum is ensured, which has a favorable impact on postoperative bone regeneration. In the final stage, the gastrocnemius and soleus muscles are mobilized and used as myoplastic flaps for muscle stabilization. The muscle ends are sutured to each other and anchored to the bone, resulting in a more stable, well-contoured stump that is functionally better suited for prosthetic fitting (d).

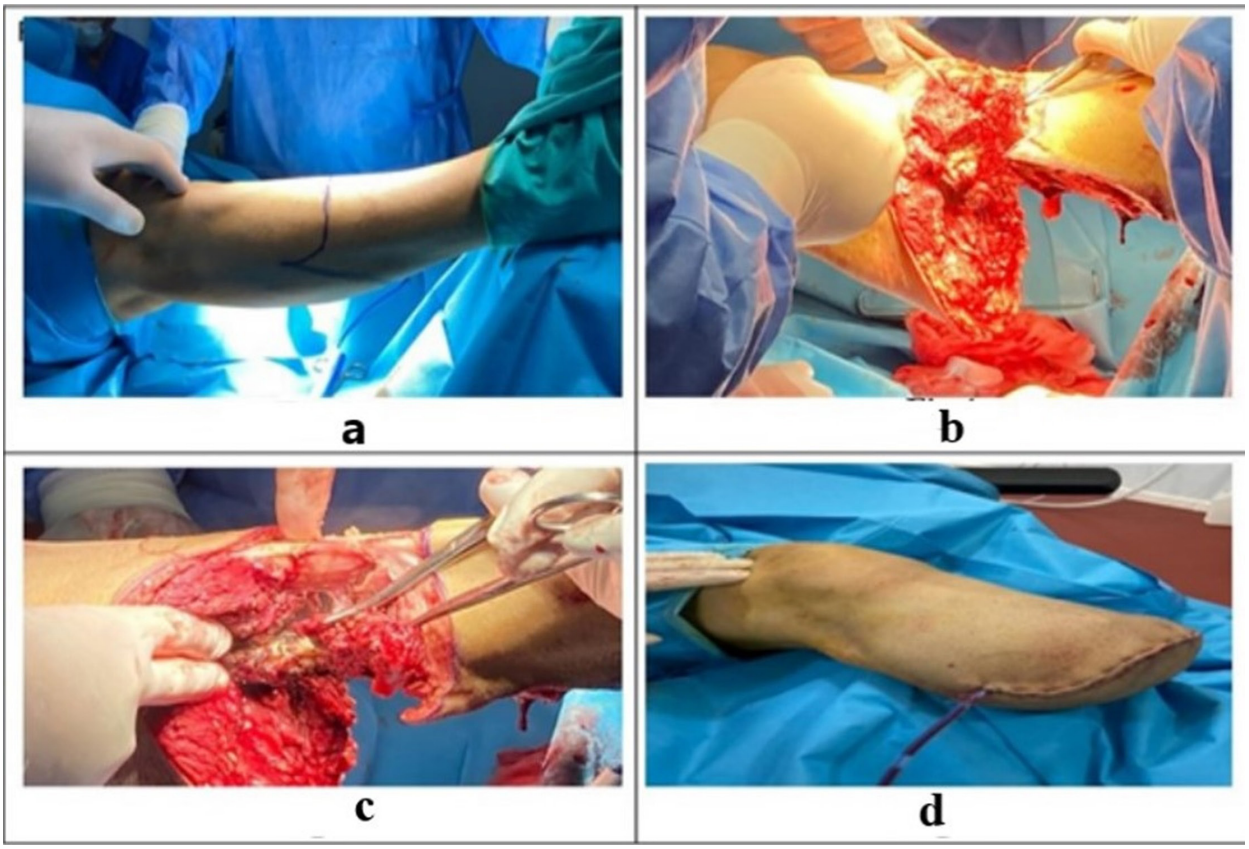

Figure 3. Staged amputation of the calf with a new technique

RESULTS

Patients treated with the newly modified technique demonstrated significantly improved outcomes compared to the control group. According to SF-36 assessment, physical functioning increased by 28%, pain levels decreased by 42%, and social adaptation improved by 35% ($p < 0.05$). EQ-5D analysis revealed significant improvements in mobility and pain/discomfort dimensions in the study group ($p < 0.01$).

PEQ results indicated that 83% of patients reported comfortable prosthetic fitting and absence of discomfort during daily activities. Postoperative mortality was 9.76%. The main causes of death included septic complications, multiorgan failure, and acute cardiovascular events.

Comparative results between classical and new methods are presented in Table 3.

Table 3. International assessment standards between classical and new methods

Measurement tool	The classic method	New methodology
SF-36 Physical Functioning	45.3 ± 7.2	62.1 ± 6.8*
EQ-5D General Health	0.62 ± 0.09	0.81 ± 0.07**
PEQ - Prosthesis Fit	55.6 ± 8.3	78.4 ± 6.5**

Note: Statistical significance of the difference between the Classical and New method indicators. Comparison: *- $p0 < 0.05$; **- $p0 < 0.01$

DISCUSSION

In 1971, Burgess et al. utilized myoplastic techniques in transtibial amputation alongside classical methods. Although this approach was supported again in 2020 for its ability to preserve the balance between skin and muscle, researchers noted that it posed challenges in prosthetic fitting and function (3).

In 2019, Wagner et al. introduced osteomyoplastic amputation during calf amputations. According to the authors, this technique improved the stability of muscle-to-bone fixation and enhanced prosthetic integration, resulting in a 40% increase in patient activity levels (4).

In 2021, Eriksson et al. performed myoplastic muscle reconstruction, which significantly improved prosthetic adaptation. Their study reported a 15–20% increase in patients' active lifestyle (5).

In 2024, Namazov et al. proposed a novel technique titled "Osteomyoplastic Modification in Lower One-Third Calf Amputation" (6). In this new approach, a flap is prepared before bone transection, allowing the muscles to be securely fixed to the bone. As a result, patients experienced reduced phantom pain, faster rehabilitation and weight-bearing capacity, accelerated wound healing, and a lower risk of infection.

This technique led to an 80% improvement in patients' quality of life. Phantom pain and neuroma formation were prevented in 90% of cases, and the need for narcotic analgesics during the postoperative period was reduced by 75%. Patients who underwent this modified technique showed significantly higher SF-36 scores compared to those treated with classical methods. Furthermore, because the technique facilitates the formation of a stump optimized for prosthetic fitting, the results were consistent with the Prosthesis Evaluation Questionnaire (PEQ).

These findings indicate that the new modification offers advantages not only from a technical standpoint but also in terms of rehabilitation outcomes and prosthetic compatibility. Compared to classical methods, this modified approach is more functional, aesthetic, and rehabilitation-oriented. It contributes to minimizing postoperative complications and improving the prosthetic fitting process by creating an anatomically favorable stump structure. A significant improvement in patient quality of life has been observed.

This innovative modification can serve as a practical and effective alternative in both orthopedic and vascular surgery.

CONCLUSION

The newly proposed modification of lower one-third calf amputation is a valuable alternative to classical techniques. It may improve postoperative outcomes, prosthetic compatibility, and patient quality of life. Increasing experience with this technique may support its wider application in clinical practice.

Conflict of Interests: The authors declare that there is no conflict of interest.

Financial Disclosure: The authors declare that there is no financial support.

Ethics Committee Approval: This study was approved by the Ethics Committee of the Scientific Surgery Center named after Academician M.A. Topchubashov (Approval No. 2025-04, dated 01.07.2025).

Patient Informed Consent: Informed consent was waived by the ethics committee due to the retrospective nature of the study.

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