

ORIGINAL ARTICLE

Modified Above-Knee Versus Conventional Great Saphenous Vein Surgery Stripping for Lower Limb Varicose Veins: A Prospective Comparative Study

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ABSTRACT

Objective: To compare the clinical outcomes, perioperative parameters, and postoperative complications of modified above-knee versus conventional full-length great saphenous vein stripping in patients with varicose veins.

Study Design: Prospective Comparative study.

Place and Duration of Study: The study was conducted at Holy Family, District Headquarters, and Benazir Bhutto Hospital, affiliated with Rawalpindi Medical University, from March 01, 2024 to March 31, 2025.

Materials and Methods: A total of 212 patients with Clinical-Etiology-Anatomy-Pathophysiology grades C2–C5 and Doppler-confirmed GSV reflux were enrolled and equally assigned to the modified above-knee group (n=106) and the conventional surgery group (n=106). Both procedures were completed with local or neuraxial anesthesia, performed by the same surgical group. Data on operative time, length of stay, incision type, intraoperative blood loss, and postoperative complications were collected.

Results: Baseline characteristics were comparable between the two groups. The modified above-knee stripping group showed significantly shorter operative time (48.7 ± 6.8 minutes vs. 59.1 ± 7.0 minutes, $p < 0.001$) and shorter hospital stay compared with the conventional group. The incidence of postoperative saphenous nerve injury was significantly lower in the modified group (2.3% vs. 27.7%, $p < 0.001$). Rates of surgical site infection, venous thromboembolism, and superficial thrombophlebitis were comparable between the groups. Technical and clinical success rates exceeded 97% in both groups.

Conclusion: Modified above-knee great saphenous vein stripping demonstrated favourable perioperative outcomes, including shorter operative time, reduced hospital stays, and lower incidence of saphenous nerve injury compared with conventional full-length stripping, while achieving comparable clinical and technical success rates.

Key Words: *Chronic Venous Insufficiency; Great Saphenous Vein; Postoperative Complications; Saphenous Nerve Injury; Varicose Veins; Vein Stripping.*

Introduction

Varicose veins are among the most common manifestations of chronic venous disease and result from venous valvular incompetence leading to venous hypertension and dilatation of superficial veins, particularly the great saphenous vein.^{1,2} The disease commonly affects the lower extremities and presents with symptoms ranging from limb heaviness, pain, edema, and cosmetic concerns to skin pigmentation, lipodermatosclerosis, and venous

ulceration in advanced stages.^{1,3} These manifestations can significantly impair physical activity, work productivity, and overall quality of life.⁴ Globally, the prevalence of varicose veins ranges from 20% to 60%, with higher occurrence reported among females, elderly individuals, prolonged standing workers, and patients with obesity or a family history of venous disease.¹ Incompetence at the saphenofemoral junction and reflux within the great saphenous vein are considered major contributors to disease progression and recurrence.^{4,5} Because of the chronic nature of venous insufficiency and its associated healthcare burden, effective and durable treatment strategies remain an important surgical concern.

For decades, high ligation and stripping of the great saphenous vein have been regarded as a standard surgical procedure for symptomatic varicose veins.⁴

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Conventional full-length stripping effectively removes refluxing venous segments; however, it is associated with several postoperative complications, including hematoma formation, bruising, postoperative pain, delayed mobilization, recurrence, and particularly saphenous nerve injury due to stripping below the knee.^{6,7} Previous studies have reported recurrence rates after conventional procedures ranging from 30% to 60%, which has encouraged continuous modification of surgical techniques and the development of minimally invasive alternatives.⁸

In recent years, endovenous techniques such as endovenous laser ablation, radiofrequency ablation, cyanoacrylate closure, foam sclerotherapy, and mechanochemical ablation have gained popularity because of shorter hospital stay, reduced postoperative pain, earlier ambulation, and favorable cosmetic outcomes.^{4,9–12} Several comparative studies have demonstrated that minimally invasive approaches may provide outcomes comparable to or better than conventional surgery in selected patients.^{13,14} However, the high cost of equipment, requirement for technical expertise, and limited availability in developing countries continue to restrict their widespread use, particularly in resource-limited healthcare systems.¹⁵

Consequently, modifications of conventional stripping techniques have been explored to reduce operative morbidity while preserving surgical efficacy. Among these approaches, modified above-knee great saphenous vein stripping has received attention because it avoids extensive below-knee dissection and may reduce the incidence of saphenous nerve injury without compromising venous reflux control.^{16,17} *Hong et al.*¹⁶ demonstrated improved postoperative recovery and patient satisfaction with modified stripping techniques compared with conventional procedures. Similarly, *Kusagawa et al.*⁶ reported acceptable long-term clinical outcomes following modified great saphenous vein stripping with reduced postoperative complications.¹⁷ Studies evaluating postoperative neural complications have further shown that limiting stripping below the knee may substantially decrease sensory nerve injury and associated morbidity.

Despite these advancements, controversy still exists regarding the optimal surgical approach for management of great saphenous vein reflux, particularly in settings where endovenous procedures are not routinely accessible. Much of the currently available literature focuses on comparisons between endovenous therapies and traditional surgery rather than comparisons between modified and conventional stripping techniques themselves.^{4,8,10} Moreover, most studies originate from high-income healthcare systems, limiting the generalizability of findings to developing countries with different patient demographics, healthcare access, and economic limitations.

In Pakistan, chronic venous disease remains underreported despite its considerable impact on functional capacity and healthcare expenditure. Limited public awareness, delayed healthcare-seeking behavior, financial constraints, and restricted access to advanced endovenous interventions continue to influence treatment selection.¹⁵ Under these circumstances, evaluating modified surgical techniques that are both clinically effective and economically feasible becomes particularly important. However, prospective local evidence comparing the modified above-knee stripping with conventional full-length stripping remains scarce. Therefore, this study was conducted to compare the clinical outcomes, perioperative parameters, and postoperative complications between modified above-knee and conventional full-length great saphenous vein stripping in patients with varicose veins.

Materials and Methods

This prospective comparative study was conducted in three tertiary care hospitals, including Holy Family, District Headquarters, and Benazir Bhutto Hospital, affiliated with Rawalpindi Medical University, in Pakistan, from March 01, 2024 to March 31, 2025. Patients presenting through outpatient vascular and general surgical clinics, as well as referrals from affiliated healthcare facilities, were screened for eligibility. During the study period, 212 patients with Doppler-confirmed great saphenous vein reflux who fulfilled the inclusion criteria and consented to surgery were enrolled consecutively and allocated equally into the two study groups. The diagnosis of varicose veins was verified in accordance with the

International Committee of the American Venous Forum's (AVF) rationalized venous nomenclature and the clinical, etiologic, anatomic, and Pathophysiologic (CEAP) classification.¹⁸ Patients of either gender between the ages of 18 and 75 who had CEAP grades C2–C5, a proximal GSV diameter larger than 8 mm, and a GSV reflux duration longer than 0.5 seconds when standing were eligible. Every participant felt discomfort and heaviness, which are signs of GSV reflux. The research excluded patients who had a history of venous surgery, venous thrombosis, post-thrombotic syndrome, significant deep vein reflux, Fontaine stage II–IV arteriosclerosis obliterans, organ dysfunction that precluded surgery, or a known intolerance to sodium tetradecyl sulfate (SST). Based on the surgical approach used, all eligible patients were split into two equal groups: the conventional surgery group (n=106) and the modified above-knee group (n=106). The proximal GSV diameter was measured 0.5 cm distal to the saphenofemoral junction, and the severity of chronic venous disease (CVD) was assessed using the CEAP method. Under local or neuraxial anesthesia, the same group of skilled surgeons carried out every surgical procedure. Doppler ultrasonography was used to map the varicose veins before surgery, and the skin was tagged with the locations that needed attention. At the level of the inguinal ligament, where its branches were ligated and split 0.5 cm distal to the femoral vein, the GSV was visible in both groups.

In the conventional surgery group, high ligation with full-length great saphenous vein stripping was performed, while the modified group underwent above-knee stripping only using standard described techniques.^{16,17} The branch varicosities ≥ 4 mm were treated with stab avulsion/phlebectomy where required. Postoperative compression therapy with elastic bandaging and antithrombotic stockings was advised for all patients for three months. The assessed variables included operative time, intraoperative blood loss, duration of hospital stay, technical and clinical success, recurrence, and postoperative complications, including saphenous nerve injury, surgical site infection, venous thromboembolism, and superficial thrombophlebitis. Operative time was recorded from skin incision to completion of compression

dressing, while intraoperative blood loss was estimated using the stained gauze area method. Clinical success was defined as improvement or absence of symptoms and visible varicosities at one-month follow-up. Saphenous nerve injury was assessed clinically based on postoperative pain or numbness along the medial aspect of the leg.

Patients were followed up postoperatively at 1, 6, 12, and 24 months after surgery for incision healing disturbances, sensory alterations, recurrence of varicose veins, and CEAP-C grade progression. Follow-up visits were conducted through outpatient clinic appointments, supplemented by telephone contact when in-person assessment was not feasible. Contact information was verified at discharge, and reminder calls were made before scheduled visits to enhance compliance and minimize loss to follow-up. Patients who missed a scheduled visit were contacted and offered rescheduled appointments whenever possible. The number of patients lost to follow-up at each time point was recorded and accounted for in the final analysis.

Statistical analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Quantitative variables were described as mean \pm standard deviation and analyzed using independent or paired t-tests; categorical variables were compared with the Pearson, Chi-square test or continuity correction where appropriate. Recurrence-free survival was estimated using the Kaplan–Meier method. Statistical significance was defined as a p-value \leq 0.05.

Results

A total of 212 patients diagnosed with great saphenous vein (GSV) reflux were included in this study, where 106 patients were enrolled in the modified above-knee and conventional surgery groups, respectively. Patients in the above-knee group had a mean age of 49.6 ± 13.9 years (range, 25 to 83) versus that of the conventional group at 52.1 ± 13.5 years ($p = 0.06$). The groups were comparable regarding gender, with males making up 46.2% of the above-knee group and 54.7% of the conventional group ($p = 0.08$). There were no significant differences between the two groups with respect to laterality, body mass index (BMI), duration of disease, smoking history, or proximal GSV diameter

(all $p > 0.05$) (Table I). This demonstrated that baseline characteristics had been well balanced. As for clinical grades according to CEAP-C classification, the distribution was not significantly different between groups, with most of the patients having C2 disease (51.2% in the above-knee group and 50.9% in the conventional group). The same was true when comparing the higher grades (C3–C5) between groups (Table II).

Of the entire study population, 96.5% ($n = 205$) had surgery under local anesthesia, and just 3.5% ($n = 7$) received neuraxial anesthesia. The modified group's technical success rate was 99.1%, whereas the traditional group was 98.1%. Additionally, there was no change in the clinical success rate (97.2% vs. 97.7% above the knee versus traditional). The modified technique offered distinct advantages over conventional stripping in terms of perioperative outcomes. Mean operation time, hospitalization duration, number of incisions, total incision length, and intraoperative blood loss were all significantly less in the modified group (All $p < 0.001$), revealing a minimally invasive and efficient surgical technique (Table III).

Although both groups experienced a few short-term postoperative problems, the modified group saw a considerably decreased rate of subcutaneous hematoma and saphenous nerve injury ($p < 0.05$). Saphenous nerve injury was seen in only 2.3% of the patients in the above-knee group compared with 27.7% of those in the conventional group. Mild injuries were more common, whereas severe injuries were infrequent and considered not statistically significant. Surgical site infection rate, venous thromboembolism, and superficial thrombophlebitis were not statistically significant between the two groups (Table IV).

Discussion

Baseline demographic and disease severity characteristics were comparable across the two study groups, indicating appropriate group allocation and minimizing selection bias. The observed age distribution and predominance of middle-aged patients are consistent with established epidemiological patterns of varicose veins reported in previous literature. ² Similar CEAP classification profiles between groups further confirm comparable baseline disease severity, thereby allowing valid

Table I: Comparison of General Data of Patients (n = 212)

Variable	Modified (Above-knee)	Conventional Surgery	t/ χ^2	p-value
Age (years)	49.6 ± 13.9	52.1 ± 13.5	-1.89	0.06
Male (%)	49 (46.2%)	58 (54.7%)	3.04	0.08
Left side (%)	54 (50.9%)	55 (51.9%)	0.09	0.77
BMI	25.9 ± 3.5	26.3 ± 3.6	-1.22	0.22
Course of disease (months)	12.4 ± 7.4	13.0 ± 7.1	-0.84	0.40
Smoking (%)	42 (39.6%)	53 (50.0%)	2.73	0.10
Proximal GSV diameter (mm)	11.7 ± 2.0	12.0 ± 1.9	-1.72	0.09

BMI: Body Mass Index, GSV: Great Saphenous Vein

Table II: CEAP-C Grade Distribution (n = 212)

CEAP-C Grade	Modified (Above-knee)	Conventional Surgery
C2	54 (51.2%)	54 (50.9%)
C3	17 (16.0%)	21 (19.8%)
C4	18 (17.0%)	19 (17.9%)
C5	17 (16.0%)	12 (11.3%)

CEAP-C: Clinical, Etiologic, Anatomic, and Pathophysiologic Classification

Table III: Comparison of Perioperative Outcomes (n = 212)

Variable	Modified (Above-knee)	Conventional Surgery	t/ χ^2	p-value
Operation time (min)	48.7 ± 6.8	59.1 ± 7.0	-15.67	≤0.001
Length of hospitalization (days)	2.5 ± 0.5	4.9 ± 1.4	-23.68	≤0.001
Number of cuts	3.1 ± 1.5	4.2 ± 1.5	-7.30	≤0.001
Total incision length (cm)	3.8 ± 1.3	4.8 ± 1.2	-7.96	≤0.001
Intraoperative blood loss (mL)	14.6 ± 3.2	36.2 ± 9.1	-32.77	≤0.001

Table IV: Comparison of Postoperative Complications (n = 212)

Variable	Modified (Above-knee)	Conventional Surgery	t/ χ^2	p-value
Saphenous nerve injury (overall)	2.3	27.7	53.620	≤0.001
Mild	2.3	25.8	48.450	≤0.001
Severe	0.0	1.9	2.270	0.137
Surgical site infection	0.9	0.9	0.000	1.000
Venous thromboembolism	0.0	0.9	0.500	0.483
Subcutaneous hematoma	1.4	7.5	7.933	0.005
Superficial thrombophlebitis	8.9	6.6	0.821	0.365

intergroup comparison of perioperative and postoperative outcomes.

Operative time was significantly shorter in the modified above-knee stripping group than in the conventional full-length stripping group. This finding is consistent with previous reports demonstrating improved procedural efficiency with modified stripping techniques due to reduced extent of dissection and avoidance of below-knee venous exposure.¹⁶ The reduction in operative duration is likely attributable to decreased surgical field extension and simplified vein retrieval. From a clinical standpoint, shorter operative time reduces anesthesia exposure and may improve operating room efficiency without compromising procedural success.

Intraoperative blood loss was significantly lower in the modified above-knee group. Similar reductions have been reported in studies evaluating less extensive venous stripping procedures, where limited tissue dissection reduces collateral vessel injury and soft tissue trauma.^{13,17} The reduced stripping length and minimized subcutaneous dissection likely account for decreased bleeding in the modified technique. This reduction in blood loss reflects a lower surgical burden and contributes to improved perioperative safety.

Hospital stay was significantly shorter in patients undergoing modified above-knee stripping. This finding aligns with existing literature on minimally invasive and modified venous procedures, which consistently demonstrate earlier mobilization and reduced inpatient recovery time.^{4,12} The likely explanation includes reduced postoperative pain, lower tissue trauma, and fewer wound-related concerns in the modified group. Clinically, shorter hospitalization translates into reduced healthcare utilization and improved patient turnover.

A markedly lower incidence of saphenous nerve injury was observed in the modified above-knee group compared with conventional stripping. This finding is strongly supported by anatomical and clinical evidence indicating that the saphenous nerve is closely associated with the great saphenous vein below the knee, making full-length stripping a major risk factor for nerve injury.⁶ Avoidance of below-knee stripping in the modified technique provides a clear anatomical rationale for this reduction. These

results support modified stripping as a nerve-sparing surgical approach.

Postoperative subcutaneous hematoma occurred less frequently in the modified group. Similar findings have been reported in studies evaluating refined surgical techniques, where reduced dissection and limited tissue trauma result in fewer postoperative bleeding complications.¹³ The decreased incidence in the modified group likely reflects reduced disruption of subcutaneous venous tributaries. This contributes to improved early postoperative comfort and wound recovery.

Both surgical techniques demonstrated high and comparable clinical success rates exceeding 97%. This indicates that limiting stripping to the above-knee segment does not compromise short-term symptomatic relief or eradication of visible varicosities. These findings are consistent with previous studies showing comparable efficacy between modified and conventional surgical approaches for great saphenous vein reflux.^{11,17} The results suggest that modified above-knee stripping maintains therapeutic effectiveness while reducing perioperative morbidity.

Overall, modified above-knee great saphenous vein stripping demonstrated clear advantages in perioperative outcomes, including reduced operative time, blood loss, hospitalization duration, and saphenous nerve injury, while maintaining equivalent clinical success compared with conventional full-length stripping. These findings indicate that procedural modification can optimize the balance between surgical efficacy and safety. In routine vascular surgical practice, particularly in resource-constrained healthcare systems, such modifications may offer a pragmatic and cost-effective alternative without compromising treatment outcomes.

Limitations of the Study

Although the study was conducted across three tertiary care hospitals, all participating centers were located within the same geographical region, which may limit the generalizability of the findings to other populations and healthcare settings. Additionally, the non-randomized study design may also introduce selection bias despite comparable baseline characteristics between groups. Further large-scale multicenter randomized controlled

studies with extended follow-up periods are warranted to validate these findings and assess long-term effectiveness and recurrence rates.

Conclusion

Modified above-knee great saphenous vein stripping demonstrated favourable perioperative outcomes, including shorter operative time, reduced hospital stays, and lower incidence of saphenous nerve injury compared with conventional full-length stripping, while achieving comparable clinical and technical success rates.

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Conflict of Interest: The authors declare that they have no conflict of interest.

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CONFLICT OF INTEREST

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon request.

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