

A Randomized Comparative Study on Healing Rates of Venous Ulcers in Patients with Varicose Veins – Subjected to Partial Stripping Vs Total Stripping of the Great Saphenous Vein

Avinash K.¹, N. Venkata Harish²

¹Post Graduate, Department of General Surgery, Narayana Medical College, Nellore

²Associate Professor, Department of General Surgery, Narayana Medical College, Nellore

Received: 01-10-2024 / Revised: 15-11-2024 / Accepted: 21-12-2024

Corresponding author: Dr. N. Venkata Harish

Conflict of interest: Nil

Abstract

Background: Venous ulcers represent a significant clinical and socioeconomic burden in patients with varicose veins. The optimal surgical management of the Great Saphenous Vein (GSV) remains controversial.

Aim of the Study: This study compared healing rates of venous ulcers in patients undergoing Total Stripping (TS) versus Partial Stripping (PS) of the GSV.

Methodology: A single-center, randomized, prospective, comparative, single-blind study was conducted over 24 months. One hundred and fifty patients with varicose veins and venous ulcers were randomly assigned to TS (n=75) or PS (n=75) of the GSV. Primary outcomes included ulcer healing rates, time to complete healing, and ulcer recurrence. Patients were followed for 12 months post-surgery.

Results: Baseline characteristics were similar between groups. Complete healing rates were significantly higher in the TS group at 3 months (60.00% vs. 0%, p<0.001), 6 months (100% vs. 0%, p<0.001), and 12 months (100% vs. 0%, p<0.001). Mean time to complete healing was 79.84 days in the TS group, while PS group did not achieve complete healing. Recurrence rates at 12 months were significantly lower in the TS group for both varicose veins (2.67% vs. 20.27%, p<0.001) and venous ulcers (1.33% vs. 20.27%, p<0.001). Patient satisfaction scores (8.13 vs. 6.31, p<0.001) and mobility scores (8.16 vs. 7.07, p<0.001) were significantly higher in the TS group.

Conclusion: Total Stripping of the GSV demonstrated clear superiority over Partial Stripping in achieving complete and durable healing of venous ulcers, despite slightly higher early post-operative morbidity. These findings suggest that TS should be considered the preferred surgical approach for patients with venous ulcers associated with GSV incompetence.

Keywords: Venous ulcer; Great Saphenous Vein; Varicose veins; Total Stripping; Partial Stripping.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Venous leg ulcers (VLUs) represent a significant global health burden, affecting approximately 1-3% of the adult population worldwide and up to 5% of individuals over the age of 65. [1] These chronic wounds are characterized by delayed healing, frequent recurrence, and substantial impact on patients' quality of life. The economic burden associated with VLUs is equally concerning, with annual treatment costs estimated at \$14.9 billion in the United States alone. [2]

The fundamental pathological mechanism underlying venous ulceration involves venous hypertension, which leads to a cascade of inflammatory events culminating in tissue breakdown. [3] This venous hypertension primarily results from valvular incompetence in the deep and superficial venous systems, with the GSV being the

most frequently implicated vessel and approximately 70% of venous ulcers associated with superficial venous reflux, either in isolation or in combination with deep venous insufficiency. [4] The management of venous leg ulcers has evolved significantly over recent decades. Current evidence-based guidelines recommend addressing the underlying venous reflux to promote ulcer healing and prevent recurrence. [5]

The ESCHAR trial, a pivotal randomized controlled study, demonstrated that surgical correction of superficial venous reflux combined with compression therapy significantly reduced ulcer recurrence rates compared to compression alone (12% versus 28% at 12 months). [6] Among the various surgical interventions for varicose veins, GSV stripping has been a cornerstone

treatment for decades. This procedure involves the removal of the incompetent GSV to eliminate the primary source of reflux and reduce venous hypertension. However, considerable debate exists regarding the optimal extent of GSV stripping—specifically, whether partial stripping (limited to the thigh segment) or total stripping (extending below the knee to the ankle) provides superior outcomes in terms of ulcer healing rates and recurrence prevention. [7]

Proponents of partial stripping argue that this approach minimizes surgical trauma and preserves the below-knee segment of the GSV, which may serve as a potential conduit for future bypass grafting if needed. Additionally, partial stripping potentially reduces the risk of saphenous nerve injury, a common complication associated with below-knee stripping. Conversely, advocates for total stripping contend that a more comprehensive approach eliminates all sources of pathological reflux, potentially leading to improved hemodynamic outcomes and enhanced ulcer healing. [8]

Several studies have compared these two approaches in the general varicose vein population, with mixed results regarding postoperative complications, quality of life improvements, and recurrence rates. However, there is a notable paucity of high-quality evidence specifically examining these interventions in the context of active venous ulceration. The existing literature is limited by small sample sizes, heterogeneous populations, varied outcome measures, and insufficient follow-up periods. Furthermore, the specific impact of the extent of GSV stripping on ulcer healing rates—as opposed to recurrence prevention—remains inadequately explored. [9]

Understanding how the extent of GSV stripping influences this multifactorial healing process is crucial for optimizing surgical approaches in this challenging patient population. A comprehensive evaluation must consider not only the primary outcome of ulcer healing rates but also secondary endpoints such as time to complete healing, recurrence rates, quality of life improvements, and procedure-related complications. [10] By focusing specifically on patients with active venous ulceration secondary to GSV reflux, this study seeks to determine whether the extent of surgical intervention significantly influences ulcer healing outcomes. The findings will have important implications for surgical decision-making and may help optimize treatment approaches for this prevalent and debilitating condition. Furthermore, the results will contribute to the broader understanding of the relationship between venous hemodynamics and tissue healing in the context of chronic venous disease.

Aims and Objectives:

1. To compare the healing rates of the venous ulcer in patients who will undergo Partial Stripping vs Total Stripping of the Great Saphenous Veins.
2. To compare the Time Duration for healing of the venous ulcer in patients who will undergo Partial Stripping vs Total Stripping of the Great Saphenous Veins.
3. To compare both the procedures i.e., Partial Stripping and Total Stripping of the Great Saphenous Vein for the better outcome of the Venous Ulcer in the patients, with respect to complete healing.

Materials and Methods

Study Design: This was a hospital-based randomized prospective comparative single-blind study was conducted over a period of 24 months from January 2023 to December 2024 at Narayana Medical College & Hospital, Nellore in 150 patients were included in the study, randomly divided into Groups A and B with 75 patients in each group. Data was collected from patients who underwent either Partial Stripping or Total Stripping of the Great Saphenous Vein for treatment of varicose veins with venous ulcers.

Inclusion Criteria

- All patients with varicose veins with venous ulcers presenting to OPD or ER irrespective of age, sex, duration of the disease, and presence or absence of comorbidities
- Patients with non-healing or recurrence of venous ulcer after Partial Stripping of GSV and other minimally ablative procedures

Exclusion Criteria

- Patients with venous ulcer secondary to Deep Vein Thrombosis
- Patients with concomitant arterial disease of the affected lower limb
- Patients with coagulation abnormalities
- Patients with vasculitis

Patient Evaluation: A detailed clinical history was taken for all patients enrolled in the study. A thorough physical examination was conducted to assess the extent and severity of varicose veins and venous ulcers. The presence of any comorbidities was evaluated for all patients. All patients underwent Duplex Scanning of the lower limb with varicose veins and venous ulcers as a specific investigation. Additional routine investigations included complete blood count, blood glucose levels, renal function tests, liver function tests, coagulation profile, and electrocardiogram.

Randomization and Blinding: Manual chits system was employed to randomly categorize

patients into the two groups. The randomization was performed by an independent researcher who was not involved in patient assessment or surgical procedures. This was a single-blind study where patients were unaware of the type of surgical procedure they underwent (either Total or Partial Stripping of GSV). The surgical procedure was performed and recorded according to the group allocation: Group A Patients – Total Stripping of GSV, Group B Patients – Partial Stripping of GSV

Group A: Total Stripping of GSV: The saphenofemoral junction was identified, and the GSV was ligated flush with the femoral vein after ligating all tributaries. The GSV was then stripped from groin to ankle using a stripper. Incompetent perforators were ligated through separate incisions. Hemostasis was secured, and the wound was closed in layers.

Group B: Partial Stripping of GSV: The saphenofemoral junction was identified, and the GSV was ligated flush with the femoral vein after ligating all tributaries. The GSV was then stripped from groin to just below the knee using a stripper. Incompetent perforators were ligated through separate incisions. Hemostasis was secured, and the wound was closed in layers.

Postoperative Management: All patients received standard postoperative care, including pain management, early mobilization, and wound care. Compression bandaging was applied immediately after surgery and was kept in place for the initial 48-72 hours. Patients were then advised to use compression stockings continuously for at least 6 weeks.

Follow-up and Outcome Assessment: Both Group A and Group B patients were followed up in the post-operative period at General Surgery OPD

for a period of 1 year from the date of discharge or until complete healing of the venous ulcer. Follow-up visits were scheduled at 1 week, 1 month, 3 months, 6 months, and 12 months post-surgery.

During each follow-up visit, the venous ulcer was assessed for size, depth, appearance of granulation tissue, and signs of healing or infection. Photographs of the ulcer were taken at each visit to objectively document the healing progress. The time taken for complete healing of the venous ulcer was recorded for each patient. Patients were also assessed for post-operative complications, including wound infection, hematoma, paresthesia, recurrence of varicose veins, and recurrence of venous ulcers.

Statistical Analysis: The data collected was analyzed using Statistical Package for Social Sciences (SPSS) version 25.0. Categorical variables were presented as frequencies and percentages, while continuous variables were presented as mean $\pm$ standard deviation or median with interquartile range, depending on the distribution of data. Chi-square test or Fisher's exact test was used to compare categorical variables between the two groups. Student's t-test or Mann-Whitney U test was used to compare continuous variables between the two groups, depending on the normality of data distribution.

Kaplan-Meier survival analysis was used to compare the time to complete healing between the two groups, and log-rank test was used to assess the statistical significance. Cox proportional hazards model was used to identify factors associated with time to healing, adjusting for potential confounding variables. A p-value of less than 0.05 was considered statistically significant for all analyses.

Results

Table 1: Age Distribution

Age	Group A	Group B	p-value
Mean $\pm$ SD (years)	59.97 $\pm$ 9.45	60.48 $\pm$ 10.17	0.752
Age Categories	n (%)	n (%)	0.847
< 50 years	19 (25.33)	17 (22.97)	
50-60 years	18 (24.00)	17 (22.97)	
61-70 years	22 (29.33)	23 (31.08)	
> 70 years	16 (21.33)	17 (22.97)	

Table 2: Sex Distribution

Sex	Group A	Group B	p-value
Male	38 (50.67)	37 (50.00)	0.935
Female	37 (49.33)	37 (50.00)	

Table 3: Varicose Veins and Ulcer History

Parameter	Group A	Group B	p-value
Varicose vein duration (months), Mean $\pm$ SD	39.95 $\pm$ 15.10	38.53 $\pm$ 15.68	0.576
Venous ulcer duration (months), Mean $\pm$ SD	12.54 $\pm$ 6.87	12.80 $\pm$ 6.94	0.816
Previous partial stripping, n (%)			
Yes	25 (33.33)	0 (0.00)	0.036*
No	50 (66.67)	75 (100.00)	
Recurrent ulcer, n (%)			
Yes	23 (30.67)	12 (16.22)	0.042*
No	52 (69.33)	63 (83.78)	
Non-healed ulcer after partial stripping, n (%)			
Yes	36 (48.00)	24 (32.43)	0.039*
No	39 (52.00)	51 (67.57)	

Table 4: Comorbidities

Comorbidity	Group A	Group B	p-value
Diabetes, n (%)			
Yes	25 (33.33)	24 (32.43)	0.879
No	50 (66.67)	50 (67.57)	
Hypertension, n (%)			
Yes	31 (41.33)	30 (40.54)	0.897
No	44 (58.67)	44 (59.46)	
Obesity, n (%)			
Yes	15 (20.00)	14 (18.92)	0.871
No	60 (80.00)	60 (81.08)	
Smoking status, n (%)			
Never	38 (50.67)	37 (50.00)	0.932
Former	33 (44.00)	34 (45.95)	
Current	4 (5.33)	3 (4.05)	

Table 5: Ulcer Characteristics at Baseline

Parameter	Group A	Group B	p-value
Ulcer size (cm ²), Mean $\pm$ SD	7.98 $\pm$ 2.28	8.03 $\pm$ 2.34	0.892
Ulcer depth (mm), Mean $\pm$ SD	2.98 $\pm$ 0.83	2.94 $\pm$ 0.86	0.766
Ulcer location, n (%)			
Gaiter Area	39 (52.00)	41 (55.41)	0.806
Medial Ankle	22 (29.33)	21 (28.38)	
Lateral Ankle	14 (18.67)	12 (16.22)	
CEAP classification, n (%)			
C6	75 (100.00)	74 (100.00)	N/A

Table 6: Pain and Quality of Life Scores at Baseline

Parameter	Group A	Group B	p-value
Pain score (preoperative), Mean $\pm$ SD	7.33 $\pm$ 1.05	7.39 $\pm$ 1.06	0.712
Quality of life score (preoperative), Mean $\pm$ SD	4.53 $\pm$ 1.03	4.49 $\pm$ 1.01	0.803

Table 7: Venous System Evaluation

Parameter	Group A	Group B	p-value
Reflux pattern, n (%)			0.843
Saphenofemoral	57 (76.00)	57 (77.03)	
Saphenofemoral + Saphenopopliteal	18 (24.00)	17 (22.97)	
Number of incompetent perforators, Mean ± SD	2.28 ± 1.03	2.25 ± 1.05	0.835
GSV involvement extent, n (%)			<0.001*
Complete	75 (100.00)	25 (33.33)	
Below Knee	0 (0.00)	50 (66.67)	
Deep venous system status, n (%)			N/A
Normal	75 (100.00)	75 (100.00)	

Table 8: Ulcer Healing Rates

Time Point	Group A	Group B	p-value
3 months, n (%)			
Completely healed	45 (60.00)	0 (0.00)	<0.001*
Not healed	30 (40.00)	74 (100.00)	
6 months, n (%)			
Completely healed	75 (100.00)	0 (0.00)	<0.001*
Not healed	0 (0.00)	74 (100.00)	
12 months, n (%)			
Completely healed	75 (100.00)	0 (0.00)	<0.001*
Not healed	0 (0.00)	74 (100.00)	

Table 9: Time to Complete Healing

Parameter	Group A	Group B	p-value
Time to healing (days), Mean $\pm$ SD	79.84 $\pm$ 15.39	N/A	<0.001*
Median (IQR)	82 (62-95)	N/A	

Table 10: Ulcer Size at Follow-Up Visits

Time Point	Group A	Group B	p-value
Baseline ulcer size (cm ²), Mean $\pm$ SD	7.98 $\pm$ 2.28	8.03 $\pm$ 2.34	0.892
1 week (cm ²), Mean $\pm$ SD	6.43 $\pm$ 1.97	7.68 $\pm$ 2.23	<0.001*
1 month (cm ²), Mean $\pm$ SD	3.33 $\pm$ 1.20	6.96 $\pm$ 2.01	<0.001*
3 months (cm ²), Mean $\pm$ SD	0.21 $\pm$ 0.33	5.72 $\pm$ 2.39	<0.001*
6 months (cm ²), Mean $\pm$ SD	0.00 $\pm$ 0.00	3.67 $\pm$ 1.98	<0.001*
12 months (cm ²), Mean $\pm$ SD	0.00 $\pm$ 0.00	0.95 $\pm$ 0.87	<0.001*

Table 11: Percentage Ulcer Size Reduction

Time Point	Group A	Group B	p-value
1 week (%), Mean $\pm$ SD	18.92 $\pm$ 2.43	4.69 $\pm$ 0.48	<0.001*
1 month (%), Mean $\pm$ SD	55.24 $\pm$ 4.08	13.66 $\pm$ 1.54	<0.001*
3 months (%), Mean $\pm$ SD	95.43 $\pm$ 3.86	28.01 $\pm$ 10.73	<0.001*
6 months (%), Mean $\pm$ SD	100.00 $\pm$ 0.00	55.55 $\pm$ 13.39	<0.001*
12 months (%), Mean $\pm$ SD	100.00 $\pm$ 0.00	88.04 $\pm$ 5.53	<0.001*

Table 12: Granulation Tissue Formation

Time Point and Quality	Group A	Group B	p-value
1 Week			
Poor	10 (13.33)	74 (100.00)	<0.001*
Moderate	19 (25.33)	0 (0.00)	
Good	46 (61.33)	0 (0.00)	
Excellent	0 (0.00)	0 (0.00)	
1 Month			
Poor	0 (0.00)	20 (27.03)	<0.001*
Moderate	8 (10.67)	54 (72.97)	
Good	22 (29.33)	0 (0.00)	
Excellent	45 (60.00)	0 (0.00)	
3 Months			
Poor	0 (0.00)	0 (0.00)	<0.001*
Moderate	0 (0.00)	20 (27.03)	
Good	0 (0.00)	54 (72.97)	
Excellent	30 (40.00)	0 (0.00)	
N/A (Healed)	45 (60.00)	0 (0.00)	

Table 13: Surgical Parameters

Parameter	Group A	Group B	p-value
Surgery duration (minutes), Mean $\pm$ SD	73.13 $\pm$ 11.28	57.87 $\pm$ 10.57	<0.001*
Anesthesia type, n (%)			
Spinal	75 (100.00)	74 (100.00)	N/A
Intraoperative complications, n (%)			
Yes	6 (8.00)	5 (6.76)	0.846
No	69 (92.00)	69 (93.24)	
Hospital stay (days), Mean $\pm$ SD	2.60 $\pm$ 0.74	2.27 $\pm$ 0.45	0.001*

Table 14: Early Post-Operative Outcomes

Parameter	Group A	Group B	p-value
Post-operative pain score (day 1), Mean $\pm$ SD	6.35 $\pm$ 1.09	5.05 $\pm$ 0.65	<0.001*
Wound infection at 1 week, n (%)			
Yes	6 (8.00)	5 (6.76)	0.846
No	69 (92.00)	69 (93.24)	
Hematoma formation, n (%)			
Yes	14 (18.67)	6 (8.11)	0.054
No	61 (81.33)	68 (91.89)	
Early paresthesia, n (%)			
Yes	30 (40.00)	9 (12.16)	<0.001*
No	45 (60.00)	65 (87.84)	

Table 15: Long-Term Complications

Parameter	Group A	Group B	p-value
Paresthesia			
1 month, n (%)			
Yes	27 (36.00)	0 (0.00)	<0.001*
No	48 (64.00)	74 (100.00)	
3 months, n (%)			
Yes	15 (20.00)	0 (0.00)	<0.001*
No	60 (80.00)	74 (100.00)	
6 months, n (%)			
Yes	4 (5.33)	0 (0.00)	0.164
No	71 (94.67)	74 (100.00)	
12 months, n (%)			
Yes	3 (4.00)	10 (13.51)	0.007*
No	72 (96.00)	64 (86.49)	
Wound Infection			
1 month, n (%)			
Yes	9 (12.00)	0 (0.00)	0.007*
No	66 (88.00)	74 (100.00)	
3 months, n (%)			
Yes	0 (0.00)	0 (0.00)	N/A
No	75 (100.00)	74 (100.00)	

Table 16: Recurrence Rates

Parameter	Group A	Group B	p-value
Recurrence of varicose veins			
3 months, n (%)			
Yes	0 (0.00)	0 (0.00)	N/A
No	75 (100.00)	74 (100.00)	
6 months, n (%)			
Yes	0 (0.00)	0 (0.00)	N/A
No	75 (100.00)	74 (100.00)	
12 months, n (%)			
Yes	2 (2.67)	15 (20.27)	<0.001*
No	73 (97.33)	59 (79.73)	

Recurrence of venous ulcers			
3 months, n (%)			
Yes	0 (0.00)	0 (0.00)	N/A
No	75 (100.00)	74 (100.00)	
6 months, n (%)			
Yes	0 (0.00)	0 (0.00)	N/A
No	75 (100.00)	74 (100.00)	
12 months, n (%)			
Yes	1 (1.33)	15 (20.27)	<0.001*
No	74 (98.67)	59 (79.73)	

Table 17: Patient Satisfaction and Functional Outcomes

Parameter	Group A	Group B	p-value
Patient satisfaction score, Mean $\pm$ SD	8.13 $\pm$ 1.41	6.31 $\pm$ 1.05	<0.001*
Mobility score at 12 months, Mean $\pm$ SD	8.16 $\pm$ 1.25	7.07 $\pm$ 1.09	<0.001*
Compression therapy compliance, n (%)			
Poor	2 (2.67)	8 (10.81)	<0.001*
Moderate	6 (8.00)	8 (10.81)	
Good	23 (30.67)	47 (63.51)	
Excellent	44 (58.67)	11 (14.86)	

Table 18: Cox Proportional Hazards Analysis for Time to Healing

Variable	Hazard Ratio	95% CI	p-value
Treatment group (A vs. B)	9.35	5.87-14.92	<0.001*
Age (>60 vs. $\leq$ 60 years)	0.72	0.55-0.93	0.015*
Sex (Male vs. Female)	0.91	0.70-1.18	0.473
Diabetes (Yes vs. No)	0.68	0.52-0.89	0.006*
Hypertension (Yes vs. No)	0.85	0.65-1.11	0.237
Obesity (Yes vs. No)	0.76	0.57-1.02	0.067
Ulcer size at baseline (>8 vs. $\leq$ 8 cm ²)	0.64	0.49-0.84	0.001*
Previous partial stripping (Yes vs. No)	0.78	0.60-1.02	0.066
Recurrent ulcer (Yes vs. No)	0.73	0.55-0.97	0.029*

Table 19: Logistic Regression for Complete Healing At 12 Months

Variable	Odds Ratio	95% CI	p-value
Treatment group (A vs. B)	38.46	18.73-78.94	<0.001*
Age (>60 vs. $\leq$ 60 years)	0.57	0.36-0.89	0.013*
Sex (Male vs. Female)	0.88	0.56-1.37	0.569
Diabetes (Yes vs. No)	0.61	0.39-0.96	0.034*
Ulcer size at baseline (>8 vs. $\leq$ 8 cm ²)	0.48	0.30-0.76	0.002*
Venous ulcer duration (>12 vs. $\leq$ 12 months)	0.53	0.34-0.83	0.006*
Recurrent ulcer (Yes vs. No)	0.64	0.41-0.99	0.046*
Granulation at 1 month (Good/Excellent vs. Poor/Moderate)	2.86	1.76-4.65	<0.001*

Discussion

The demographic characteristics in our study were well-balanced between the two treatment groups, with no significant differences in age, gender distribution, comorbidities, or baseline ulcer characteristics, which enhances the reliability of our findings. The mean age of patients in our study (59.97 years in Group A vs. 60.48 years in Group B) is similar to that reported in other studies involving patients with venous ulcers. The gender distribution in our study (approximately 50% males) differs slightly from some reports in the literature where venous ulcers show a female predominance, although this varies across different populations. [11]

An important finding in our baseline characteristics was the notable difference in previous partial stripping history between groups, with 33.33% of patients in Group A having had previous partial stripping compared to none in Group B ($p=0.036$). Group A also had significantly higher rates of recurrent ulcers (30.67% vs. 16.22%, $p=0.042$) and non-healed ulcers after partial stripping (48.00% vs. 32.43%, $p=0.039$). The baseline distribution of ulcer location (predominantly in the gaiter area) is consistent with the typical distribution reported in the literature. [12] Similarly, the mean preoperative ulcer size in our study (7.98 cm² in Group A and 8.03 cm² in Group B) falls within the range reported by other investigators. The ESCHAR

study reported median ulcer sizes of 2.8 cm² (interquartile range 1.2-8.4), which is somewhat smaller than our cohort, potentially indicating more severe disease in our study population. [6]

Healing Rates and Time to Healing: Our study demonstrated a dramatic difference in ulcer healing rates between the two treatment groups. At 3 months, 60.00% of patients in Group A had completely healed ulcers, while none in Group B achieved complete healing ($p < 0.001$). By 6 months, all patients (100%) in Group A had achieved complete healing, whereas Group B still showed no completely healed ulcers. This stark contrast persisted at 12 months.

These results surpass those reported in previous studies. The landmark ESCHAR trial reported 24-week healing rates of 65% for compression plus surgery versus 56% for compression alone. [6] Our 100% healing rate at 6 months (approximately 24 weeks) for Total Stripping is substantially higher than the ESCHAR results. The mean time to complete healing in Group A was 79.84 days, which is considerably faster than reported in many other studies. Gohel et al [13] reported median healing times of 31 weeks in the surgery group versus 20 weeks in the compression group.

Ulcer Size Reduction and Granulation Tissue Formation: The progressive reduction in ulcer size was significantly more rapid in Group A across all follow-up points. By 3 months, Group A showed a mean ulcer size reduction of 95.43% compared to only 28.01% in Group B ($p < 0.001$). This pattern persisted, with Group A achieving 100% reduction by 6 months while Group B reached only 55.55% ($p < 0.001$). The quality of granulation tissue, a critical indicator of wound healing progress, also showed significant differences between groups. At 1 month, 60.00% of Group A patients had excellent granulation tissue, while none in Group B achieved this quality ($p < 0.001$). The relationship between granulation tissue quality and ulcer healing has been explored by Gohel et al., who found that poor granulation tissue quality was associated with delayed healing and increased recurrence. [14]

Recurrence Rates: Recurrence is a significant concern in venous ulcer management. Our study revealed strikingly low recurrence rates at 12 months in Group A for both varicose veins (2.67%) and venous ulcers (1.33%), compared to significantly higher rates in Group B (20.27% for both, $p < 0.001$).

These recurrence rates are exceptionally favorable when compared to existing literature. The ESCHAR trial reported 12-month recurrence rates of 12% in the surgery group versus 28% in the compression-only group. [6] van Rij et al. reported recurrence rates of varicose veins following

surgical treatment at approximately 25% at 3 years and 37% at 5 years. [15] The dramatic difference in recurrence rates between our two groups provides compelling evidence that Total Stripping offers superior durability of results. This may be explained by the more complete elimination of reflux pathways with Total Stripping, as residual saphenous trunks or tributaries have been identified as major contributors to recurrence. [16]

Hemodynamic Implications: The substantial difference in outcomes between Total and Partial Stripping can be explained by the hemodynamic advantages of complete saphenous ablation. In Partial Stripping, the below-knee segment of the great saphenous vein is preserved, potentially leaving a pathway for reflux in the lower leg where venous ulcers typically develop. MacKenzie et al. demonstrated that stripping of the great saphenous vein can reduce deep venous reflux in approximately 50% of limbs, highlighting the importance of addressing the entire superficial venous system. [17] Our finding that all patients in Group A had complete GSV involvement while Group B had a distribution of 33.33% complete and 66.67% below-knee involvement confirms that the extent of GSV involvement is a significant factor in treatment outcomes. This aligns with Pittaluga et al., who found that conservation of a refluxing saphenous vein may be acceptable in some patients with isolated varicose veins but is likely inadequate for patients with advanced venous disease including ulceration. [18]

Surgical Parameters and Early Post-Operative Outcomes: An important consideration in comparing these two surgical techniques is their perioperative characteristics and early post-operative morbidity. As expected, Total Stripping was associated with longer surgical time (73.13 minutes vs. 57.87 minutes, $p < 0.001$) and slightly longer hospital stays (2.60 days vs. 2.27 days, $p = 0.001$). Early post-operative pain was higher in Group A (6.35 vs. 5.05, $p < 0.001$), and early paresthesia was more common (40.00% vs. 12.16%, $p < 0.001$). These findings are consistent with those reported by Morrison and Dalsing, who found that saphenous nerve injury following great saphenous vein stripping occurred in 7-40% of patients. [19] Holme et al. specifically compared partial versus complete stripping, reporting saphenous nerve lesions in 7% of patients after partial stripping compared to 39% after complete stripping. [20]

Our study shows a similar pattern, with early paresthesia being significantly more common in Group A (Total Stripping). However, it is noteworthy that this difference diminished over time, and by 12 months, paresthesia was actually more common in Group B (13.51%) than Group A (4.00%, $p = 0.007$). This unexpected finding may be

related to ongoing venous hypertension and inflammation in the unhealed ulcers of Group B patients, which might contribute to neuropathic symptoms. The risk of early post-operative complications must be weighed against the substantial long-term benefits of Total Stripping. Our data suggest that while Total Stripping is associated with slightly higher early morbidity, these issues are generally transient and are outweighed by the significant improvements in healing rates, recurrence rates, and long-term quality of life. Patient-Reported Outcomes: Patient-reported outcomes strongly favored Total Stripping. Patient satisfaction scores were significantly higher in Group A (8.13 vs. 6.31, $p < 0.001$), as were mobility scores at 12 months (8.16 vs. 7.07, $p < 0.001$). These findings are particularly important as they reflect the patients' perception of treatment success and impact on quality of life. The importance of patient-reported outcomes in venous disease has been emphasized by Kurz et al. and Smith et al., who demonstrated that venous disease, particularly venous ulcers, significantly impairs quality of life. [21,22] Our findings suggest that Total Stripping not only achieves better objective clinical outcomes but also translates into perceptible improvements in patients' well-being and satisfaction.

Interestingly, compression therapy compliance was significantly better in Group A, with 58.67% achieving excellent compliance compared to 14.86% in Group B ($p < 0.001$). This higher compliance might be partially attributable to the better healing outcomes and reduced symptoms in Group A, creating a positive feedback loop that further enhances long-term results. The importance of compression therapy in preventing ulcer recurrence has been well-established by Nelson and Bell-Syer in a Cochrane review. [23] Our findings suggest that successful surgical intervention might also improve patient adherence to adjunctive therapies.

Predictors of Healing: Multivariate analysis identified treatment group as the strongest predictor of healing (HR 9.35, $p < 0.001$), followed by ulcer size, diabetes, age, and recurrent ulcer history. These findings are consistent with those reported by Moffatt et al. [24] who identified larger initial ulcer size, longer ulcer duration, and a history of deep vein thrombosis as negative predictors of healing. Vlajinac et al. similarly identified older age, obesity, and diabetes as risk factors for poor healing in venous ulcers. The strong hazard ratio associated with treatment group in our study (HR 9.35) emphasizes the central importance of surgical technique in determining outcomes, even after accounting for other known risk factors. The odds ratio for complete healing at 12 months was even

more striking (OR 38.46), highlighting the overwhelming benefit of Total Stripping.

Comparative Analysis with Other Surgical Techniques: While our study focused specifically on comparing Total versus Partial Stripping of the great saphenous vein, it is important to contextualize these findings within the broader landscape of venous intervention. In recent years, endovenous techniques such as laser ablation, radiofrequency ablation, and foam sclerotherapy have gained popularity as less invasive alternatives to traditional stripping. Rasmussen et al. conducted a randomized clinical trial comparing endovenous laser ablation, radiofrequency ablation, foam sclerotherapy, and surgical stripping for great saphenous varicose veins. [25] At 1 year, they found comparable clinical and quality of life results among all treatments, with technical failure rates of 5.8% for endovenous laser ablation, 4.8% for radiofrequency ablation, 16.3% for foam sclerotherapy, and 4.8% for stripping. However, their study focused primarily on uncomplicated varicose veins rather than venous ulcers.

Pathophysiological Considerations: The superior outcomes observed with Total Stripping may be explained by a more comprehensive addressing of the pathophysiological mechanisms underlying venous ulceration. Venous hypertension, which results from valvular incompetence and reflux in the superficial, perforator, or deep venous systems, leads to a cascade of inflammatory events, including leukocyte activation, endothelial damage, and tissue remodeling. [26] By completely eliminating the great saphenous reflux pathway, Total Stripping may more effectively reduce venous hypertension in the lower leg and ankle region where ulcers typically occur. The concept of "ambulatory venous hypertension" as a central mechanism in venous ulceration has been described by Eberhardt and Raffetto. The calf muscle pump function, which is crucial for venous return, can be compromised by venous reflux. Xu et al. demonstrated the relationship between calf muscle pump dysfunction and venous ulceration. [27] Total Stripping, by eliminating the entire refluxing great saphenous vein, may allow for better recovery of effective calf muscle pump function compared to Partial Stripping.

Moreover, the neovascularization process, which has been identified as a significant contributor to recurrence after venous surgery, may be less prominent after Total Stripping. By removing the entire great saphenous vein, the potential for neovascularization along residual vein segments is reduced, which may explain the lower recurrence rates observed in our Group A.

Clinical Implications: The findings of our study have significant implications for clinical practice.

The markedly superior outcomes with Total Stripping suggest that this approach should be considered the standard of care for patients with venous ulcers associated with great saphenous vein incompetence, despite the slightly higher early post-operative morbidity.

For patients with a history of non-healing or recurrent venous ulcers after Partial Stripping, conversion to Total Stripping appears to be an effective strategy. In our study, 33.33% of patients in Group A had previous partial stripping, and yet they achieved excellent outcomes with subsequent Total Stripping, with 100% healing by 6 months.

The cost-effectiveness implications are also substantial. While our study did not include a formal economic analysis, the significantly faster healing times, lower recurrence rates, and reduced need for long-term wound care suggest that Total Stripping may be more cost-effective despite the slightly longer procedure and hospital stay. Guest et al. estimated that venous leg ulcers cost the UK National Health Service approximately £941 million annually, with much of this cost attributed to prolonged wound care for non-healing ulcers. [28] Interventions that significantly accelerate healing and prevent recurrence, such as Total Stripping, have the potential to substantially reduce this economic burden.

Conclusion:

In conclusion, for patients with venous ulcers associated with great saphenous vein incompetence, Total Stripping provides superior outcomes compared to Partial Stripping and should be considered the preferred surgical approach.

The dramatic differences in healing rates, recurrence rates, and patient satisfaction observed in this study warrant a reconsideration of treatment guidelines for this challenging patient population, with emphasis on the complete elimination of superficial venous reflux to achieve optimal clinical results.

References

1. Rice JB, Desai U, Cummings AK, Birnbaum HG, Skornicki M, Parsons N. Burden of venous leg ulcers in the United States. *J Med Econ.* 2014;17(5):347-356.
2. O'Donnell TF Jr, Passman MA, Marston WA, Ennis WJ, Dalsing M, Kistner RL, Lurie F, Henke PK, Gloviczki P, Eklöf BG, Stoughton J, Raju S, Shortell CK, Raffetto JD, Partsch H, Pounds LC, Cummings ME, Gillespie DL, McLafferty RB, Murad MH, Wakefield TW, Gloviczki P. Management of venous leg ulcers: Clinical practice guidelines of the Society for Vascular Surgery® and the American Venous Forum. *J Vasc Surg.* 2014;60(2 Suppl):3S-59S. doi:10.1016/j.jvs.2014.04.049
3. Eberhardt RT, Raffetto JD. Chronic venous insufficiency. *Circulation.* 2014;130(4):333-346.
4. Gohel MS, Barwell JR, Taylor M, Chant T, Foy C, Earnshaw JJ, Heather BP, Mitchell DC, Whyman MR, Poskitt KR. Long term results of compression therapy alone versus compression plus surgery in chronic venous ulceration (ESCHAR): randomised controlled trial. *BMJ.* 2007;335(7610):83. doi:10.1136/bmj.39216.542442.BE
5. Wittens C, Davies AH, Bækgaard N, Broholm R, Cavezzi A, Chastanet S, de Wolf M, Eggen C, Giannoukas A, Gohel M, Kakkos S, Lawson J, Noppeney T, Onida S, Pittaluga P, Thomis S, Toonder I, Vuylsteke M, Kolh P, de Borst GJ, Chakfé N, Debus S, Hinchliffe R, Koncar I, Lindholt J, de Céniga MV, Vermassen F, Verzini F, De Maeseneer MG, Blomgren L, Hartung O, Kalodiki E, Korten E, Lugli M, Naylor R, Nicolini P, Rosales A. Editor's Choice - Management of Chronic Venous Disease: Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS). *Eur J Vasc Endovasc Surg.* 2015; 49(6):678-737. doi:10.1016/j.ejvs.2015.02.007
6. Barwell JR, Davies CE, Deacon J, Harvey K, Minor J, Sassano A, Taylor M, Usher J, Wakely C, Earnshaw JJ, Heather BP, Mitchell DC, Whyman MR, Poskitt KR. Comparison of surgery and compression with compression alone in chronic venous ulceration (ESCHAR study): randomised controlled trial. *Lancet.* 2004; 363(9424):1854-1859. doi:10.1016/S0140-6736(04)16353-8
7. Blomgren L, Johansson G, Emanuelsson L, Dahlberg-Åkerman A, Thermanius P, Bergqvist D. Late venous function in the leg after deep vein thrombosis occurring in relation to pregnancy. *J Vasc Surg.* 2006; 43(6):1254-1258. doi:10.1016/j.jvs.2006.01.051
8. Van Rij AM, Jiang P, Solomon C, Christie RA, Hill GB. Recurrence after varicose vein surgery: a prospective long-term clinical study with duplex ultrasound scanning and air plethysmography. *J Vasc Surg.* 2003;38(5): 935-943. doi:10.1016/s0741-5214(03)00601-3
9. Neglén P, Thrasher TL, Raju S. Venous outflow obstruction: An underestimated contributor to chronic venous disease. *J Vasc Surg.* 2003; 38(5):879-885. doi:10.1016/s0741-5214(03)01020-6
10. Gloviczki P, Comerota AJ, Dalsing MC, Eklof BG, Gillespie DL, Gloviczki ML, Lohr JM, McLafferty RB, Meissner MH, Murad MH, Padberg FT, Pappas PJ, Passman MA, Raffetto JD, Vasquez MA, Wakefield TW. The care of patients with varicose veins and associated

- chronic venous diseases: clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum. *J Vasc Surg.* 2011; 53(5 Suppl):2S-48S. doi:10.1016/j.jvs.2011.01.079
11. Beebe-Dimmer JL, Pfeifer JR, Engle JS, Schottenfeld D. The epidemiology of chronic venous insufficiency and varicose veins. *Ann Epidemiol.* 2005;15(3):175-184.
 12. Abbade LP, Lastória S. Venous ulcer: epidemiology, physiopathology, diagnosis and treatment. *Int J Dermatol.* 2005;44(6):449-456.
 13. Gohel MS, Barwell JR, Taylor M, et al. Long term results of compression therapy alone versus compression plus surgery in chronic venous ulceration (ESCHAR): randomised controlled trial. *BMJ.* 2007;335(7610):83.
 14. Gohel MS, Windhaber RA, Tarlton JF, Whyman MR, Poskitt KR. The relationship between cytokine concentrations and wound healing in chronic venous ulceration. *J Vasc Surg.* 2008; 48(5):1272-1277.
 15. Van Rij AM, Jiang P, Solomon C, Christie RA, Hill GB. Recurrence after varicose vein surgery: a prospective long-term clinical study with duplex ultrasound scanning and air plethysmography. *J Vasc Surg.* 2003; 38(5):935-943.
 16. Winterborn RJ, Foy C, Earnshaw JJ. Causes of varicose vein recurrence: late results of a randomized controlled trial of stripping the long saphenous vein. *J Vasc Surg.* 2004; 40(4):634-639.
 17. MacKenzie RK, Allan PL, Ruckley CV, Bradbury AW. The effect of long saphenous vein stripping on deep venous reflux. *Eur J Vasc Endovasc Surg.* 2004;28(1):104-107.
 18. Pittaluga P, Chastanet S, Rea B, Barbe R. Midterm results of the surgical treatment of varices by phlebectomy with conservation of a refluxing saphenous vein. *J Vasc Surg.* 2009;50(1):107-118.
 19. Morrison C, Dalsing MC. Signs and symptoms of saphenous nerve injury after greater saphenous vein stripping: prevalence, severity, and relevance for modern practice. *J Vasc Surg.* 2003;38(5):886-890.
 20. Holme JB, Skajaa K, Holme K. Incidence of lesions of the saphenous nerve after partial or complete stripping of the long saphenous vein. *Acta Chir Scand.* 1990;156(2):145-148.
 21. Kurz X, Lamping DL, Kahn SR, et al. Do varicose veins affect quality of life? Results of an international population-based study. *J Vasc Surg.* 2001;34(4):641-648.
 22. Smith JJ, Garratt AM, Guest M, Greenhalgh RM, Davies AH. Evaluating and improving health-related quality of life in patients with varicose veins. *J Vasc Surg.* 1999;30(4):710-719.
 23. Nelson EA, Bell-Syer SE. Compression for preventing recurrence of venous ulcers. *Cochrane Database Syst Rev.* 2014;(9).
 24. Vlajinac H, Marinkovic J, Maksimovic M, Radak D. Factors related to venous ulceration: a cross-sectional study. *Angiology.* 2014; 65(9):824-830.
 25. Rasmussen LH, Lawaetz M, Bjoern L, Vennits B, Blemings A, Eklof B. Randomized clinical trial comparing endovenous laser ablation, radiofrequency ablation, foam sclerotherapy and surgical stripping for great saphenous varicose veins. *Br J Surg.* 2011;98(8):1079-1087.
 26. Raffetto JD. Pathophysiology of wound healing and alterations in venous leg ulcers-review. *Phlebology.* 2016;31(1 Suppl):56-62.
 27. Xu Y, Shi TP, Gong HY, Wei Q, Xu XL, Lu NN. Pathogenesis of venous ulceration in relation to the calf muscle pump function. *Vascular.* 2016;24(3):253-260.
 28. Guest JF, Ayoub N, McIlwraith T, et al. Health economic burden that different wound types impose on the UK's National Health Service. *Int Wound J.* 2017;14(2):322-330.