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Does concomitant treatment of tributary varicose veins improve the results of standard endovenous thermal ablation of the great or small saphenous trunk? A systematic review and metanalysis

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Abstract

The optimal management of tributary varicose veins during Endovenous Thermal Ablation (EVTA) of the saphenous trunk for Chronic Venous Disease (CVD) remains an area of ongoing clinical debate. This study compares the "hybrid" approach (EVTA with concomitant treatment of tributaries) with the "standard" approach (EVTA alone).

A systematic review and meta-analysis were conducted according to PRISMA guidelines. PubMed, EMBASE, and the Cochrane Library were searched up to December 2025 for comparative studies, including Randomized Controlled Trials (RCTs) and observational studies. The primary outcome was the need for re-intervention for residual or recurrent varicose veins at ≥1 year. Secondary outcomes included improvement in Quality of Life (QoL) and clinical severity,

assessed using validated scores. A random-effects model was used to calculate pooled Odds Ratios (ORs).

Nine studies enrolling 1,954 patients were included; re-intervention data for the primary outcome were available for 1,830 patients (916 hybrid; 914 standard). Meta-analysis showed that hybrid treatment significantly reduced the need for re-intervention compared with standard treatment, with a pooled OR of 0.15 (95% CI: 0.04-0.62; $p=0.009$, $I^2=93\%$). Clinical severity scores were significantly lower in the hybrid group, and most studies reported a faster improvement in QoL. Complications were uncommon and similarly distributed between groups.

Hybrid treatment appears to reduce re-intervention rates compared with isolated saphenous trunk ablation and may accelerate clinical improvement. This strategy should be considered a preferred approach in patients with saphenous insufficiency and significant tributary varicose veins.

Key words: chronic venous disease; varicose veins; endovenous ablation; concomitant treatment; re-intervention.

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Introduction

Clinical background

Chronic Venous Disease (CVD) is one of the most common pathological conditions in the Western world, with an estimated prevalence affecting up to 40% of the adult population.[1] Its most frequent clinical manifestation is lower limb varicose veins; however, the disease spectrum is broad and includes telangiectasias, edema, trophic skin changes, and, in advanced stages, venous ulcers. The Clinical-Etiological-Anatomical-Pathophysiological (CEAP) classification represents the standard system for staging CVD.[2] Patients commonly report symptoms such as pain, heaviness, and cramps, which may significantly impair Quality of Life (QoL),[3] with a substantial socio-economic impact.[4]

Pathophysiology of chronic venous disease

The primary driving mechanism of CVD is venous hypertension, mainly sustained by valvular incompetence of the superficial venous system.[5] Chronic venous hypertension triggers a cascade of inflammatory and remodeling processes, leading to progressive venous dilation and trophic skin alterations.[6]

Evolution of therapeutic strategies

For several decades, surgical stripping represented the gold standard treatment for saphenous vein insufficiency.[7] In the early 2000s, Endovenous Laser Ablation (EVLA) and Radiofrequency Ablation (RFA) emerged as first-line treatment modalities recommended by international guidelines.[8,9] These techniques have demonstrated success rates exceeding 90% and reduced morbidity compared with conventional surgery.[10]

The management of tributaries: an unresolved issue

Despite the effectiveness of EVLA and RFA in treating axial reflux, the optimal management of tributary varicose veins remains debated. The "staged" approach involves ablation of the saphenous trunk alone, with subsequent treatment of residual tributaries if clinically indicated; however, a considerable proportion of patients require a second intervention for persistent or recurrent tributary varicosities.[11,12] Consequently, a "hybrid" or "concomitant" approach has been proposed, consisting of simultaneous treatment of the saphenous trunk and tributary veins during the same procedural session.

Study objective

A meta-analysis published in 2020 by Aherne *et al.* provided a quantitative synthesis of the available evidence on this topic.[13] The aim of the present systematic review and meta-analysis is to summarize and critically appraise the current evidence comparing hybrid and standard approaches.

Materials and Methods

Search strategy

A systematic search of the electronic databases PubMed/MEDLINE, EMBASE, and the Cochrane Central Register of Controlled Trials (CENTRAL) was performed up to December 1, 2025. The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords, including: ("varicose veins" [MeSH Terms] OR "venous insufficiency" [MeSH Terms]) AND ("endovenous laser ablation" OR "radiofrequency ablation" OR "mechanochemical ablation") AND ("phlebectomy" OR "sclerotherapy" OR "concomitant" OR "simultaneous" OR "staged").

The reference lists of all included studies were manually screened to identify additional relevant publications (*Appendix 1, Supplementary Table 1*).

Eligibility criteria

Randomized Controlled Trials (RCTs) and comparative observational studies were eligible for inclusion if they compared a hybrid approach (thermal or mechanochemical ablation combined with concomitant treatment of tributary veins) with a standard approach (thermal or mechanochemical ablation alone) in adult patients with chronic venous disease classified as CEAP C2-C6 and documented reflux of the great or small saphenous vein. A minimum follow-up duration of 12 months was required. The primary outcome of interest was the need for re-intervention for residual or recurrent varicose veins, defined as any additional procedure performed after the index treatment, including ultrasound-guided foam sclerotherapy, phlebectomy, repeat endovenous ablation, or other secondary interventions.

Study selection and data extraction

Two independent reviewers screened titles and abstracts for eligibility and subsequently assessed the full texts of potentially relevant articles. The same reviewers independently extracted data using a standardized data collection form. Extracted data included study characteristics, patient demographics, intervention details, follow-up duration, and numerical outcome data for each treatment group. Any disagreements were resolved through discussion and consensus.

Risk of bias assessment

Methodological quality and risk of bias were independently assessed by two reviewers. For randomized controlled trials, the Cochrane Risk of Bias tool version 2 (RoB 2) was used.[14] For

non-randomized observational studies, the Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool was applied.[15] Any discrepancies in assessment were resolved by consensus (*Supplementary Tables 2 and 3, Supplementary Figure 1*).

Data synthesis and analysis

A meta-analysis was performed using a random-effects model according to the DerSimonian and Laird method. Pooled Odds Ratios (ORs) with corresponding 95% Confidence Intervals (CIs) were calculated for the primary outcome. Statistical heterogeneity among studies was assessed using Cochran's Q test and quantified with the I^2 statistic, with I^2 values greater than 50% indicating substantial heterogeneity. All statistical analyses were planned and conducted using R software (metafor package).

Results

Study selection and characteristics

The initial literature search yielded a large number of records. After removal of duplicates and screening of titles and abstracts, a total of nine studies enrolling 1,954 patients met the inclusion criteria and were included in the quantitative analysis; re-intervention data for the primary outcome were available for 1,830 patients (916 hybrid; 914 standard). The study selection process is illustrated in the PRISMA flow diagram (Figure 1). The main methodological and clinical characteristics of the included studies are summarized in Table 1.

Risk of bias

Risk of bias was independently assessed for all included studies. Most of the included randomized controlled trials had a low to moderate risk of bias, whereas observational studies were generally judged to be at moderate risk due to their non-randomized design.[15,16]

Primary outcomes

The primary outcome, defined as the need for re-intervention for residual or recurrent varicose veins, was reported in all included studies. The pooled meta-analysis of the nine studies demonstrated a significant reduction in re-intervention rates in favor of the hybrid treatment approach, with a combined OR of 0.15 (95% CI: 0.04-0.62; $p=0.009$, $I^2=93\%$). The forest plot illustrating the pooled results is shown in Figure 2. Detailed numerical data for the primary outcome are reported in Table 2.

In one study,[17] denominators for the primary outcome were lower than the total enrolled population due to incomplete follow-up data.

Secondary outcomes

Several studies reported outcomes related to quality of life and clinical severity, assessed using validated instruments such as the Aberdeen Varicose Vein Questionnaire (AVVQ) and the Venous Clinical Severity Score (VCSS). Overall, a faster and more pronounced improvement in both QoL and VCSS was observed in patients treated with the hybrid approach during the early post-procedural period. The meta-analysis by Aherne *et al.* demonstrated significantly lower overall VCSS values in the concomitant treatment group.[13] Post-procedural complications, including hematoma formation and pain, were generally uncommon and similarly distributed between treatment groups, with no clinically relevant differences reported.

Discussion

Key findings

This updated systematic review and meta-analysis demonstrates, that a hybrid and simultaneous approach is superior to isolated saphenous trunk ablation in reducing the need for re-intervention due to residual or recurrent varicose veins. The benefit of the hybrid strategy is supported by a statistically and clinically significant reduction in re-intervention rates, as reflected by the pooled odds ratio favoring concomitant treatment. These findings reinforce and extend previous quantitative syntheses, while incorporating more recent randomized evidence and observational data.[13,16-24]

Relationship to previous studies

Current international guidelines, including those from the European Society for Vascular Surgery,[25] recommend endovenous ablation as first-line treatment for saphenous vein insufficiency, but do not provide strong or specific recommendations regarding the timing of adjunctive treatment of tributary varicose veins. In this context, the findings of the present analysis support the concept that a concomitant approach may offer advantages in terms of reducing early re-intervention rates and accelerating clinical improvement, while maintaining a comparable safety profile. The present results are fully concordant with the landmark meta-analysis by Aherne *et al*., which first demonstrated a significant reduction in re-intervention rates when tributary veins were treated concomitantly with saphenous ablation.[13] By expanding the evidence base with additional randomized trials and prospective cohort studies, the current analysis strengthens the concept that incomplete treatment of the pathological venous reservoir is a major determinant of early clinical failure and subsequent retreatment.[13,16-19,24]

Randomized controlled trials have consistently shown that the advantage of the hybrid strategy is most evident in the early post-procedural phase. The AVULS trial demonstrated significantly better symptom relief and quality-of-life scores within the first weeks following synchronized treatment compared with staged management, without an increase in major complications.[18] These findings have been confirmed by mechanochemical ablation studies, in which concomitant treatment of tributaries resulted in faster improvement in VCSS and reduced need for additional procedures.[16,19]

Long-term follow-up studies provide important perspective. While early benefits favor the hybrid approach, differences in quality of life and clinical severity tend to attenuate over time once patients in the staged groups undergo delayed tributary treatment. Five-year data from randomized cohorts show convergence of outcomes, indicating that the principal value of the one-stop strategy lies in accelerating symptom resolution and minimizing the total number of procedures rather than altering ultimate long-term results.[17,20]

More recent randomized evidence confirms that concomitant treatment markedly reduces early retreatment rates and improves short-term clinical scores, while maintaining a favorable safety profile.[24] Collectively, these data support the hybrid approach as the most efficient strategy for achieving rapid and durable clinical improvement. Overall, the safety of the hybrid approach is well supported by the available literature. Most randomized and prospective studies report low and comparable rates of peri-procedural complications between hybrid and staged strategies. Meta-analytic data do not demonstrate an increased risk of deep vein thrombosis or major adverse events associated with concomitant treatment.[13,18-20]

However, safety findings are not entirely uniform. Hicks *et al.* reported a higher incidence of endovenous heat-induced thrombosis following radiofrequency ablation when concomitant

phlebectomy was performed, identifying simultaneous phlebectomy as an independent risk factor.[21] Importantly, the absolute event rate remained low, and events were generally manageable with surveillance and conservative management. These data do not contraindicate hybrid treatment but emphasize the need for careful technique, appropriate patient selection, and routine duplex follow-up.

Pre-operative hemodynamic assessment and limits of CEAP classification

A central issue emerging from this analysis is the inadequacy of relying solely on CEAP classification to guide treatment strategy. Although CEAP remains essential for clinical staging, it does not capture the complexity of venous hemodynamics, particularly the contribution of individual tributaries, perforators, and junctional anatomy.[25-27]

Several studies have demonstrated that a proportion of tributary varicosities may regress or become clinically silent after isolated truncal ablation. Dexter *et al.* reported spontaneous regression of untreated tributaries in a substantial number of patients following EVLA.[11] Similar findings were observed in earlier series evaluating isolated radiofrequency ablation, where approximately two-thirds of patients avoided secondary phlebectomy.[23]

Conversely, registry-based and prospective data indicate that concomitant treatment provides superior early outcomes even in patients with less advanced disease. Analysis of the VQI registry showed significantly greater early improvement in VCSS and quality-of-life scores in patients undergoing concomitant phlebectomy, without a relevant increase in complications.[24] These apparently divergent findings highlight the importance of individualized decision-making based on detailed duplex ultrasound assessment rather than CEAP class alone.

Significance of study findings and what this study adds to our knowledge

This study further consolidates the evidence supporting a "one-stop" strategy and suggests that the hybrid approach should be considered the preferred option in appropriately selected patients. Its significance extends beyond procedural efficacy, translating into a faster treatment pathway, improved patient satisfaction, and potential optimization of healthcare resources. The inclusion of recent studies adds further robustness and contemporaneity to the conclusions and may influence future guideline recommendations and everyday clinical practice.

Strengths of the study

Several studies provide valuable insights into alternative hybrid and conservative strategies. Gianesini *et al.* proposed a laser-assisted approach integrated into a modified CHIVA strategy, combining selective saphenous ablation with targeted treatment of incompetent tributaries while preserving large segments of the saphenous vein. Durable reflux control and significant clinical improvement were achieved, supporting a physiology-driven hybrid concept.[28]

Innovative techniques such as sclerofoam-assisted laser therapy further illustrate the potential of hybrid approaches to reduce invasiveness while maintaining efficacy.[29] These strategies aim to optimize hemodynamic correction and patient comfort, challenging the paradigm of complete saphenous destruction in all cases.

The role of the saphenofemoral junction has also been critically re-evaluated. Contemporary reviews suggest that durable clinical outcomes can be achieved without routine surgical ligation of the junction, potentially reducing neovascularization and recurrence.[30] Ethical and conceptual arguments in favor of saphenous vein preservation further support a tailored approach that balances efficacy with anatomical conservation.[31,32]

The main strengths of this study include adherence to a rigorous methodological framework (PRISMA), inclusion of a substantial number of comparative studies including randomized controlled trials, and incorporation of the most recent available evidence. In some analyses, the relatively low statistical heterogeneity for the primary outcome increases confidence in the pooled estimates.

Limitations of the study

Nevertheless, several limitations must be acknowledged. Clinical heterogeneity among included studies persists, particularly regarding the specific techniques employed and follow-up duration, which ranged from medium- to long-term (1-5 years or longer). A moderate RoB in some observational studies may have influenced effect size estimates. In addition, the lack of complete blinding in many trials may have introduced assessment bias. The OR reported in the study by Rahman *et al.* did not reach statistical significance, underscoring the need for larger, adequately powered trials.

A further important limitation of the available literature, and consequently of the present meta-analysis, is the lack of standardized reporting of pre-operative hemodynamic assessment. Many studies provide insufficient detail on ostial incompetence patterns, saphenofemoral junction morphology, or deep venous system status, all of which may substantially influence clinical outcomes. This heterogeneity limits the feasibility of subgroup analyses based on hemodynamic parameters and highlights the need for future studies to systematically integrate these aspects into study design and reporting.[27-32]

Future studies and prospects

Future research should focus on: long-term follow-up exceeding 5-10 years to confirm the durability of hybrid treatment benefits; randomized controlled trials directly comparing different hybrid techniques (e.g., phlebectomy versus foam sclerotherapy) and mechanochemical versus thermal ablation strategies; robust cost-effectiveness analyses; and predefined subgroup analyses, including patients with below-knee varicosities or different CEAP stages.

Conclusions

Based on the best currently available evidence, hybrid treatment consisting of saphenous trunk ablation combined with concomitant treatment of tributary varicose veins could be considered a preferred strategy in appropriately selected patients with great saphenous vein insufficiency and significant tributary varicosities. This strategy might reduce the likelihood of re-intervention and provides faster improvement in both quality of life and clinical severity compared with isolated truncal ablation.

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Availability of data and materials: all data generated or analyzed during this study are included in this published article.

Table 1. Characteristics of the included studies.

The table summarizes the main methodological and clinical characteristics of the comparative studies evaluating hybrid strategies (thermal ablation plus adjunctive treatment) versus standard procedures. For each study, the study design, total number of enrolled patients, type of intervention performed in the hybrid and standard groups, duration of follow-up, and re-intervention rates observed in the respective treatment arms are reported.

Author (year)	Design	Total enrolled (N)	Hybrid treatment	Standard treatment	Follow-up (months)	Reoperation hybrid	Reoperation standard
Mohamed (2019)	Prospective	83	MOCA + Phlebectomy	MOCA alone	12	2/50 (4.0%)	4/33 (12.1%)
Wang (2018)	Prospective	542	EVLA + UGFS	EVLA alone	12	8/163 (4.9%)	52/255 (20.4%)
Lane (2015)	RCT	101	RFA + Phlebectomy	EVLA alone	6	1/51 (2.0%)	18/50 (36.0%)
El-Sheikha (2014)	RCT	49	EVLA + Phlebectomy	EVLA alone	24	1/25 (4.0%)	16/24 (66.7%)
Harlander-Locke (2013)	Retrospective	507	RFA + Phlebectomy	RFA alone	36	19/355 (5.4%)	126/152 (82.9%)
Kim (2009)	Retrospective	265	EVLA + Phlebectomy	EVLA alone	37	12/132 (9.1%)	11/133 (8.3%)
Theivacumar (2008)	RCT	68	EVLA + Phlebectomy	EVLA alone	12	8/22 (36.4%)	18/46 (39.1%)
Welch (2006)	Retrospective	254	EVLA	EVLA alone	12	0/77 (0.0%)	59/177 (33.3%)
Rahman (2025)	RCT	85	MOCA + Phlebectomy	MOCA alone	36	2/41 (4.9%)	5/44 (11.4%)

MOCA, Mechanochemical Ablation; EVLA, Endovenous Laser Ablation; RFA, Radiofrequency Ablation

Table 2. Summary of primary outcomes (re-intervention) by study.

The table reports, for each included study, the number of re-intervention events in the hybrid and standard groups, the total number of treated patients, and the effect measure expressed as Odds Ratio (OR) with the corresponding 95% confidence interval. The last row shows the overall pooled effect obtained by combining the results of the nine analyzed studies.

The analyzed patients were 1,830 (hybrid 916; standard 914).

Author (year)	Hybrid events/total	Standard events/total	Effect measure (95% CI)
Mohamed (2019)	2/50	4/33	OR 0.3 [0.05-1.75]
Wang (2018)	8/163	52/255	OR 0.2 [0.09-0.44]
Lane (2015)	1/51	18/50	OR 0.04 [0.01-0.28]
El-Sheikha (2014)	1/25	16/24	OR 0.02 [0.01-0.18]
Harlander-Locke (2013)	19/355	126/152	OR 0.01 [0.01-0.02]
Kim (2009)	12/132	11/133	OR 1.11 [0.47-2.61]
Theivacumar (2008)	8/22	18/46	OR 0.89 [0.31-2.54]
Welch (2006)	0/7	59/177	OR 0.13 [0.01-2.36]
Rahman (2025)	2/41	5/44	OR 0.40 [0.07-2.19]
Pooled (random effects)	53/916	309/914	OR 0.15 [0.04-0.62]

CI, Confidence Interval

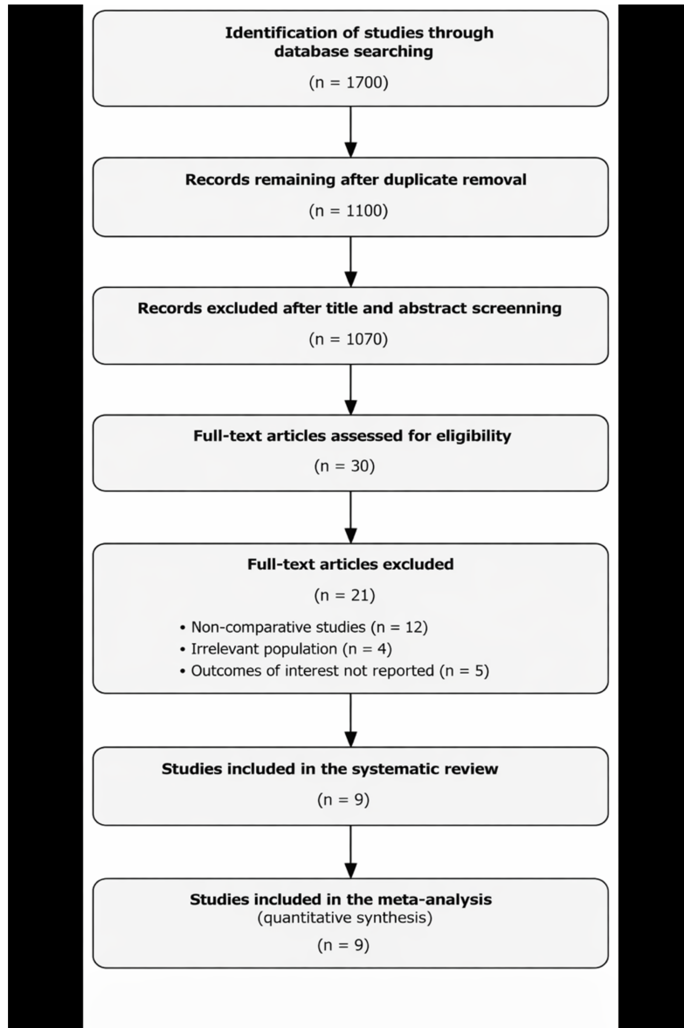

Figure 1. PRISMA flow diagram.

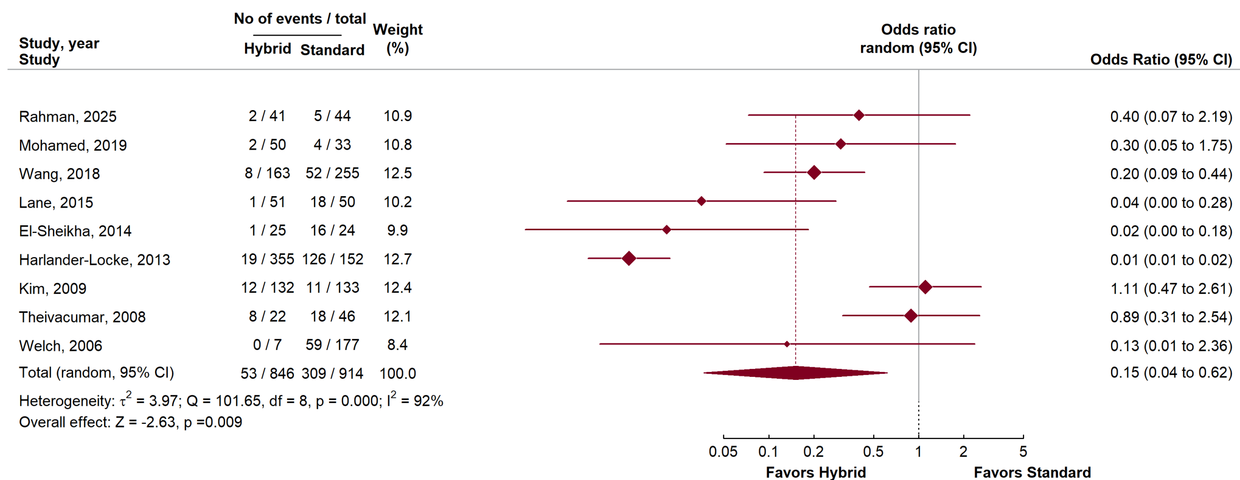

Figure 2. Primary outcome forest plot.

Online supplementary material.

Appendix 1. *Detailed search strategy.*

Supplementary Table 1. *PRISMA 2020 checklist.*

Supplementary Table 2. *Risk of bias assessment – randomized controlled trials (RoB 2).*

Supplementary Table 3. *Risk of bias assessment – observational studies (ROBINS-I).*

Supplementary Figure 1. *Funnel plot for publication bias.*