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A comparative evaluation of radiofrequency ablation and conventional surgery in management of varicose veins

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Abstract
Varicose veins have been the commonest venous problem among adults and surgery is the gold standard in treatment of Chronic Venous Insufficiency leading to varicose veins. We compares two treatment modalities conventional surgery with Radio Frequency Ablation in the treatment of varicose veins using physical, clinical and radiologic imaging. This was a single institute based prospective cohort study. It was reported that 100 patients in total were assessed in the study, out of which, 40 were non-randomized, and 60 underwent the intervention as a daily procedure. 30 patients (Group R) underwent RFA, and 30 patients (Group C) had conventional surgery. Postoperative follow-up at one week and at three months was done clinically and using Doppler ultrasound to look for any complication or the recanalization of vein. Follow-up ultrasound revealed 98.3% reflux-free in the RFA group and 92.7% in the conventional surgery group, with RFA patients returning to normal activities in 1 days compared to 7 days for conventional surgery group patients. RFA is a preferred alternative for treating superficial and perforator venous reflux disease, outperforming conventional surgery in terms of morbidity and in terms of early ambulation, early return to work, less intense post-operative pain, quick recovery, and few complications.

Keywords: Varicose veins, Radio frequency ablation (RFA), sapheno femoral junction (SFJ) Great Saphenous Vein (GSV)

Introduction
The term “Varicose” is derived from the Latin “Varix” (pleural “Varices”) which in turn possibly derived from ‘varus’ meaning bent. The definition of varicose veins varies widely ranging from “clearly visible, dilated, tortuous and possibly prominent subcutaneous veins of lower extremities” according to Arnoldi, to “dilated veins secondary to loss of valvular efficiency” according to Dodd and Cockett, “Vein with a saccular dilatation which is often tortuous” according to WHO [1].

Varicose veins are tortuous, twisted blood vessels that appear blue or purple and typically develop in the lower body. The condition can occur anywhere in the body where there is poor venous return; however, they are most often associated with the lower limb. In varicose veins surgery remains the preferred method due to its ability to achieve both satisfactory aesthetic results and fewer complications or recurrence rates [2]. Studies show higher varicose vein incidence in women, suggesting a role for sex hormones, but more research is needed on venous tissue function and vasoreactive responses [3].

Genetic factors significantly contribute to varicose vein development, but specific factors are unknown due to the influence of various factors, including heredity, weight, and lifestyle (58) Genes Associated with Varicose Veins includes Desmuslin, Thrombomodulin, FOXC2 gene, HFE gene, PIEZO1 gene, TGFB2 gene, PROX1 gene, Notch3 a mutation in this gene and Klippel-Trenaunay Syndrome Chuvash polycythemia are associated with varicose veins [4, 5].

The venous obstruction, venous reflux, calf muscle pump dysfunction or combination of these, are the cause for the signs and symptoms of Chronic Venous Insufficiency (CVI). Reflux is the principle cause in most cases. CVI may be primary or secondary. The primary CVI has no obvious etiological mechanism of valvular dysfunction, it develops from the loss of elasticity in the vein valve. Secondary CVI is due to valvular incompetence and there is an obvious antecedent event, most frequently a deep vein thrombosis.

Venous hypertension is caused by ambulatory venous pressure (AVP). With AVP below 40 mm of Hg patients have minimal incidence of venous obstruction. Venous recovery time (VRT) has also been used as the indicator of valve dysfunction. With contraction of muscle pump, the veins again empty and reduce the venous pressure [6].

The conventional surgical method for managing varicose veins in the lower legs involves procedures such as high ligation trendelenburg's operation and Perforator ligation. The primary goal is to resolve the issue of refluxing veins while also alleviating related symptoms. In these treatments, the great saphenous vein may be tied near its intersection with the femoral vein; alternatively, perforating veins are identified through reflected fascia and manually knotted using an absorbable suture material. However, this area being tied off can lead to adverse wound healing outcomes coupled with significant scarring which then leads ankle mobility reduction incidence a raised issue from undergoing surgeries like these before [7].

Newer minimally invasive techniques have been developed for treating varicose veins, including RFA, Transilluminated Power Phlebectomy (TIPP), Foam Sclerotherapy and Endovenous laser Ablation (EVLA). Among these options, patients worldwide have largely accepted RFA due to its reduced invasiveness [8].

In RFA patients experience less post-operative pain and require a shorter stay compared to conventional surgery [9]. Other Complications like wound infection, bruising, phlebitis, skin necrosis was significantly lower for RFA compared with conventional surgery. However, there is paucity of studies which compare the outcome of the RFA and Conventional surgery, thus we have planned this study.

Aim and Objectives

- To compare the clinical outcome between the conventional surgery and RFA patients at the end of three months.
- To compare the hospital stay and complications among the conventional surgery and RFA.
- To assess & compare the obliteration of the superficial venous systems following conventional surgery and RFA at the end of three months.

Materials and Methods

Sixty patients with varicose veins will be randomly allocated to two groups: RFA Group “R” (N=30) and conventional surgery Group “C” (N=30). Group R consisted of 20 males; 10 females, Group C consisted of 15 males and 15 females. Detailed patient histories was recorded. Color Doppler ultrasound assessed venous abnormalities, and pre-and postoperative results compared. All patients received treatment based on standard guidelines. Patients randomly selected for conventional surgery and RFA after anesthesia clearance. Postoperative complications and recovery monitored, with follow-ups at one week and three months. Institutional Ethics Committee clearance not required & a written Informed consent taken from the participants for conducting the study from every patient before inclusion in the study. The conventional surgical method for managing varicose veins in the lower legs involves procedures such as high ligation trendelenburg's operation and Perforator ligation. The primary goal was to resolve the issue of refluxing veins while also alleviating related symptoms. In these treatments, the great saphenous vein tied near its intersection with the femoral vein; alternatively, perforating veins are identified through reflected fascia and manually knotted using an absorbable suture material. However, this area being tied off can lead to adverse wound healing outcomes coupled with significant scarring which then leads ankle mobility reduction incidence a raised issue from undergoing surgeries like these before.

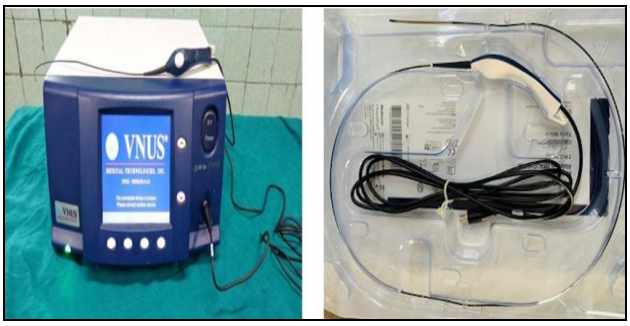

Fig 1: RFA Machine with RFA Fiber Probe

Radiofrequency Ablation is a type of minimally invasive technique for treating varicose veins. Access to the refluxing superficial vein is obtained with a 16 or 18 F needle at the lowest point of its incompetence. The radiofrequency ablation catheter is then advanced and placed at least 2 cm distal to the sapheno-femoral junction through a small incision. Once the catheter is in place, an anesthetic solution is injected around the vein along the entire course of the vein. The RFA fiber has a special design with a 7 cm long active tip through which RFA energy is emitted. Along with this 7 cm segment, the vein wall is heated, treating the varicose veins. The RF generator is active for 20 seconds for each 7 cm segment of the vein, raising the temperature of the veins up to 120 degrees, making the process quick and simple.

Funding Declaration

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Results

In the newer era, endovenous radio frequency ablation (RFA) has emerged as the preferred treatment option for superficial and perforator venous reflux disease. RFA surpasses traditional vein stripping and perforator interruption in terms of morbidity and outcomes. Moreover, it significantly reduces the formation of neovascularization, which is often cited as a contributing factor to the higher recurrence rates associated with vein stripping.

This disease affects mostly lower socioeconomic classes and those who stand for prolonged periods. Farmers forms the largest proportion around 31.66%. Manual laborer forms 25%, Housewives accounts for 8.34% and 3.33% students were affected from varicose veins with p-value < 0.0001 (highly significant). In study, sapheno-femoral incompetence accounts for most of the pathology, comprising 80% of the cases. Sapheno-popliteal incompetence is relatively uncommon, affecting only 13.33% of the patients. Below-knee perforator incompetence is more prevalent, occurring in 73.33%, while above-knee perforator incompetence affects 60%.

At the time of presentation, almost all patients complained of prominent varicose veins. Notably, 91.60% of patients presented with isolated varicose veins. Other symptoms commonly associated with varicose veins include pain, pigmentation, Edema, and ulceration. Here Mean square is 2.81, Standard Deviation (σ) is 1.06 and P value < 0.0001 (Highly significant).

Table 1: Post-operative complications

Compilation	Radiofrequency	Conventional Surgery
Bleeding	0	8
Limb Edema:	0	5
Infection:	0	2
Saphenous Neuralgia (0 to 4)	4	2
Paraesthesia	3	6
Skin Changes	2	4
Burning sensation	2	2
Bruising	1	3
Pain scoring (0 to 4)*	1	2
Recurrence	1	3
Mean	1.4	3.7
Standard Deviation (σ)	1.25	1.82
P-Value	0.0039 (significant)	

*Pain scoring (0-none, 1-Mild, 2-moderate, 3-Severe, 4-very severe)

In this study hematoma was the most prevalent post-operative complication observed in 27% of patients undergoing conventional surgery, compared to 0% in patients undergoing radiofrequency ablation (RFA).

Of the patients treated with RFA, 86.67% remained in the hospital for a mean duration of 1-2 days. In contrast, 66.67% of patients treated with conventional surgical procedures remained in the hospital for approximately 5-6 days, while 10% of patients required a hospital stay exceeding 10 days. The duration of hospital stays for patients treated with RFA ranged from 1 to 14 days, while the duration of hospital stays for patients treated with conventional surgical procedures ranged from 1 to 14 days.

Table 2: Outcome & analysis of clinical class at presentation vs follow up

Clinical	Score	AT Presentation		After Surgery			
				(1 Week)		(3 Months)	
		Group R	Group C	Group R	Group C	Group R	Group C
No visible signs	C0	-	-	10	8	29	27
Telangiectasia	C1	-	-	-	-	-	-
Varicose veins	C2	27	28	-	2	1	3
Edema	C3	9	8	10	8	-	-
Eczema	C4a	8	7	4	7	-	1
Lipodermatosclerosis	C4b	4	4	4	4	1	1
Healed venous ulcer	C5	-	-	2	-	-	-
Active venous ulcer	C6	2	1	-	1	-	-
Mean		2.86	2.75	2.47	2.67	0.21	0.45
SD(σ)		1.04	1.00	1.66	1.48	0.63	0.92
P-Value		0.63		0.51		0.29	

Group R-Radiofrequency Ablation Treated Patients
Group C-Conventional Surgery Treated Patients

Fig 2: At Presentation (a) and Post-Op Day 7 of RFA (b)

Table 3: Follow up analysis in RFA v/s conventional surgery

Outcome	RFA		Conventional Surgery	
	Patients	Percentage (%)	Patients	Percentage (%)
Recurrence	1	1.6%	3	5%
Recanalization	1	1.6%	2	3.33%
Neovascularization	1	1.6%	3	5%
Technical Failure	2	3.33%	0	0%
Mean	1.25		2.0	
SD	0.43		1.22	
P-Value	0.022 (Significant)			

Table 4: Demographic and baseline characteristics of patients

Characteristic	RFA Group (N=30)	Conventional Surgery Group (N=30)	Total (N=60)
Age (years)	20-70 (majority 20-40)	20-70 (majority 20-40)	20-70 (51.67% in 20-40)
Sex, n (%)	Male 20 (66.7%) Female 10 (33.3%)	Male 15 (50%) Female 15 (50%)	Male 35 (58.3%) Female 25 (41.7%)
Occupation, n (%)	Farmers 10 (33.3%) Laborers 7 (23.3%) Housewives 2 (6.7%) Students 1 (3.3%) Others 10 (33.3%)	Farmers 9 (30%) Laborers 8 (26.7%) Housewives 3 (10%) Students 1 (3.3%) Others 9 (30%)	Farmers 19 (31.6%) Laborers 15 (25%) Housewives 5 (8.3%) Students 2 (3.3%) Others 19 (31.6%)
Presenting symptom	Prominent veins, pain, edema, pigmentation	Prominent veins, pain, edema, pigmentation	Prominent veins 55 (91.6%)
Venous incompetence, N (%)	SFJ 24 (80%) SPJ 4 (13.3%) Below-knee perforators 22 (73.3%) Above-knee perforators 18 (60%)	SFJ 24 (80%) SPJ 4 (13.3%) Below-knee perforators 22 (73.3%) Above-knee perforators 18 (60%)	Same as group-wise (overall pathology distribution)

Comparison of perioperative and postoperative outcomes between Radiofrequency Ablation (RFA) and conventional surgery. The operative duration, postoperative pain intensity (measured by Visual Analogue Scale, VAS), requirement for analgesia, functional recovery (time to normal activity and return to work), and corresponding statistical measures. RFA was associated with significantly shorter operative time, reduced pain, faster recovery, and earlier return to work compared with conventional surgery. Statistical analysis demonstrates a significantly lower mean recovery period in the RFA group (P=0.023), highlighting the clinical advantage of minimally invasive management.

Discussion

The study on varicose veins analyzed various aspects including age, sex, occupation, limb involvement, clinical presentation, and treatment outcomes. The age range of patients was between 20 to 70 years, with the majority (51.67%) falling within the 20-40 years age group. This aligns with other studies that indicate a higher prevalence of varicose veins during active adult life. Males were predominantly affected, making up 78.33% of the study population, a trend consistent with multiple referenced studies. Occupational factors played a significant role, as 80% of patients had jobs requiring prolonged standing, such as farmers, manual laborers, and teachers, suggesting that standing for long periods is a major contributory factor.

In terms of limb involvement, the right leg was slightly more commonly affected (32 cases), followed by the left leg (21 cases), with both legs involved in 7 cases. While the exact reason for this right-side predominance is not clear, anatomical differences may play a role. The great saphenous vein was the most frequently involved (96.67%), followed closely by perforator veins (93.33%). Most patients (86.67%) had combined saphenofemoral and perforator vein involvement, while the short saphenous vein was affected in only 10% of cases. Isolated incompetence of the perforators and great saphenous vein was also common, observed in 70% and 80% of patients respectively.

Clinically, the most common presenting symptom was prominent, visible veins (91.6%), often accompanied by pain, edema, eczema, pigmentation, or ulceration. Edema was noted in 28.33% of the patients. Pathologically, 93.33% of patients showed multiple perforator incompetence, particularly below the knee (73.33%) and above the knee (60%). Post-operative complications were more frequent in the conventional surgery group, with hematoma being the most common (27%). Saphenous neuralgia was observed more in RFA patients (13.33%) compared to conventional surgery (7%).

Hospital stay was significantly shorter for patients undergoing radiofrequency ablation (RFA), with 86.67% discharged within 1-2 days. In contrast, conventional surgery patients often required a stay of 5-6 days, and 10% stayed longer than 10 days. Analgesic requirements were also lower in RFA patients; only 20% needed pain relief, while all patients in the conventional group required oral analgesics and 60% needed injectable ones. Recovery was faster with RFA, with most patients resuming normal activities within a day, compared to an average of seven days for conventional surgery. RFA was also a quicker procedure (15-20 minutes) compared to conventional surgery (60-90 minutes).

Finally, the recurrence rate was significantly lower in the RFA group (3.33%) compared to the conventional surgery group (10%), indicating a more durable outcome with RFA. These findings, consistent with other literature, suggest that RFA offers several advantages over conventional surgery, including fewer complications, faster recovery, reduced hospital stay, less pain, and lower recurrence rates [10-12].

Conclusion

RFA is a preferred alternative for treating superficial and

perforator venous reflux disease, outperforming conventional surgery in terms of morbidity and outcomes. RFA reduces the formation of neovascularization, which is often responsible for higher recurrence rates seen with vein stripping. Both RFA and conventional surgery achieve similar short-term obliteration of the superficial venous system, but RFA shows better clinical improvement as measured by the CEAP class. Complications are significantly lower with RFA, and it is less morbid than surgery. Patients undergoing RFA have shorter hospital stays, return to work earlier, and experience less postoperative pain compared to those undergoing conventional surgery.

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