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Original Article

Efficacy of Mechanical Thrombectomy in Preventing Post-Thrombotic Syndrome in Acute DVT: A Retrospective Study

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Abstract

Background Lower limb deep vein thrombosis (DVT) is associated with significant morbidity and death. DVT can result in complications such as postphlebitic syndrome, pulmonary embolism, and death. Combining pretest probability, D-dimer testing, and compression ultrasound imaging enables a safe and convenient study of suspected lower-extremity thrombosis. This study aimed to assess the expanding body of research supporting thrombectomy as a form of DVT therapy.

Methods A retrospective study was performed on individuals with venous Doppler-confirmed DVT and occlusive thrombus. Four-hundred fifty-one consecutive patients were selected for the study based on the inclusion and exclusion criteria. In this investigation, thrombectomy was the preferred therapeutic approach.

Results The study reports a male predominance of 56.1%. Most patients (25.7%) were between the age of 51 and 60, with 84.7% reporting pain and lower-extremity swelling as the two most common clinical symptoms. The femoral vein was noted as the most frequent site of thrombus in the current research (51.0%), with acute DVT accounting for most cases (85.1%). Most of the patients (97.3%) were primarily asymptomatic after one year of follow-up.

Conclusion Thrombectomy is a reliable treatment modality for DVT patients in regaining venous patency, preventing DVT recurrence, treating post-thrombotic syndrome, and preventing pulmonary embolism.

Keywords

- deep vein thrombosis
- pulmonary embolism
- post-thrombotic syndrome
- thrombectomy

Introduction

Deep venous thrombosis (DVT) is a public health issue that places a heavy clinical and financial burden on the healthcare system.[1] DVT is a blood clot that prevents blood flow in the deep venous system and often occurs in the lower extremities but may occasionally develop in the splanchnic veins, cerebral veins, or in the upper extremities.[2] Each year, there are over 59,000 new occurrences of DVT in the United Kingdom alone,[3] and venous thromboembolism (VTE) kills more people than breast cancer, acquired immunodeficiency syndrome, and car accidents combined. Pulmonary embolism (PE) is a potentially fatal consequence, which can be seen in 10 to 25% of patients with DVT.[4] A few researches have been done in this field, and the frequency of DVT is underappreciated in India. Most of the material is from

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orthopaedic departments, even though the prevalence of DVT in India's general population is unclear.[5] A Scandinavian randomized controlled trial found that patients randomly assigned to open thrombectomy had improved patency, lower venous pressures, less edema, and fewer post-thrombotic symptoms at 10 years' follow-up than those who were only given anticoagulation. This suggests that early clot removal is beneficial.[3]

Anticoagulation therapy reduces the likelihood of recurrence, stops the spread of the thrombus, and avoids complications, including PE. Anticoagulation does not entirely prevent the development of new thrombi and has no direct lytic impact.[6] Early lysis or thrombectomy is a promising alternative for treating DVT because it may reduce post-thrombotic syndrome (PTS) and recurrent venous ulcers.[3] As possible treatments, systemic and catheter-directed thrombolysis (CDT) have been proposed to increase venous patency. Percutaneous mechanical thrombectomy (PMT) is an alternative to surgical thrombectomy by providing an endovenous solution for aggressive thrombus removal and reducing the morbidity of CDT by decreasing the dosage of thrombolytic drugs.[1]

In patients with significant proximal DVT, mechanical thrombectomy is a new treatment that may help lower the likelihood of PE or the incidence of the postphlebitic leg by manually reducing the thrombus load.[7] Venous thrombectomy performed by contemporary vascular surgeons is linked with little to no PE, no operative mortality, and a significant decrease in the early and late sequelae of iliofemoral venous thrombosis.[8]

PMT is a successful therapy for acute DVT in the upper and lower extremities to restore venous patency. A rising body of research supporting the potential benefits of early thrombus removal has sparked the development of innovative products and procedures aiming at safe and effective methods for fast patency restoration by thrombus extraction without the bleeding concerns associated with thrombolysis.[9] There are several techniques, and the newly arriving data have not undergone thorough scrutiny. This study aimed to assess the expanding body of research supporting thrombectomy as a form of DVT therapy.

Materials and Methods

A retrospective observational study was conducted in the department of plastic and microvascular surgery at a tertiary care hospital from January 2017 to April 2022. The study was conducted in 451 consecutive patients with venous Doppler-confirmed DVT and occlusive thrombus.

Inclusion Criteria

Patients aged between 10 and 90 years of both sexes, blue leg syndrome, and DVT of the popliteal, femoral, common femoral, external iliac, common iliac veins, and inferior vena cava were included in the study.

Exclusion Criteria

Patients with proximal DVT that extends up to the right atrium, DVT distal to the popliteal vein, proximal DVT that extends over the level of the hepatic vein, and PE were excluded. Also, the study did not include patients who were classified under American Society of Anesthesiologists class IV or above and DVT, which was not confirmed by venous Doppler ultrasonography.

Surgical Technique Utilizing Thrombectomy

The study was conducted after receiving informed consent from the patients. The participants included in the study were administered spinal anesthesia under aseptic conditions. Demographic details of the patients were recorded. Patient history, physical examination, and Doppler ultrasonography were all used to diagnose and confirm DVT in all patients. Parts of the patient were painted and draped while they were lying supine. A longitudinal incision is created across the groin. After identifying the great saphenous vein, it was traced to the common femoral vein, and intermediary branching veins were clipped. After investigating the thrombosed common femoral vein, control was obtained proximally and distally. The thrombus was removed during venotomy. A suction catheter was used for the proximal removal of the clots. After establishing proximal control, irrigation was performed distally to remove the thrombi from the superficial femoral vein. The limit of proximal clearance in the lower limb was the length of the suction catheter (Romson's Suction Catheter TC GS-2030 Fr 12/14/16). We employed suction catheters rather than Fogartys' for the removal of the thrombi. The return blood flow was then evaluated. The venotomy was stitched up with a 5'0 Prolene suture, and layers were used to close the wound. Parenteral Fondaparinux/low molecular weight heparin was administered immediately after surgery and until discharge which was usually on post-op day 3 along with Aspirin 75mg. Upon discharge, Fondaparinux/low molecular weight heparin was switched with nonvitamin K oral anticoagulants (NOACs), for instance, Rivaroxaban 10 mg once a day in addition to aspirin for a period of 6 months.

Statistical Analysis

Data collected from the study were represented as frequency and percentage using the tabular form. The Pearson chi-squared test was used to compare categorical variables. Two tailored tests were used to determine the significance. A *p*-value of less than 0.05 was considered significant. Data were analyzed using IBM-SPSS version 21.0 (IBM-SPSS Science Inc., Chicago, Illinois, United States).

Results

This research included 451 individuals with DVT. Most patients (25.7%) were between the ages of 51 and 60, with a male preponderance (56.1%). The most prevalent clinical signs were pain and swelling, reported by 84.7% of patients. Also, 56.3% of patients presented within 5 days of onset of symptoms, while 34.1% presented after 11 days. About 8.6% of patients had coronary artery disease, and 74.1% of the patients had no comorbidities that were related to DVT. ►**Supplemental Table S1** (online only) provides an overview

of the demographic distribution and clinical presentation in the cohort.

Almost three out of every four patients (334) had unprovoked DVT in our study. While 23 patients (5.1%) underwent recent surgery involving immobilization greater than 72 hours, 20 patients had a prior DVT/ PE. Only 1.6% of the patients had inherited thrombophilias. The predisposing factors and comorbidities in the patient population are further discussed in ►**Supplemental Table S1** (online only). About 94.5% of patients had elevated D-dimer levels. Most cases had acute DVT (85.1%), 1.1% had chronic, and 13.7% reported subacute DVT. The femoral vein was the commonest thrombus location in this study (51.0%), followed by the proximal DVT (27.5%), while 6.9% had it in the popliteal vein. The appearance of thrombus was mainly hypoechoic in most patients (86.3%) and anechoic in 5.3% of the cohort. About 96.9% of patients had complete occlusion. ►**Supplemental Table S2** (online only) portrays the various diagnostic findings in the patients.

The Outcome of the Study

Two patients (0.4%) had major bleeding during the procedure, and four (0.9%) had PE. Residual thrombus was visualized in 6.4% of patients' postsurgery. Complete recanalization was seen in 93.8% of patients, and 6.2% had partial recanalization. The thrombosed vein was identified during the procedure in nearly all of the patients. ►**Supplemental Table S3** (online only) delves into the outcomes of the thrombectomy seen in the patient cohort.

After 1 year of follow-up, patients were mostly asymptomatic (439 patients (97.3%)). After 3 years of follow-up, 346 (76.7%) patients remained asymptomatic, while 71 (15.7%) developed varicose veins. Seventy-four (16.4%) patients presented to the hospital after several weeks of having signs and symptoms, for instance, varicose veins. Most patients, 430 (95.3%), did not develop any comorbidities after the procedure. After 3 years of follow-up, a recanalized deep vein was observed during Doppler ultrasonography in 319 (70.7%) patients. ►**Table 1** provided a comprehensive overview of the findings during the follow-up period. Seventeen patients were lost to follow-up (3.8% of the study population). ►**Table 2** illustrates the venous Doppler findings during the course of the 3-year follow-up period of the study.

All of the four patients who had PE survived were being regularly revisited for follow-up. Computed tomography pulmonary angiography was employed, if there was a high pretest probability of a PE was high. Two-tier Well's score and D-dimer were used to assess the pretest probability. A positive D-dimer and/or a Well's score more than 4, prompted further evaluation to discover a potential PE. Postoperative residual thrombi were observed during follow-up in 34.5% of the patients, followed by saphenous femoral junction incompetence (27.6%). Residual thrombus was least visualized in multiple perforators' incompetence (3.4%). A partially recanalized deep vein was found in 35.7% of the patients during the follow-up period, while a completely recanalized deep vein was observed in almost every three out of four patients who underwent thrombectomy. ►**Table 3** provides an insight into the degree of recanalization and visualization of residual thrombus, if any, during the follow-up period.

Discussion

In DVT patients, treatment prevents PE, restores unimpeded venous return, prevents recurrent DVT, and preserves venous valve function. Several treatment choices are accessible today, but none have shown improvement. Anticoagulation has been regarded as the "gold standard" among these.[10] However, anticoagulation alone does not decrease the thrombus load or restore valve function. Surgical thrombectomy, while capable of effectively eliminating thrombi, has historically been linked with a high risk of thrombosis recurrence and poor clinical outcomes.[11] CDT is potentially appealing for restoring venous patency and preserving valve performance.[10]

Long-term consequences of DVT include unresolved or exacerbated symptoms, skin ulceration, recurrence of acute thrombosis, and PTS. These symptoms are usually caused by venous hypertension and thrombus-related outflow blockage.[12] Mechanical thrombectomy is an appealing option for DVT therapy because it can remove thrombus from the deep vein network without increasing the risk of bleeding.[13] Adequate anticoagulant treatment avoids PE in individuals with acute DVT but is inadequate to restore valvular vein function, resulting in PTS. Recent advancements in thrombectomy have allowed quicker treatment of acute symptoms, preservation of valve structure, and prevention of PTS.[14] The study by Prandoni et al reported long-term outcomes of patients with DVT with recurrent VTE, PTS, arterial thrombotic events, and a history of cancer. The study demonstrated the impact of NOACs on residual vein thrombosis and mentioned the need for treatment in patients with chronic DVT.[12] DVT patients in our research had comorbidities such as autoimmune disorders, coronary artery disease, chronic liver disease, hematopoietic disorders, inherited thrombophilia, history of a prior DVT or PE, and a history of a prior stroke or transient ischemic attack, but no death was reported.

Anticoagulant medication and elastic compression stockings should be used to reduce late DVT sequelae, and endovascular thrombolysis may improve long-term therapy results in patients with proximal DVT.[15] While thrombectomy can restore blood flow, partial thrombi frequently remain and may contribute to recurrent blockage. In contrast, even a partially effective thrombectomy can convert an occlusive thrombus into a nonocclusive thrombus, which is more susceptible to pharmacological therapy.[16] The best complementary therapeutic strategy for mechanical thrombectomy is unknown. PMT is safe and effective in treating DVT, with no postprocedural bleeding.[1]

This study reports the beneficial use of venous Doppler for assessing thrombus location in patients with VTE. Our findings parallel the cohort study by Needleman et al, where venous Doppler can effectively evaluate the thrombus location. In addition, complete duplex ultrasound can be used to diagnose acute DVT.[17]

Table 1 Follow-up findings

		Number of patients	Percentage of patients
One-year follow-up: clinical presentation	Asymptomatic	439	97.3
	Chronic lymphedema	2	0.4
	Post-thrombotic syndrome	6	1.3
	Recurrent DVT	4	0.9
Three years follow-up: clinical presentation	Asymptomatic	346	76.7
	Chronic lymphedema	7	1.6
	Post-thrombotic syndrome	11	2.4
	Recurrent DVT	16	3.5
	Venous insufficiency- varicose veins	71	15.7
Three years follow-up: presenting illness duration	Asymptomatic	346	76.7
	Several days	17	3.3
	Several months	14	3.1
	Several weeks	74	16.4
Three years follow-up: comorbidities developed postsurgery	Autoimmune disorders	1	0.2
	Chronic liver disease	1	0.2
	Coronary artery disease	14	3.1
	Stroke/TIA	5	1.1
	None	430	95.3
Three years follow-up: Doppler findings	Deep venous reflux	6	1.3
	Fibrotic strands in the deep vein	30	6.7
	Multiple perforators incompetence	6	1.3
	Saphenofemoral saphenopopliteal junctions and perforators incompetence	14	3.1
	Saphenofemoral and saphenopopliteal junctions incompetence	5	1.1
	Saphenofemoral junction incompetence	47	10.4
	Saphenopopliteal junction incompetence	1	0.2
	Superficial thrombophlebitis	4	0.9
	Thrombus in a deep vein	19	4.2
	Recanalized deep vein	319	70.7
Three years follow-up: duration between surgery and illness	None	346	76.7
	Three years	85	18.8
	Four years	16	3.5
	>5 years	4	0.9
Occupational prognosis	Disability	14	3.1
	Functional impairment	11	2.4
	Perform only half-time duties	44	9.8
	Return to a full-time job	382	84.7

Abbreviations: DVT, deep vein thrombosis; TIA, transient ischemic attack.

Complete lysis was observed in 31% of patients in a multicenter venous registry, with a 1-year patency rate of 79%. Contraindications to the use of thrombolytic drugs may restrict their utility; in one trial, it was beneficial in just 7% of patients.[18] The use of lytic medicines was contraindicated in 35% of the patients in the study population. Furthermore, a recent multicenter venous registry on the use of lytic drugs to treat DVT found an 11% significant hemorrhagic complication risk, including one fatal cerebral hemorrhage and one subdural hematoma, events that might have been related to

Table 2 Cross-tabulation of 3 years follow-up Doppler findings

		Three years follow-up: Doppler findings																				*p*- Value
		Deep venous reflux		Fibrotic strands in the deep vein		Multiple perforators incompetence		Recanalized deep vein		Saphenofemoral saphenopopliteal junctions and perforators incompetence		Saphenofemoral and saphenopopliteal junctions incompetence		Saphenofemoral junction incompetence		Saphenopopliteal junction incompetence		Superficial thrombophlebitis		Thrombus in the deep vein		
		N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	
Venous Doppler: thrombus timeline	Acute	4	1.0	26	6.8	6	1.6	275	71.6	12	3.1	3	0.8	36	9.4	1	0.3	4	1.0	17	4.4	0.511
	Chronic	0	0.0	0	0.0	0	0.0	4	80.0	1	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	
	Subacute	2	3.2	4	6.5	0	0.0	40	64.5	1	1.6	2	3.2	11	17.7	0	0.0	0	0.0	2	3.2	
Venous Doppler: thrombus location	Common iliac vein	0	0.0	1	33.3	0	0.0	2	66.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<0.0001
	Extending across multiple veins	1	4.2	0	0.0	0	0.0	6	25.0	7	29.2	1	4.2	6	25.0	0	0.0	0	0.0	3	12.5	
	External iliac vein	1	3.0	4	12.1	1	3.0	22	66.7	0	0.0	0	0.0	0	0.0	0	0.0	1	3.0	4	12.1	
	Femoral vein	2	0.9	11	4.8	1	0.4	191	83.0	4	1.7	2	0.9	12	5.2	0	0.0	2	0.9	5	2.2	
	Inferior vena cava	0	0.0	0	0.0	0	0.0	3	60.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	40.0	
	Others	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	
	Popliteal vein	1	3.2	6	19.4	0	0.0	21	67.7	0	0.0	0	0.0	3	9.7	0	0.0	0	0.0	0	0.0	
	Proximal common Femoral vein	1	0.8	8	6.5	4	3.2	73	58.9	3	2.4	2	1.6	26	21.0	1	0.8	1	0.8	5	4.0	
Venous Doppler: thrombus echogenicity	Anechoic	1	4.2	4	16.7	0	0.0	14	58.3	1	4.2	1	4.2	3	12.5	0	0.0	0	0.0	0	0.0	0.512
	Hyperechoic	0	0.0	3	7.9	1	2.6	24	63.2	0	0.0	0	0.0	7	18.4	0	0.0	1	2.6	2	5.3	
	Hypoechoic	5	1.3	23	5.9	5	1.3	281	72.2	13	3.3	4	1.0	37	9.5	1	0.3	3	0.8	17	4.4	
Venous Doppler: occlusion	Complete	5	1.1	29	6.6	5	1.1	313	71.6	13	3.0	5	1.1	45	10.3	0	0.0	4	0.9	18	4.1	<0.0001
	Partial	1	7.1	1	7.1	1	7.1	6	42.9	1	7.1	0	0.0	2	14.3	1	7.1	0	0.0	1	7.1	

Table 3 Cross-tabulation of postoperative thrombus residue and recanalization

		Postoperative Doppler: residual thrombus				Postoperative Doppler: recanalization			
		Not visualized		Visualized		Complete		Partial	
		Number of patients	Percent of patients	Number of patients	Percent of patients	Number of patients	Percent of patients	Number of patients	Percent of patients
Three years follow-up: Doppler findings	Deep venous reflux	6	1.4	0	0.0	6	1.4	0	0.0
	Fibrotic strands in a deep vein	26	6.2	4	13.8	26	6.1	4	14.3
	Multiple perforators incompetence	5	1.2	1	3.4	5	1.2	1	3.6
	Recanalized deep vein	309	73.2	10	34.5	309	73.0	10	35.7
	Saphenofemoral, saphenopopliteal junctions and perforators incompetence	12	2.8	2	6.9	12	2.8	2	7.1
	Saphenofemoral and saphenopopliteal junctions incompetence	4	0.9	1	3.4	4	0.9	1	3.6
	Saphenofemoral junction incompetence	39	9.2	8	27.6	41	9.7	6	21.4
	Saphenopopliteal junction incompetence	1	0.2	0	0.0	1	0.2	0	0.0
	Superficial thrombophlebitis	4	0.9	0	0.0	4	0.9	0	0.0
	Thrombus in the deep vein	16	3.8	3	10.3	15	3.5	4	14.3
p-Value		0.004				0.005			

the dose and duration of lytic therapy.[19] The research examined two PMT devices to treat acute DVT. The primary aim of venous patency was achieved technically, with a short-term follow-up of up to 6 months. During the most recent checkup, roughly 88% of the veins were patent. All individuals who experienced recurrent thrombosis had an underlying hypercoagulable condition. Additionally, (27 patients (90%)) vascular patency was attained in most patients in a single setting.[7]

In this study, the range of the population who presented with DVT was between 41 and 60 years with male predominance (56.1%). Our study also reported pain and swelling as the most common symptom (84.7%). In comparison, the PEARL registry that included 329 patients, only 4% underwent thrombectomy in stark contrast to 52% who underwent pharmacomechanical CDT. CDT was not required in almost 40% of the patients in the study as they underwent a successful thrombectomy.[20] In our study, the distribution of clot reduction grades by treatment groups did not differ significantly. The significance of our study can be reciprocated in conducting further research based on observational or interventional methods for assessing the effective use of thrombectomy and pharmacological treatment in patients with DVT. In addition, the efficacy of thrombectomy along with anticoagulants can be evaluated based on randomized controlled studies. Our study reports a productive use of thrombectomy in patients with DVT with a prominent success rate and minor complications.

In a recent study on Hispanic patients who have significantly low rates of venous thromboembolism compared with other ethnicities, the authors discovered that proximal DVT had a significant impact on 30-day mortality and survival in those presenting with acute PE, and often demonstrated an increase in clot burden and several parameters for right heart strain in CT.[21]

There is debate on the clinical implications of concurrent DVT in individuals suffering from acute PE. While some research found no correlation between simultaneous DVT and bad outcomes in patients with acute PE, other studies did establish a risk factor for these outcomes. Proximal DVTs were associated with saddle (81.8%, against 18.2%, $p < 0.01$) and lobar PEs (62.9%, vs. 37.1%, $p < 0.01$) prevalence as compared with distal DVTs.[21]

There are some limitations to our study. Our research was performed at a single center; to build on this study, a larger-scale multicenter randomized controlled trial is warranted to evaluate the long-term patency and complications associated with venotomy and thrombectomy. Further studies are needed to investigate the relationship between DVT and chronic venous insufficiency. The retrospective nature of the study design carries a substantial risk of confounding by indication. Until prospective randomized trials can demonstrate a benefit of thrombectomy to avoid the development of life-threatening complications like PE, the individual decision whether to perform thrombectomy or not must include all relevant factors, especially with regard to long-term patency of the deep veins and the recurrence of DVT. Additionally, patients who did not undergo thrombectomy were not included in the study and this would have precluded making statistically significant comparisons between these patient groups.

Conclusion

Compared with earlier findings, modern venous thrombectomy has significantly improved early and long-term outcomes for patients with severe DVT. Thrombectomy is an alternative and highly reliable treatment modality for DVT patients in restoring venous patency, reducing DVT recurrence, alleviating PTS, and preventing PE. The overall success rate of thrombectomy was high, with few problems from bleeding.

Authors' Contributions

V.K.P. was involved in conceptualization and designing and critical revision of the study. M.Y. contributed to analysis and interpretation, data collection, and writing of the article. All the authors provided final approval of the article.

Conflict of Interest

None declared.

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