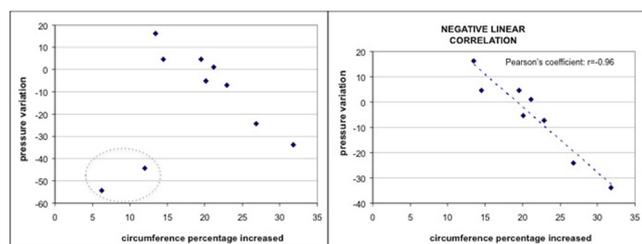


Table. Lower limb volume assessment by truncated cone formula (Kuhnke formula), before and after exercise (walking) or postural condition (standing and sitting), with and without graduated compression stockings (GCS)

	Limb volume before sampling (mean \pm SD), mL	Limb volume after sampling (mean \pm SD), mL	Mean variation, %	P	
Walking, no GCS	2513 \pm 406	2525 \pm 413	0.4	NS	—
Walking, GCS	2469 \pm 432	2361 \pm 416	-4.4	.0001	↓
Standing, no GCS	2493 \pm 399	2561 \pm 392	2.7	.0001	↑
Standing, GCS	2497 \pm 386	2381 \pm 367	-4.6	.0001	
Sitting, no GCS	2534 \pm 402	2547 \pm 380	0.5	NS	—
Sitting, GCS	2483 \pm 400	2362 \pm 406	-4.8	.0001	↓

NS, Not significant; SD, standard deviation.

**Fig.** Negative linear trend between lower limb circumference and interface pressure variation. Excluding the two outliers leads to a strong negative correlation (Pearson coefficient, $r = -0.96$).

Background: The literature supports use of graduated compression stockings (GCS) for leg edema. Nevertheless, there is a paucity of data on the GCS effect related to sitting, standing, and walking on limb edema. Data on different limb shapes and their impact on GCS-exerted pressure are lacking. This investigation provides evidence-based information on GCS effect on edema reduction and the limb shape impact on GCS pressure.

Methods: Thirty healthy individuals (15 male, 15 female; mean age, 32 \pm 5 years) were included. All the participants underwent lower limb volume (Kuhnke formula) and bioimpedance (Biody Xpert II; eBiody SAS, La Ciotat, France) measurement, before and after sitting for 30 minutes, wearing below-ankle noncompressive socks. The same assessment was repeated 7 days later, in the same individuals, but wearing a below-knee 16 to 20 mm Hg GCS.

At a 7-day interval, 1 week with below-ankle noncompressive socks and 1 week with below-knee 16 to 20 mm Hg GCS, all the participants repeated the same protocol including standing and walking. Ten individuals underwent bioimpedance assessment before and after sitting, standing, and walking. In the same group, B and B1 interface pressure values were measured.

Results: All 60 limbs completed the data collection. Sitting or walking, without GCS, led to no significant volume changes, whereas volume was decreased by the use of GCS (-4.8% [$P < .00001$] and -4.4% [$P < .00001$], respectively). Standing up, without GCS, led to an increase in volume (2.7%; $P < .0001$), whereas limb volume was decreased (4.6%; $P < .0001$) by use of GCS (Table).

Bioimpedance showed an extracellular water reduction only while walking with GCS (from 40.55% \pm 1.66% to 40.45% \pm 1.71%; $P < .017$). Mean interface pressure was 19 \pm 5 mm Hg (B) and 16 \pm 5 mm Hg (B1). The interface pressure variation from B to B1 was not homogeneous among participants (mean percentage variation of -13% \pm 25%, ranging from -54% to 16%).

The Fig shows a negative linear trend between pressure variation and circumference percentage increase. The subanalysis excluding the two outliers shows a strong negative linear correlation (Pearson coefficient, $r = -0.96$).

Conclusions: GCS led to a significant limb volume reduction irrespective of limb position and muscle pump function. However, extracellular fluid is mobilized only during muscle walking with GCS. Interestingly, leg shape variation influences the interface pressure gradient, indicating the importance of proper fitting of both B and B1 during prescription. These data provide a foundation for future investigations dealing with GCS effect on fluid mobilization and with limb geometry impact on compression performance.

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Total Laparoscopic Removal of Inferior Vena Cava Filters

Peng Jiang, Jianlong Liu. Vascular Surgery, Beijing Jishuitan Hospital, Beijing, China

Background: Indwelling inferior vena cava (IVC) filters can cause significant complications. With more frequent use of optional IVC filters, there has been increasing need for filter retrieval procedures. Perforations of the IVC wall by the struts of the filter are frequent. These complicated filters have increased because of low retrieval rates. Some filters cannot be removed through endovascular techniques. In this study, we report our experience of total laparoscopic removal of IVC filters in eight patients when the struts were nonretrievable through an endovascular approach.

Methods: Retrospective analysis was performed of eight patients who underwent filter laparoscopic retrieval procedures between December 2016 and July 2018. Seven patients had the Celect filter (Cook Medical, Bloomington, Ind) placed. One patient had the Denali (Bard, Covington, Ga) filter implanted. In all patients, an attempt to remove the filter by means of the standard percutaneous procedure failed. Eight cases of IVC filter removal due to caval perforation were identified by computed tomography venography. Patients' demographics, clinical presentation, laparoscopic indication and technique, and outcomes were recorded.

Results: Six patients were male, and the median age was 45 years (24-58 years). All IVC filters were the retrievable type and had an average indwelling time of 4.2 months (2-10 months). In each patient, removal had been attempted at least two times through endovascular retrieval. One filter was implanted above the left renal vein. Seven patients underwent total laparoscopic surgical removal of complicated IVC filters, which included six Cook Celect filters and one Bard Denali filter. Open surgical removal of the filter that could not be removed by laparoscopy was performed in one patient. The total removal rate was 100%, and the laparoscopic retrieval rate was 87.5%. All patients recovered well after the operation. No death related to laparoscopic and open removal occurred.

Conclusions: Total laparoscopic removal with minimally invasive IVC manipulation is feasible for extraction of complicated IVC filters that cannot be removed with an endovascular procedure. Laparoscopic removal is associated with excellent outcomes and minimal morbidity.

Author Disclosures: P. Jiang: Nothing to disclose; J. Liu: Nothing to disclose.

Is Compression Required After Radiofrequency Ablation? A Randomized Controlled Trial

Madu Onwudike,^{1,2} Kazim Abbas,¹ Paula Thompson². ¹Vascular Surgery, Manchester University NHS Foundation Trust; ²Vascular Surgery, Bolton Hospitals NHS Foundation Trust

Background: With endovenous procedures becoming increasingly preferred to open surgical operations, radiofrequency ablation (RFA) is now established as an efficacious endothermal modality for superficial truncal incompetence. Postprocedure limb compression, hitherto

routine after open varicose vein surgery, has been extended to endovenous procedures. There is, however, no robust evidence to support this practice. This study comparatively evaluated the outcome with and without postoperative compression after RFA.

Methods: This single-center prospective randomized controlled trial recruited adult patients undergoing RFA into two groups (A, compression stocking for 2 weeks; B, no compression). Duplex ultrasound scan was performed at 2 weeks, but the primary outcome was successful obliteration of target vein as determined by duplex ultrasound scan at 12 to 14 weeks. Secondary outcome measures included quality of life scores (Aberdeen Varicose Vein Symptom Severity [AVVSS] score and Venous Clinical Severity Score [VCSS]), patient satisfaction, and complications. To detect 2.5% difference in success rate between the groups, assuming 90% power and a type I error of 5%, a minimum of 39 patients were required in each arm. Stata 15 (StataCorp, College Station, Tex) was used to perform statistical analysis. Ethical approval was granted by Regional NHS National Research Ethics Service. The study was registered with ISRCTN (Registration No.: 18119345).

Results: In total, 100 patients were recruited (group A, 51; group B, 49), with no significance difference in age, sex, clinical class, mean AVVSS score (17.7 vs 15.7), and VCSS (10.2 vs 10.4) between groups. At 2 weeks, the occlusion rate of the target vein was similar in both groups at 96.1% and 95.9%, respectively, with no significant change at 12 weeks. There was no significant difference in the incidence of deep venous thrombosis. One patient in each group did not achieve vein occlusion, and three patients in each group did not attend for the final ultrasound scan. There was no statistical difference in mean AVVSS score (5.7 vs 5.0) and mean VCSS (3.2 vs 3.7) score at 12 weeks. Of the 93 patients who returned their satisfaction survey, 97% would recommend the RFA procedure, and this did not differ between groups.

Conclusions: The outcome of RFA without post-treatment compression is no worse than with compression. Use of compression after RFA did not improve success rate, quality of life scores or patient satisfaction, or postoperative complications. It may be concluded that the widely practiced use of compression after RFA adds no clinical benefit for the patients.

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Serum ¹H Nuclear Magnetic Resonance Metabolomic Profiling in Acute Deep Venous Thrombosis



Marina Kafeza,¹ Richmond Bergner,² Joseph Shalhoub,² Sarah Onida,² Elaine Holmes,² Alun H. Davies,² ¹Academic Section of Vascular Surgery, Department of Surgery, and Cancer Faculty of Medicine, Imperial College London; ²Imperial College London

Background: Deep venous thrombosis (DVT) biomarker research is an area of great interest, given the significant morbidity and mortality associated with the disease. High-throughput metabolomic profiling of circulating metabolites has emerged as a promising method in biomarker research. An untargeted metabolic profiling approach using ¹H nuclear magnetic resonance spectroscopy may reveal possible diagnostic biomarkers of acute DVT.

Methods: Comprehensive untargeted metabolic profiling of serum of patients with acute DVT (DVT+) compared with serum of patients with similar symptoms and excluded DVT (DVT-) and nonsymptomatic volunteers (controls) was undertaken using ¹H nuclear magnetic resonance spectroscopy. Multivariate analysis including principal component analysis and orthogonal partial least squares discriminant analysis was performed to assess whether there was a differential metabolic profile in comparing serum of DVT patients and controls, followed by univariate analysis to identify possible compounds responsible for any difference between the groups.

Results: In total, 121 patients were included in the study: 41 DVT+ patients, 40 controls, and 40 DVT- patients. Multivariate analysis of the blood samples showed a differential metabolic profiling in comparing the serum of DVT+ patients with that of controls ($R^2 = 0.806$; $Q^2 = 0.352$) or DVT- patients ($R^2 = 0.848$; $Q^2 = 0.199$). Univariate analysis showed that the compounds responsible for the metabolic difference between DVT+ and controls were *N*-acetylglucosamines, histidine, tyrosine, alanine, choline and lipids. *N*-Acetylglucosamine was also driving the metabolic difference between DVT+ and DVT- groups.

Conclusions: The study proves the presence of a specific metabolic signature of acute DVT and utility of a metabolomic approach to identify possible diagnostic DVT biomarkers in serum.

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Risk of Acute Kidney Injury with Intervention for Acute Deep Venous Thrombosis



Sarah Sternbach,¹ Yaron Sternbach,² John Taggart,² Kathleen Ozsvath,³ ¹Albany Medical Center; ²Vascular Surgery, Albany Medical Center; ³Vascular Surgery, Albany Medical Center

Objective: The treatment of acute deep venous thrombosis (DVT) continues to evolve. Whereas catheter-directed thrombolysis with mechanical thrombectomy has been used to treat patients successfully, such treatment regimens carry an inherent risk of nephropathy that has yet to be quantified. The goal of this study was to determine the risk of acute kidney injury in patients treated for acute DVT with mechanical thrombectomy and lysis.

Methods: A retrospective review of prospectively collected data was conducted for 152 patients presenting to the two hospitals in Albany, New York, where lysis is performed by the Vascular Group, a large single-specialty vascular surgery group composed of board-certified vascular surgeons. Data collection included demographics, preprocedural and postprocedural creatinine concentration and glomerular filtration rate (GFR), number of interventions within the acute episode, total contrast material dose, adjuvant procedures, and anatomic location of the DVT. All interventions were performed by vascular surgeons adept at evaluation and endogenous treatment. Decisions about initiation of therapy and method of intervention were made at the discretion of the treating surgeons.

Results: During 5 years (2012-2017), 152 patients underwent intervention for treatment of acute DVT. Group 1 included 144 patients who had no significant periprocedural renal changes. Group 2 had eight patients with changes in renal function periprocedurally. Mean age, number of procedures, anatomic location of the DVT, and contrast material dose were similar in the two groups. Patients in group 2 did have both a higher baseline creatinine concentration (0.87 vs 1.35 mg/dL; $P = .03$) and lower GFR (58.6 vs 48.3 mL/min/1.73 m²; $P = .046$). Patients with abnormal GFR were more likely to have periprocedural renal impairment ($P = .0023$). The addition of mechanical thrombectomy to any procedure conferred an increased risk of acute renal impairment ($P = .039$). No patient required permanent hemodialysis, although two patients with normal initial renal function required temporary hemodialysis after intervention.

Conclusions: This study represents initial evidence that for patients undergoing intervention for acute DVT, there is a small (5.2%) but real risk of temporary periprocedural renal impairment. Predisposing factors in the study are limited to impaired renal function at admission, although normal renal function is not completely protective. Renal tubular necrosis may complicate mechanical thrombectomy and augment the risk of nephropathy posed by the use of iodinated contrast agents. Whereas intervention for acute DVT can be safely undertaken, additional investigation is necessary to clarify what specific elements of mechanical thrombectomy pose the greatest risk to patients and how that risk may best be mitigated in the future.

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A Pathologic Perforator May Predict the Presence of an Ipsilateral Central Venous Stenosis



Mikel Sadek, Lowell Kabnick, Thomas Maldonado, Caron Rockman, Neal Cayne, Todd Berland, Glenn Jacobowitz. New York University Langone Health

Objective: The treatment of a refluxing perforator is indicated in the setting of severe venous insufficiency (ie, pathologic perforator), but there