Iliofemoral venous stenting in patients with central neuromuscular disorders

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ABSTRACT

Background: Leg swelling in patients with various central neuromuscular disorders is a common clinical scenario and can lead to significant morbidity. The aim of the present study was to evaluate a subset of patients with central neuromuscular disorders who had undergone iliofemoral venous stenting at a specialty venous clinic at a tertiary care hospital.

Methods: From January 2000 to December 2020, the medical records of all patients with a known central neuromuscular disorder who had undergone iliofemoral venous stenting for chronic iliofemoral venous obstruction were retrospectively analyzed.

Results: A total of 42 patients (45 limbs) with central neuromuscular disorders had undergone iliofemoral stenting after failure of a trial of conservative therapy. The central neuromuscular disorders included Parkinson disease (n = 20 limbs), multiple sclerosis (n = 15 limbs), and other neuromuscular conditions (n = 10 limbs). The mean age of the sample was 59 ± 14 years. The ratio of post-thrombotic to nonthrombotic iliac vein lesions was 3:1. Most of the patients had had CEAP (clinical, etiologic, anatomic, pathophysiologic) class ≥C4 (64.4%); 25 limbs had a history of venous thromboembolism (56%). A trend was seen toward improvement in all clinical parameters measured (venous clinical severity score, visual analog scale for pain score, and edema grade) after stenting. An ulcer healing rate of ≤90% was noted after stenting. Of the 45 limbs, 24 had required some form of reintervention (53%) after initial stent placement.

Conclusions: Venous intervention in the form of endovenous stenting was associated with improvement in the clinical parameters for patients with central neuromuscular disorders. However, these patients should be counseled regarding the relatively higher rate of reinterventions that might be required to correct residual or recurrent symptoms. (J Vasc Surg Venous Lymphat Disord 2021;■:1-7.)

Keywords: Central neuromuscular disorders; Iliac vein stent; Intravascular ultrasound; IVUS; Nonthrombotic iliac vein lesions; Post-thrombotic syndrome

Leg swelling in patients with central neuromuscular disorders is a common clinical scenario. In addition to systemic causes, leg swelling in these patients can be due to underlying venous or lymphatic abnormalities. Often, these patients have limited overall mobility and are unable to perform even positional transfers independently. The self-application of compression stockings is prohibitive for these patients because of the lack of independent functioning and significant disturbances in central neuromuscular function. Untreated leg swelling in these individuals can lead to significant morbidity in daily life and can also impose a significant burden on their caregivers.

The aim of the present study was to evaluate a subset of patients with various central neuromuscular disorders who had undergone iliofemoral venous stenting at a specialty venous clinic at a tertiary care hospital.

METHODS

Study design and setting

In the present study, the medical records of all patients with a known central neuromuscular disorder who had undergone iliofemoral venous stenting for chronic iliofemoral venous obstruction (CIVO) from January 2000 to December 2020 were retrospectively analyzed. Our study was a single-center study with three surgeons at a specialty venous clinic located at a tertiary care hospital. All the patients provided written informed consent. The institutional review board approved the use of de-identified patient data for the present study.

Inclusion criteria

The inclusion criteria for the present study were as follows: a known central neuromuscular disorder; venous stenting performed for CIVO; and failure of a 3- to

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6-month trial of conservative therapy. Only patients with air plethysmography data and ≥6 months of follow-up data available were included in the present study.

Exclusion criteria

All the patients with a known central neuromuscular disorder who had received conservative treatment only were excluded from the present study. Patients with peripheral neuropathy were also excluded to not confound the results. Several studies have shown that venous microangiopathy from peripheral venous hypertension can cause mild to severe peripheral neuropathy in patients with chronic venous insufficiency (CVI) and could also play a role in the etiology of chronic venous leg ulcers.[1,2]

Conservative therapy

Conservative therapy for most patients included a combination of graduated compression stockings, leg elevation, calf muscle exercises, ambulation with assistance, and comprehensive manual decongestive therapy, with wound care in the case of lower extremity venous ulcers. A trial of conservative therapy was attempted for all patients for ≥3 to 6 months.

Data collection

Data were collected for the following variables: type of neuromuscular disorder, age, sex, type of venous lesion (ie, post-thrombotic, nonthrombotic, mixed) seen on intravascular ultrasound (IVUS), body mass index, other medical comorbidities, CEAP (clinical, etiologic, anatomic, pathophysiologic) class, nature (provoked vs unprovoked) of deep vein thrombosis (DVT), occurrence of pulmonary embolism, intervention details, clinical presentation, and reinterventions.

Air plethysmography parameters

Only patients with air plethysmography data available were included in the present study. Essentially, these patients had limited mobility and reduced activity but were not yet completely bedridden or wheelchair dependent. A commercially available instrument (ACI Medical, San Marcos, Calif) was used for the air plethysmography measurements. We used the standard protocol described in detail by Christopoulos et al.[3]

Technical success

The criteria to define procedural technical success have been described previously.[4] In brief, these included the following:

1. Successful treatment of the lesion without any intraoperative device complications
2. Establishment of in-line central venous flow
3. The presence of <20% residual stenosis on completion IVUS and restoration of luminal venous diameters to normal rated diameters: common femoral vein, 125 mm^2 (diameter, 12 mm); external iliac vein, 150 mm^2 (diameter, 14 mm); and common iliac vein, 200 mm^2 (diameter, 16 mm)

ARTICLE HIGHLIGHTS

- **Type of Research:** A single-center, retrospective study
- **Key Findings:** Venous stenting improved the clinical parameters for patients with central neuromuscular disorders, including an ulcer healing rate of ≤90%.
- **Take Home Message:** A relatively higher rate of reinterventions might be required to correct residual or recurrent symptoms after stenting for patients with central neuromuscular disorders.

Management

Acute venous thromboembolism. Acute venous thromboembolism (VTE) was treated with oral anticoagulation medication. Percutaneous pharmacomechanical or mechanical thrombectomy was performed in selected patients with native VTE or stent thrombosis with consideration of a number of important factors, including symptom severity, time since the onset of symptoms, chronicity of thrombus on imaging, the proximal extent of VTE, and the patient's overall surgical risk.[5]

Chronic venous disease. For all patients with CVI signs and symptoms, a 3- to 6-month trial of conservative therapy was undertaken. Failure of conservative therapy and lifestyle-limiting symptoms warranted further investigation and subsequent intervention to treat CIVO. A particular vein was considered stenosed if the cross-sectional area or diameter was less than the following measurements on IVUS: common iliac, external iliac, and common femoral vein segments: diameter, 16 mm (area, 200 mm^2); diameter, 14 mm (area, 150 mm^2), and diameter, 12 mm (area, 125 mm^2), respectively. The derivation of these minimal sizes based on Poiseuille's equation and Young's scaling ratios from healthy volunteers has been described previously in detail and validated in several clinical series.[6] Contiguous, relatively normal venous segments should not be used as an index comparator when stenting because of the presence of unique Rokitansky-type iliac lesions. Rokitansky lesions are diffuse iliac lesions unique to the venous system without a focal narrowing and can be easily missed on venography. Thus, IVUS was used because it can provide a definitive diagnosis of Rokitansky lesions.

IVUS was used in all cases to guide venous intervention, stent sizing, and determination of the proximal and distal landing zones. The Visions PV 0.035-in. catheter (Phillips Volcano, San Diego, Calif) with a 90-cm catheter length and 60-mm maximum imaging

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diameter was used. A recent systematic review has shown that IVUS is more sensitive than multiplanar venography and that reliance on venography alone can lead to the underdiagnosis of the presence or severity of iliofemoral venous lesions.[7] IVUS can be used to more accurately delineate the position of the iliac–caval confluence and can be used safely for patients with renal insufficiency or severe contrast allergy and minimize radiation exposure.[7]

The endovascular stenting technique has been described previously.[4] In brief, intervention was performed using angioplasty and stenting with the Wallstent (Boston Scientific, Marlborough, Mass) with the addition of a Zenith stent (Cook Medical, Bloomington, Ind) at the iliac–caval confluence if additional radial strength was required.[4] Wallstents ranging from 14 to 24 mm in diameter and Zenith stents ranging from 20 to 30 mm were used. An overlap of 2 to 3 cm was used for cases in which multiple Wallstents had been used. For post-thrombotic syndrome cases, skip areas were avoided in between the lesions.[8] If significant superficial reflux was present in the great saphenous veins (GSVs) or small saphenous veins (SSVs), endovenous laser ablation (EVLT) of these veins was usually performed during the initial stenting procedure.

Stent surveillance and reinterventions. The stent surveillance protocol has been previously described in detail.[9,10] Reintervention was performed for residual or recurrent symptoms such as pain, swelling, cellulitis, and/or venous ulceration unresponsive to conservative measures for ≥6 months and significantly affecting the patient's quality of life.[9-11] For these patients, ultrasound surveillance usually demonstrated stent malfunction. Reintervention was performed because of clinical symptoms and evidence of stent malfunction on ultrasound. For stent compression or in-stent restenosis (ISR), reintervention was performed with an angioplasty balloon to improve the luminal caliber of the previously placed stents. Isodilation refers to balloon dilation of the stent up to its originally rated diameter, and hyperdilation refers to balloon dilation of the stent to 2 to 4 mm beyond its original rated diameter.

Clinical parameters

Swelling was graded clinically from 0 to 4 (grade 0, none; grade 1, pitting but overall not obvious; grade 2, ankle edema; grade 3, gross and involving the leg below the knee; grade 4, gross and involving the whole limb). Pain was rated using the visual analog scale (VAS) for pain, with a scale from 0 to 10, with a score of 10 indicating the most severe pain. The venous clinical severity score (VCSS) was also computed. These clinical parameters were assessed at the initial visit and at every subsequent follow-up visit. Data from the last follow-up visit were used for the present analysis.

Perioperative anticoagulation and compression protocol

The anticoagulation protocol for patients undergoing deep venous intervention has been described previously.[9] The patients received prophylactic low-molecular-weight heparin perioperatively for ≥24 to 48 hours. Bivalirudin 75 mg was also administered during the procedure. Postoperatively, chronic anticoagulation medication was prescribed for selected patients with post-thrombotic syndrome, a strong history of recurrent DVT, or thrombophilia.[9] Most patients continued antiplatelet therapy (eg, 81 mg of aspirin) indefinitely unless medical contraindications were present. For patients undergoing reintervention for ISR, low-dose anticoagulation was typically started after the procedure and continued indefinitely. This was generally apixaban 2.5 mg twice daily or rivaroxaban 10 mg once daily. For the patients with stent thrombosis, full-dose anticoagulation was instituted at the detection of stent thrombosis and continued indefinitely. This was generally apixaban 5 mg twice daily or rivaroxaban 20 mg once daily. For the patients who had required more than one reintervention, we also selectively add cilostazol to the regimen. At intervention, all the patients were provided with a pair of compression wraps and graduated compression stockings (20-30 mm Hg). Our recommendation to patients has been to wear these regularly.[12] The patients were also instructed on the correct use of these compression garments in detail at discharge after their procedure.

Statistical analysis

Statistical analysis was performed using a commercially available statistics program (Prism software; GraphPad, San Diego, Calif). The χ^2 test or t test was used for analysis, as appropriate. $P < .05$ was considered to indicate statistical significance.

RESULTS

Demographics. From January 2000 to December 2020, 42 patients (45 limbs) with central neuromuscular disorders had undergone iliofemoral stenting after failure of a trial of conservative therapy. The distribution of central neuromuscular disorders was Parkinson disease (n = 20 limbs), multiple sclerosis (n = 15 limbs), and other neuromuscular conditions (n = 10 limbs). These other neuromuscular conditions included muscular dystrophy (n = 6), Friedreich ataxia (n = 2), and quadriplegia (n = 2). The mean age of the patients was 59 ± 14 years. Other demographic details are presented in Table I. The ratio of post-thrombotic to nonthrombotic iliac vein lesions was 3:1.

CEAP classification. Most of the patients had had CEAP (clinical, etiologic, anatomic, pathophysiologic) class of ≥C4 (64.4%; Table I).

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Table I. Demographic patient details (n = 45 limbs)

Variable	Parkinson disease (n = 20)	Multiple sclerosis (n = 15)	Other (n = 10)	Total limbs (N = 45)
Age, years				
Median (range)	71 (50-81)	55 (35-63)	50 (25-72)	59 (25-81)
Mean ± SD	69 ± 8.3	52 ± 8.1	50 ± 16.6	59 ± 14
Sex, No.				
Male	7	5	4	16
Female	13	10	6	29
Laterality, No.				
Left	13	8	4	25
Right	7	7	6	20
NIVL, No.	6	4	2	12
PTS, No.	14	11	8	33
CEAP clinical class, No.				
≤2	0	0	0	0
3	8	5	3	16
4	9	5	6	20
5	0	0	0	0
6	3	5	1	9

CEAP, Clinical, etiologic, anatomic, pathophysiologic; *NIVL*, nonthrombotic iliac vein lesion; *PTS*, post-thrombotic syndrome; *SD*, standard deviation.

Venous thromboembolism. Of the 45 limbs, 25 (56%) had a history of VTE. On IVUS, 33 (73%) of the lesions had appeared post-thrombotic.

Compression use. At the initial visit to our clinic, 70% of the patients were not using compression stockings regularly despite having been instructed to do so by their primary care physician or referring specialist. This was the case although nine limbs (20%) had had a CEAP class of 6 at the initial presentation (Table I). The reasons for noncompliance with stocking use were not available for the present analysis.

Superficial and deep reflux. Of the 45 limbs, 20 (44%) did not have any evidence of reflux. Superficial and deep reflux alone were present in 7 limbs each (~15% each), and 11 limbs had had both superficial and deep reflux (24%). Five patients with Parkinson disease, three with multiple sclerosis, and one with other neuromuscular disorders had undergone concomitant GSV EVLT with endovenous stenting. SSV EVLT was only performed in one patient with multiple sclerosis concurrent with stenting. A total of 10 limbs had undergone superficial vein EVLT in our sample (22%). In addition, five patients had undergone stab avulsion of refluxing varicose veins.

Air plethysmography parameters. The various air plethysmography parameters are shown in Table II. The *P* values for none of the associations were statistically significant.

Clinical parameters. Overall, a trend was seen for improvement in all clinical parameters (ie, VCSS, VAS for pain score, and edema grade) after stenting (Table III). For those with Parkinson disease, this association was statistically significant for the VCSS ($P = .001$) and the VAS for pain score ($P = .005$). For those with multiple sclerosis, this association was significant for the VCSS ($P = .006$).

Ulcer healing. Longstanding ulcers with a suspicious appearance had undergone biopsy to ensure that no underlying cancerous condition was present. The ulcer beds were also evaluated for underlying incompetent perforators; none were found in the present study. In the present sample, nine limbs had ulcers (20%; Table IV). Conservative therapy was attempted for all patients with venous ulcers before stenting was considered for CIVO in the patients with nonhealing ulcers. After stenting, ulcer healing occurred in eight of nine patients (89%). Of these nine patients, four had undergone GSV EVLT concurrent with stenting. One patient with Parkinson disease experienced ulcer recurrence during follow-up (12.5%). The ulcer had recurred 2 years after initially healing. The mean duration of the ulcers before intervention was 11 ± 1.5 months. The mean duration for ulcer healing after intervention was 50 ± 20 days.

Reintervention. Overall, the rate of reintervention for this group of patients was high (Table V). Of the 45 limbs, 24 had required some form of reintervention (53%) after initial stent placement. The mean duration to reintervention was 13 ± 2 months. Distal stent extension was performed in 3 patients (12.5%), hyperdilation for stent compression or ISR in 18 patients (75%), and thrombectomy for stent thrombosis in 3 patients (12.5%).

Table II. Air plethysmography parameters

	Preoperative			Postoperative		
Neuromuscular condition	VFI_{90}, mL/s	VFT, seconds	EF, %	VFI_{90}, mL/s	VFT, seconds	EF, %
PD (n = 20)	2.3 ± 1.7	46.1 ± 23.8	57.8 ± 21.5	1.8 ± 1.4	52.0 ± 29.5	63.5 ± 43.6
MS (n = 15)	2.5 ± 2.8	56.4 ± 50.9	39.0 ± 14.8	3.1 ±4.3	67.6 ± 68.7	33.8 ± 15.4
Other (n = 10)	0.9 ± 0.6	57.6 ± 26.5	60.2 ± 38.7	1.0 ± 0.5	44.9 ± 18.8	55.6 ± 17.4
Total (n = 45)	2.1 ± 2.1	51.8 ± 36.3	50.1 ± 22.8	2.3 ± 3.0	57.7 ± 48.5	49.6 ± 33.0

EF, Ejection fraction; *MS,* multiple sclerosis; *PD,* Parkinson disease; *VFI_{90},* venous filling index; *VFT,* venous filling time.
Data presented as mean ± standard deviation; *P* values were not statistically significant for any association.

All three patients who had required thrombectomy for stent thrombosis had had multiple sclerosis. In one patient, the stent thrombosis was acute (<30 days of stent placement). The other two patients had presented with stent thrombosis at 3 and 5 months after stenting. For all three patients, pharmacomechanical thrombectomy was performed, in addition to balloon maceration of thrombus. Recurrent thrombosis did not occur in any patient. Of the 18 patients who had required hyperdilation for stent compression or ISR, 5 (28%) had required two or more reintervention hyperdilation procedures.

Anticoagulation therapy. No complications related to anticoagulation therapy were noted. Anticoagulation therapy was continued for these patients until a medical contraindication to it had developed.

Follow-up. The median follow-up was 39 months, and the mean follow-up was 49 ± 51 months (range, 6-234 months). At the last documented follow-up visit, only 40% of patients were using compression stockings.

DISCUSSION

Improvement in clinical parameters. Venous intervention in the form of endovenous stenting was associated with an improvement in clinical parameters such as VCSS, VAS for pain score, and swelling grade for patients with central neuromuscular disorders in the present study.

CVI morbidity. As a group, patients with central neuromuscular disorders will experience significant morbidity from leg swelling, pain, and associated skin changes from CVI, including venous ulceration. Most of these patients cannot function independently and require long-term assisted living conditions. The loss of muscle mass or atrophy in the affected extremities is common.[13] Of these patients, ≤90% will come to our clinic in a wheelchair for the initial consultation. It was clear that most of these patients had spent most of their days with their legs in a gravity-dependent position that exacerbated the CVI symptoms. Most of these conditions are also progressive. In a survey of 171 patients with neuromuscular diseases affecting the upper and lower extremities, 45% had stated they would choose cure of their lower extremities if only one of the two could be corrected.[14]

Poor compliance with compression use. The lack of functional independence and help could also represent a significant barrier to the use of compression

Table III. Effect of intervention on clinical parameters

Variable	Preoperative	Postoperative	*P* value
Parkinson disease (n = 20)			
VCSS	6.9 ± 2.1	4.2 ± 1.9	**.001**
VAS for pain score	5.5 ± 3.4	2.5 ± 3.3	**.005**
Edema grade	2.7 ± 1.0	2.2 ± 1.0	.168
Multiple sclerosis (n = 15)			
VCSS	7.5 ± 4.0	4.9 ± 3.7	**.006**
VAS for pain score	4.6 ± 3.4	3.1 ± 3.5	.157
Edema grade	2.1 ± 1.1	1.4 ± 1.2	.063
Other (n = 10)			
VCSS	6.1 ± 3.1	4.0 ± 2.5	.109
VAS for pain score	4.1 ± 4.1	2.2 ± 2.4	.094
Edema grade	2.9 ± 1.1	1.9 ± 1.2	.125

VAS, Visual analog scale; *VCSS,* venous clinical severity score.
Data presented as mean ± standard deviation.
Boldface *P* values represent statistical significance.

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Table IV. Ulcer prevalence, healing, and recurrence

NM group	Ulcer prevalence	Ulcer healing	Ulcer recurrence
PD (n = 20)	3 (15)	3 (100)	1 (33)
MS (n = 15)	5 (33)	4 (80)	0 (0)
Other (n = 10)	1 (10)	1 (100)	0 (0)

MS, Multiple sclerosis; *NM*, neuromuscular; *PD*, Parkinson disease.
Data presented as number (%).

Table V. Reintervention

Reintervention	Parkinson disease (n = 20)	Multiple sclerosis (n = 15)	Other (n = 10)
Stent extension	1 (5)	2 (13)	0 (0)
Hyperdilation	4 (20)	6 (40)	8 (80)
Thrombectomy for stent thrombosis	0 (0)	3 (20)	0 (0)
Total	5 (25)	11 (73)	8 (80)

Data presented as number (%).

stockings by these patients. Only 30% of our patients were using compression at the initial consultation. This had improved marginally to 40% during follow-up after intervention despite instructions on the use of compression stockings and the provision of a pair of compression stockings to each patient. Stocking noncompliance was evaluated in a sample of 3144 patients with chronic venous disease.[15] However, >60% patients were not using compression stockings at all.[15]

Ulcer healing. Endovenous stenting (with or without superficial reflux ablation) significantly improved ulcer healing in this group of patients with central neuromuscular disorders. The utility of venous stenting for ulcer healing has been well described in multiple clinical series.[16-18] In our study, almost 90% patients had experienced ulcer healing after stenting, with a low rate of ulcer recurrence. Chronic venous leg ulcers represent major morbidity for these patients in terms of the resources expended on wound care, repeated hospitalizations because of associated cellulitis, frequent visits to wound care centers, and the physical aspects of pain and continuous drainage resulting from such wounds that many patients find bothersome.

High rate of reintervention. In this group of patients with central neuromuscular disorders, a relatively high rate of reintervention was noted after initial stent placement. Up to 40% of limbs had required reintervention for either ISR or stent compression. It is known that the incidence of ISR and stent compression after endovenous stenting is generally high. ISR has been noted in 74% of limbs at 3 months, which subsequently stabilized, with stent compression noted in 79% of limbs on postoperative day 1, which had stabilized afterward.[11] However, despite this high incidence of ISR and stent compression, reintervention will usually only be needed for ≤16% of patients.[11] In our sample, the higher rate of reintervention required for ISR and stent compression might have been related to factors such as poor venous inflow, post-thrombotic pathology, overall muscle pump atrophy or disuse, and the relative immobility of the lower extremities. However, only three patients had had stent thrombosis (6.7%). In a large series of 3468 stents, stent occlusion was noted in ~3% of patients overall (n = 102), and ISR had rarely progressed to complete stent occlusion (<10%).[19]

Special subgroups. We have previously shown the clinical improvement resulting from endovenous stenting in special patient population subsets such as octogenarians, obese individuals, and postmenopausal women.[20-22] In the former two groups, compression stocking use was challenging, similar to that for patients with neuromuscular disorders. In our patient population, despite instructions on compression stocking use, only 40% were using compression stockings at follow-up. Therefore, stenting is a safe and effective option for these patients when compression use is not feasible.

Calf pump ejection fraction in patients with multiple sclerosis. An interesting observation was that the calf muscle pump ejection fraction was abnormal at baseline in the patients with multiple sclerosis (39% ± 14.8%). The ejection fraction remained abnormal during follow-up even after intervention (33.8% ± 15.4%). This likely reflects the calf muscle dysfunction that exists in many patients with multiple sclerosis once they are wheelchair bound or bed bound.

Consideration for anticoagulation therapy. In the present study, 25 limbs had a history of VTE (56%). Of these 25 patients, 10 had had multiple sclerosis (10 of 15; 67%). Prior studies have shown that patients with central neuromuscular disorders have a higher risk of VTE. In a population-based cohort study, multiple sclerosis was found to be a risk factor for VTE.[23] During a follow-up period of ≤29 years, those with multiple sclerosis had had an adjusted incidence rate ratio of 2.28 (95% confidence interval, 2.09-2.59) for DVT.[23] In another study, the frequency of DVT in those with multiple sclerosis was ~44%.[24] In our study, three patients had experienced stent thrombosis; all three patients had had multiple sclerosis. Stronger consideration should be given to prolonged anticoagulation therapy for patients with central neuromuscular disorders after stenting because most will have a history of VTE and a high reintervention rate. This was likely related to the restricted mobility,

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poor muscle pump performance and, lack of good blood flow to support the stents. The benefits of anticoagulation therapy must be balanced against the risks and requires a detailed discussion between patients and their physicians. In the present study, no complications related to anticoagulation therapy were noted.

Study limitations. The main limitations of the present study included its retrospective nature and the small sample size. The outcomes were measured in terms of ulcer healing, grade of swelling, VAS score for pain, and VCSS. A trend toward improvement was noted in these parameters after intervention. For patients with skin damage, durometer readings would have been helpful to assess the changes in skin texture over time in response to the intervention. However, a durometer was not used as an assessment tool in the present study. We also acknowledge that some potentially confounding variables could have contributed to the improvements in the VCSS such as increased medical attention, compliance with compression or bandaging, and superficial venous interventions, when performed. For patients with residual edema after the primary intervention, additional adjunctive therapies have been instituted at our center, including manual decongestive therapy and pneumatic compression devices. However, the effect of these therapies was not assessed in the present study.

CONCLUSIONS

Venous intervention in the form of endovenous stenting was associated with an improvement in clinical parameters such as the VCSS, VAS score for pain, swelling grade, and ulcer healing in patients with central neuromuscular disorders. However, these patients should be counseled regarding the relatively higher rate of reintervention that might be needed to correct residual or recurrent symptoms.

AUTHOR CONTRIBUTIONS

Conception and design: TS, SR
Analysis and interpretation: TS, TP, SR
Data collection: TP
Writing the article: TS, TP, SR
Critical revision of the article: TS, TP, SR
Final approval of the article: TS, TP, SR
Statistical analysis: TP
Obtained funding: Not applicable
Overall responsibility: TS

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