WeMPiC protocol to prevent Deep Venous Thrombosis in patients with neurosurgical diseases

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Abstract

Background: Deep Venous Thrombosis is a common yet difficult problem to prevent in neurosurgical patients. Recent trials did not find sufficient evidence to support use of graduated compression stockings, however we believe, this inefficiency may be due to the method of application which needs to be modified. We have been following a patient specific mechanical prophylaxis protocol, nicknamed WeMPiC. This study aims to evaluate the effectiveness of WeMPiC protocol.

Methods: An observational cohort study was performed including consecutive patients admitted to neurosurgical ICU who were bedridden for >7 days between April 2014 and September 2017. We developed WeMPiC protocol of early weaning off, early mobilization, limb physiotherapy and alternate two hours on and off application of thigh length graduated compression stockings. Lower limbs compression ultrasound studies were performed on alternate days.

Results: One hundred thirty-one patients were included in the study. Mean age of patients was 53.7+ 20.6 years. Of these patients, 52.7% had stroke (91% had hemorrhages), 32.1% had head injury and 7.6% each had spine problem and brain tumor each. five (3.8%) developed deep venous thrombosis on the 4th and 6th day of ICU stay, mainly in popliteal veins (2.3%) and femoral veins (1.5%). Deep venous thrombosis was associated with younger age (47 years, p=0.005), ICU stay (13 days, p=0.014), Wells' score (4.6, p<0.0001) and Poor Glasgow Coma Score at presentation (9, p=0.004). Power of study calculated for the cohort incidence of 3.8% was 100%. Cost benefit of $336 with WeMPiC protocol was seen as compared to the Low molecular weight heparin prophylaxis over four weeks.

Conclusions: Compared to incidence of 12.1% in CLOTS 3 trial among the unexposed patients, we report a risk reduction of 8.3% with WeMPiC protocol which is cost effective and highly applicable in resource constraint scenarios.

Key words: Deep venous thrombosis, Intermittent graduated compression stockings, Low molecular weight heparin, Mechanical prophylaxis

Introduction

Deep venous thrombosis (DVT) is known to occur in 2-8% of patients with spine injuries, 9.7% in Sub-arachnoid hemorrhages (SAH), 16.9% in traumatic brain injuries (TBI) and highest in brain tumours (21.3%).[1,2,3,4] Neurosurgical patients due to poor sensorium and weakness are often bed ridden exposing them to risk of DVT and consequent pulmonary embolism (PE). Without prophylaxis, incidence of DVT is estimated to be 60%. Not surprisingly, DVT is the single most preventable cause of morbidity and mortality in surgical specialties.[5] Adequate mechanical and/or pharmacological prophylaxis decreases the risk to as low as 6%.[6,7,8]

Mechanical devices like pneumatic or sequential compression devices are not readily available in developing countries due to financial constraints. Use of pharmacological prophylaxis is fraught with risk of re-bleeding in surgical patients. Despite initial encouraging results, CLOTS-1 and 2 trials have casted nihilistic attitude towards use of graduated compression stockings (GCSg).[9,10] Though the observations were not wrong, we believe the way GCSg have been applied need to be modified along with concomitant use of ancillary physical therapies.

We had devised a protocol combining early **W**eaning off of patients from the ventilator, **e**arly **M**obilization, limb **P**hysiotherapy and **i**ntermittent application of thigh length graduated **C**ompression stocking to prevent DVT in neurosurgical patients, also called as **WeMPiC** protocol at our center.

We constructed a study to analyze the effectiveness of this protocol to prevent DVT and study the difficulties associated with its implementation.

Methods and Materials

An observational cohort study was carried out in neurosurgical ICU of Kathmandu Medical College Teaching Hospital (KMCTH) from April 2014 till September 2017.

Study selection criteria

All patients who were consecutively admitted to neurosurgical ICU of the hospital with immobility (i.e. unable to walk independently to the toilet) for ≥7 days or were bedridden were enrolled in the study within first 24 hours of admission. They underwent routine investigation for their primary disease. Compression Ultrasound (CUS) of both lower limbs was performed by co-authors RC and ER as a part of routine bedside workup every alternate day after inclusion in trial. Patients were daily examined for signs of clinical DVT (unilateral leg swelling, warmth and redness). Cases of clinical DVT were confirmed by Doppler ultrasound. Repeat CT scans were performed in patients with clinical neurological worsening to rule out expansion of hemorrhage. D-dimer concentration was not assessed in patient with suspected DVT.

Study exclusion criteria

Patients with congestive cardiac failure, dermatological problems in lower limbs with ulcer and blisters, or with known peripheral vascular disease or an ankle brachial pressure index <0.8 or with active DVT already under anti-thrombotic were excluded from the study.

Sample size calculation

Sample size of the cohort was calculated with power of 80% and 95% confidence interval. Due to large variability in incidence of DVT in patient with neurosurgical diseases (ranging from 2 to 21.3%),[1,2,3,4] incidence reported for TBI i.e. 16.9%[3] was used as incidence in population. With the intervention we expected to decrease the incidence at least to one reported with use of Intermittent Pneumatic Compression (IPC) devices as in CLOTS 3 trial i.e. 8.5%.[11] With the model of dichotomous endpoint and one sample study, the sample size was calculated as 131 based on formula

$$N = \frac{p_0 q_0 \left\{ z_{1-\alpha/2} + z_{1-\beta} \sqrt{\frac{p_1 q_1}{p_0 q_0}} \right\}^2}{(p_1 - p_0)^2}$$

$$q_0 = 1 - p_0$$

$$q_1 = 1 - p_1$$

Where N = sample size for study group, p0 = proportion (incidence) of population (0.169), p1 = proportion (incidence) of study group (0.085), q_0=1-p_0, q_1=1-p_1, α = probability of type I error (0.05), β = probability of type II error (0.2), z = critical Z value for a given α or β (Z score (α/2) =1.96, Z score (1-β) =0.842)

WeMPiC protocol

Our protocol consisted of early **W**eaning off of patients from ventilator after surgery, early **M**obilization of the patient from the bed, limb **P**hysiotherapy and **i**ntermittent application of the thigh length graduated **C**ompression stocking (GCSg) on both legs (for alternate 2 hours on and off throughout day and night) (Figure 1) until either the patient was independently mobile or were discharged or the patient refused to wear them or develops some skin problem. GCSg provided 18 mmHg pressure over ankle, 14mmHg over mid-calf, 8mmHg over popliteal fossa, 10mmHg over mid-thigh and 8mmHg over femoral triangle. Patient with high risk probability on Wells' criteria[12] were started on prophylactic low molecular

weight heparin (LMWH) after 48 hours of cerebral event or neurosurgical intervention. Pneumatic or sequential compression devices were not used. All patients enrolled in the study were exposed to this protocol. To increase compliance all these instructions were written in the treatment charts.

Data extraction

The details of all patients included in the study were recorded. Diagnosis, types of intervention done, chemoprophylaxis if done, and mobility status were also noted. Well's score was calculated with all its components for risk analysis of the patient. Alternate day bedside compression ultrasound (CUS) of femoral and popliteal veins was recorded to see for DVT. Clinical signs for DVT were also recorded.

Outcome

Primary outcome of the study was presence of DVT, confirmed by compression ultrasound (CUS). Clinical markers of DVT were sudden swelling in one limb, pain or tenderness in the thigh or calf, skin that is warm to touch, surface veins becoming more visible and change in color (blue, red or very pale). Patient with positive bedside CUS were also subjected to ultrasound by blinded radiologist for confirmation. On being diagnosed with DVT, study was terminated and patient was put on low molecular weight heparin (LMWH) and GCSg was discontinued, however other components of WeMPiC were continued.

Secondary outcome was death, any DVT or PE and skin breaks. We also analyzed the applicability of Wells Risk Score prediction with occurrence of DVT.

Statistical analysis

Descriptive statistics were used to assess patients' demographic and clinical characteristics. Statistical analysis was performed on SPSS Statistics version 17.0.0 (SPSS Inc., Chicago, IL, USA). Unpaired t-test, $\chi 2$ test, Fisher's exact test, and Mann–Whitney U tests were used to perform univariate comparisons. $p<0.05\%$ was used to identify statistical significance.

This was a non-invasive observational study without any study related additional invasive investigations or interventions which could have added financial burden to the patients. Patients and their family were informed and consent was taken. Prophylactic LMWH was administered to patients who had high probability of having DVT on wells' criteria. Ultrasound analysis was done free of charge by the authors. No incriminating personal data were collected or shared. Ethical clearance from institutional review board was received for the publication of the data.

Results

Characteristics of the cohort

131 neurosurgical patients who met the inclusion criteria, were prospectively followed. Mean age to the patients was 53.7 +/- 20.6 years. 47 patients (35.9%) were females. 48 (36.6%) had hemorrhagic stroke, 6 (4.6%) had ischemic stroke, 42(32.1%) had traumatic brain injury, 15 (11.5%) with aneurysm or arteriovenous malformation (AVM), 10 (7.6%) had brain tumor and 10 (7.6%) had spinal injury. Mean GCS at admission was 9+/- 4. Mean ICU stay of the cohort was 12.3+/- 5.8 days. 81 patients (61.8%) had undergone surgical intervention, of which 17 (13%) had craniotomy, 23 (17.6%) decompressive craniectomy with lax duraplasty, 13 (9.9%) clipping of aneurysm or excision of AVM, 7 (5.3%) CSF drainage procedures, 9 (6.9%) burr hole, 11 (8.4%) spinal instrumentations and 1 (0.8%) had caesarian section.

10 patients (7.6%) with high probability of DVT on Well's criteria, had to be started on prophylactic LMWH. 8 (6.1%) patients on day 1 and 2 (1.5%) on day 2 of study.

17 (13%) patients died during the study and 103 (78.6%) could be discharged in good condition. Eleven patients left against medical advice after the study period.

Wells' risk factor analysis of the cohort

(Table 1) 56 (42.7%) patients were smoker of which 15 had reformed. All the patients were bed ridden initially but during the course of treatment 66 (50.4%) could be wheel chaired and 15 (11.5%) could walk with support. Only 9 patients had active cancer. 107 had paralysis or paresis or had undergone lower extremity orthopedic casting. 103 had gone recently bedridden (>3 days) or had major surgery within past 4 weeks, none had swelling of entire leg or calf swelling or pitting edema at the start of the study or collateral non-varicose superficial veins. Only 1 patient had previously documented DVT.

Mean wells score of the cohort was 1.8+/- 1. 15 (11.5%) patients scored 0, 24 (18.3%) 1, 75 (57.3%) 2, 10 (7.6%) 3, 4 (3.1%) 4 and 3 (2.3%) scored 5 on wells scale. 17 (13%) patients had a high probability of DVT (Wells score 3-8), 99 (75.6%) moderate probability (Wells score 1-2) and 15 (11.5%) had low probability of DVT (wells score <1). All patients with high probability on Wells' score had DVT and none in other two groups (p=0.000).

Termination of study

35 patients (26.7%) completed 2 weeks follow up, 16 (12.2%) expired, 5 (3.8%) developed DVT and 75 (57.3%) started moving by themselves, hence study was terminated.

Factors	DVT Absent	DVT Present	p value
Gender			0.654
Male	80	4	
Female	46	1	
Diagnosis			0.868
Hemorrhagic stroke	45	3	
Ischemic stroke	6	0	
Traumatic Brain Injury	40	2	
Aneurysm or AVM	15	0	
Brain tumor	10	0	
Spinal injury	10	0	
Mean Age in years	53.9± 20.7	47± 18.4	0.005
GCS on admission	9.1± 4.4	9.2± 3.6	0.004
Smoking			0.525
No	74	3	
Active smoker	31	2	
Reformed smoker	21	0	
Mobility status			0.380
Bed ridden	47	3	
Wheel chair bound	65	1	
Walk with support	14	1	
Active Cancer or cancer treated within 6 months			0.536
Yes	9	0	
No	117	5	
Paralysis, paresis or recent orthopedic casting of lower extremity			0.280
Yes	102	5	
No	24	0	
Recently bedridden (>3days) or major surgery within past 4 weeks			0.907
Yes	98	4	
No	28	1	
Previously documented DVT			0.842
Yes	1	0	
No	125	5	
LMWH prophylaxis			0.000
Yes	7	3	
No	119	2	
ICU stay in days	12.3± 5.7	13± 7.0	0.000
Wells score mean	1.7± 0.9	4.6± 0.6	0.000
Death	17	0	0.493

Table 1: Risk factors for DVT in the cohort

Occurrence of DVT

5 (3.8%) patients developed DVT during the study period. 2 patients (1.5%) developed DVT on day 4 both in popliteal vein and 3 (2.3%) on day 6 all in femoral veins. Patients were followed up for 4 weeks but there was no new DVT in remaining patients.

DVT occurred in younger patient group (47 ± 18.4 years Vs 53.9± 20.7) (p=0.005), with relatively better GCS (9.2 ± 3.6 Vs 9.1± 9.2) (p=0.004), with more stay in ICU (13 ± 7 days Vs 12.3± 5.7) (p=0.000) and higher wells score (4.6 ± 0.6 Vs 1.7± 0.9) (p=0.000) (Table 1).

Secondary outcome measures

None of the patient developed any skin ulceration or blisters. There were some skin creases due to crumpling of ends of GCSg however they were transient and did not cause any wound.

Effect of prophylactic LMWH on the study

Despite of prophylactic LMWH in 10 patients, 3 developed DVT (p=0.000) (Table 1).

Symptoms/ Sign	DVT absent	DVT present	p value
Swelling of entire leg			0.000
No	126	3	
Yes	0	2	
Calf swelling 3 cm greater than other leg (measured 10 cm below the tibial tuberosity)			0.000
No	123	0	
Yes	3	5	
Pitting edema greater in the symptomatic leg			0.000
No	126	2	
Yes	0	3	
Collateral non varicose superficial veins measured 10cm below tibial tuberosity			0.842
No	125	5	
Yes	1	0	
Localized tenderness along the deep venous system			0.000
No	122	1	
Yes	4	4	
Wells' criteria DVT risk group			0.000
High probability	12	5	
Moderate probability	99	0	
Low Probability	15	0	

Table 2: Manifestation of DVT in the cohort

	Year, study size	Incidence of DVT	Remark
Wasay et al[29]	2008, 200 (sc heparin) vs 258 (stockings)	Heparin (0%) vs stockings (0.4%)	Expansion of hematoma: Heparin (0.5%) vs stockings (0%)
Muir et al[44]	2003, 65 (GCSg) vs 32 (non GCSg)	Non-significant reduction in DVT in GCS group with an odds ratio of 0.43 (95% CI: 0.14–1.36)	
CLOTS-1 trial[9]	2009, 1256 (GCSg) vs 1262 (Non GCSg)	10% (GCSg) vs 10.5% (Non GCSg), Nonsignificant 0.5% reduction (95% CI −1·9% to 2·9%)	Skin complications: 5% (GCSg) vs 1% (Non GCSg), odds ratio 4·18, 95% CI 2·40–7·27)
CLOTS-3 trial[11]	2015, 1438 (IPC) vs 1438 (No IPC)	8.5% (IPC) vs 12.1% (Non-IPC) OR of 0.65 (95% CI 0.51 to 0.84; p = 0.001)	Skin breaks: 3.1% (IPC) vs 1.4% (no IPC), OR 2.23, 95% CI 1.31 to 3.81
Lederle etal[45]	101 (Heparin) vs 105 (No heparin)	0% (Heparin) vs 0.9% (no Heparin)	Major bleeding 1.5%(heparin) vs 0.8% (No Heparin)
Sachdeva etal[39]	1445 (GCSg) vs 1408 (other than GCSg)	9% (GCSg) vs 21% (other than GCSg)	Meta-analysis of 20 RCTs (10 involving patients undergoing general surgery; 6 orthopedic surgery; 1 neurosurgery, 1 cardiac surgery, and 1 gynecological surgery and only one trial included medical patients

Table 3: Effectiveness of prophylaxis in different series to prevent DVT

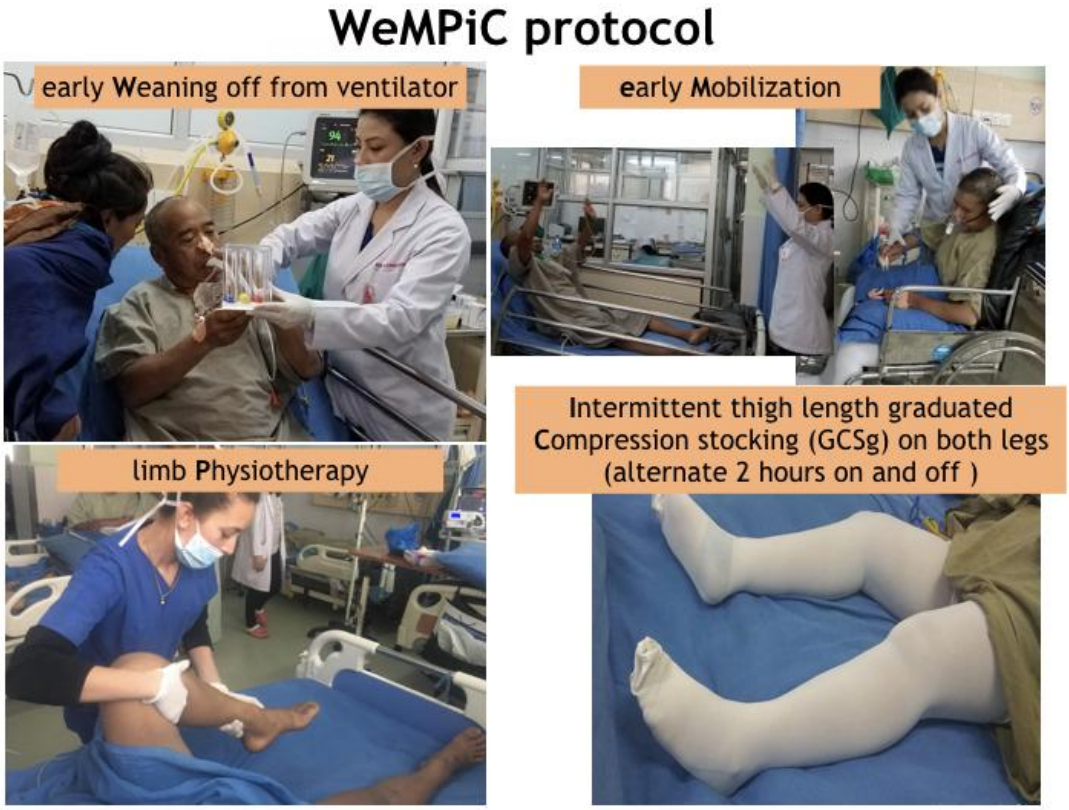

Figure 1: WeMPiC Protocol

Cost Effectiveness

To calculate the cost effectiveness, we included the cost of equipment and consumables and disregarded the cost of manpower and services as the study involved in-patient care over 2weeks period which would not be different between various modalities of thrombo-prophylaxis. LMWH cost $360 for 1 month and IPC devices with one pair of foot garment around $549. However, GCSg would cost only $17-24 each pair. Hence with the use of GCSg, relative cost reduction of $340 over use of LMWH and $532 over IPC could be achieved.

Manifestation of DVT

Table 2 summarizes the symptom presentation of DVT in our cohort. Except for collateral non-varicose superficial veins (p=0.842), statistically significant number of patients with DVT presented with swelling of entire leg (p=0.000), calf swelling 3 cm greater than other leg (p=0.000), pitting edema in symptomatic leg (p=0.000) and localized tenderness along deep venous system (p=0.000).

Discussion

Deep venous thrombosis (DVT) is frequent in patients with neurological diseases. Frequency of DVT is reportedly between 2 to 21.3%.[1,2,3,4,13,14,15] In 102 acute ischemic stroke patients, 40% incidence of venous thromboembolism (VTE) at 21 days was noted.[16] Within first month of stroke, risk of fatal pulmonary embolism (PE) is 1-2%.[17,18] In patients with hemorrhagic stroke, risk of DVT and PE is probably 3-5%.[19] CLOTS-3 trial found 12.1% incidence of DVT in patients of stroke without prophylaxis.[11] In neurosurgical patients, known risk factors for DVT or PE include advanced age, malignancy, limb weakness, history of hypercoagulable state, impaired peri-operative mobility, prolonged surgery, and cranial lesions as opposed to spinal surgery.[20] 92.7% of the hospitalized patients who develop DVT are potentially preventable. [21]

In our series, DVT occurred in first week of the incidence. This finding is similar to Khaldi et al publication of intensively studied 555 patients. They however used subcutaneous heparin within 24 to 48 hours of neurosurgical intervention.[22]

Use of anti-platelet drugs like aspirin or clopidogrel or anticoagulants like unfractionated heparin or enoxaparin are usually recommended to mitigate this risk. However prophylactic anticoagulant or anti-platelet agents is associated with risk of recurrent or new bleeding which limits its early introduction.[23] As such the risk of re-bleed in patients with intracranial hemorrhage (ICH) not receiving aspirin or heparin, is about 0.5% within first

three months.[24,25] The literature on risk of re-bleeding with heparin is scanty. In their prospective study, Dickmann et al had noted re-bled in 1 of 45 patients after receiving 5000 units of unfractionated heparin (UFH).[26] In a retrospective study of 22 patients on long term anticoagulation, Vermeer et al found 2.7 times increased risk of bleeding compared to those patients not on anticoagulants.[27] Contrary to these findings, Jones et al in their study of 68 patients with ICH on heparin did not find any patient of re-bleeding.[28]

Even though a Cochrane meta-analysis had shown highly significant reduction in risk of DVT in patients with ischemic stroke (OR, 0.21; 95% CI, 0.15–0.29) with the use of unfractionated heparin (UFH),[23] International stroke trial found increase in rate of intracranial hemorrhagic (ICH) events, negating the net benefit from this preventive strategy.[13] Wasay et al in their non-randomized comparison study did not find subcutaneous heparin superior to compression stockings, although heparin did increase in hematoma in 0.5% patients.[29]

Low Molecular Weight Heparin (LMWH) is easy to administer and does not need to be monitored. A meta-analysis showed LMWH to reduce the risk of DVT (OR, 0.27; 95% CI, 0.08–0.96) in patients with acute ischemic stroke compared with placebo, but was associated with a twofold increase in the risk of extra-cranial bleeding.[30] Another meta-analysis showed risk reduction of 7.9% (95% CI, 4.2–11.6), with the use of prophylactic enoxaparin when compared to UFH, however symptomatic intra and extra-cranial hemorrhage occurred in 1% of both the groups.[31] Even use of aspirin increases the risk of re-bleeding from 0.5% to 1%.[24] This conflicting risk-to-benefit results are seen even in patients undergoing routine neurosurgical procedures including brain tumors.[32,33,34] To compound to this uncertainty, most of the studies include medical population and hence appropriate dosing for surgical population is still undecided.[21]

To summarize, risk of re-bleed with the use of prophylactic anticoagulants is a major deterrent against recommending it in neurosurgical patients.

In bed ridden patients, venous reflux and blood stasis as a result of loss of muscular pumping action leads to venous hypertension causing increase risk of thrombo-embolism. Graduated compression stockings (GCSg) also called thromboembolic deterrent stocking ('TED' stockings)[35] improves micro-circulation and cutaneous oxygenation, improves lymphatic flow, increases volume and rate of venous blood flow owing to improved efficiency of skeletal-muscle pump and reduced vein diameter, reduces venous reflux owing to improved valve function, reduces edema and inflammation, thereby reducing the relative risk of thromboembolism by 64% in general surgical patients.[36] CLOTS -1 trial did show 8.6% absolute risk reduction on applying GCSg from 15.5% to 6.9% however it was not significant.[9] A recent Cochrane review published in 2018 analyzing 20 RCT with a total of 1681 patients found high quality evidences to support effectiveness of GCSg in reducing risk of DVT in hospitalized patients undergoing surgical interventions with or without background thromboprophylaxis.[37]

A major impediment to widespread use of GCSg has been skin ulceration due to its prolonged use and paradoxical thrombosis in some patient possibly due to tourniquet effect by clumping of stocking over a segment of leg or thigh. To improve outcome patient also requires physical therapy and mobilization. These may be the possible reasons for getting a non-significant absolute risk reduction of DVT of 0.5% after stroke with thigh length GCSg in CLOTS-1 trial. GCSg was rather associated with increase skin ulcers, breaks, blister and necrosis (5% in GCS group vs 1% in control).[9] GCSg may increase risk of critical limb ischemia and are contraindicated in patient with known peripheral vascular disease or an ankle brachial pressure index <0.8.[38] CLOTS-2 trial showed 2.5% increased absolute risk in DVT with knee length stocking as compared to thigh length stocking.[10] Both the earlier two trials actually did not try intermittent application of GCSg which could have avoided skin problems. It can be argued that thigh length GCSg could have provided more benefit than knee length GCSg, while exposing the patient to same skin complications.[35] To avoid these possible complications, we advised alternate 2 hourly off and on application of stockings to allow skin to relax in between and allow inspection and adjustment of stocking. By this technique we did not find any of our patients developing skin ulceration with the use of stockings. This off and on technique could have benefitted the patient similar to the action of Intermittent pneumatic compression (IPC) devices. This intermittent but sequential circumferential compression via thigh length sleeves at a frequency determined by venous refill may have led CLOTS-3 trial to show decrease in the risk of DVT by 3.6% from 12.1% to 8.5% on use of IPC.[11] Reduced venous stasis and possibly the effects on intrinsic fibrinolysis observed with IPC are the other reasons.[39] However, due to continuous application of IPC devices, these patients still develop significantly more skin problems.

On comparing with the 12.1% risk of DVT in unexposed group in CLOTS-3 trial, the absolute risk reduction of 8.3% was achieved by WeMPiC protocol.[11] In our series there was no asymptomatic DVT. We believe this benefit was supplemented by early weaning and mobilization allowing effective limb physiotherapy. Besides use of prophylactic LMWH in high probability cases could have helped prevent DVT from developing further. This may be the reason of having the lowest incidence of DVT in our patients following WeMPiC protocol of 3.8% as compared

to 10% in CLOTS-1, 6.5% in CLOT-2, 8.5% in CLOT-3 trial and 9% in Cochrane review when they were exposed to mechanical prophylaxis.[9,10,11,37] (Table 3)

Besides, this protocol also helps in decreasing the chances of chest infection and resultant sepsis. Early mobilization also increases appetite, improves bowel movement, allows good sleep, activates brain and tones up muscle.

Considering the cost of equipment and consumables, we found this protocol easy to implement yet very cost effective. IPC has been shown to be associated with increase hospital cost.[11] Moreover, patients' relatives could be easily taught and by being physically involved in patient care, they feel emotionally connected.

We have not evaluated the long-term effect on survival or functional outcome by using our protocol. However previous studies like CLOTS 3 trial (use of IPC)[11] or other interventions aimed to prevent or treat complications after stroke like tube feeding[40] or antibiotics[41] does not appear to improve the outcome of survivors.

In this study similar to Dybowska et al we did find a highly accurate Wells scale performance, and thus confirm its usefulness in the assessment of the probability of deep venous thrombosis of the lower limbs. [12]

Advantages of this study

This protocol being a low technology regimen is replicable and cost effective. Our study suggests a method to avoid skin problems associated with GCSg and at the same time underlies the importance of ancillary physical therapies to harvest the maximum benefit of mechanical thrombo-prophylaxis. Beside GCSg other components of WeMPiC protocol offers to avoid preventable reasons of DVT. What we need is a dedicated nursing team, physiotherapist, good clinical judgment and routine evaluation for occurrence of DVT. As both clinical and sonographical parameters were evaluated, chance of missing DVT is minimized. The screening CDU undertaken on alternate days was far more frequent than adopted in CLOTS-1 trial (day 7, 10, 25 and 30 after randomization).9

On Post hoc analysis, with a sample size of 131 the intervention which led to decrease in incidence of DVT to 3.81% (compared to 16.9% of DVT in literature[3]), power of this study was found to be 100%.

We found our protocol simple yet a cost-effective method to prevent DVT.

Limitation of the study

This was a cohort study without randomization and hence statistically would provide a weak evidence. Moreover, the cohort analyzed in this study had varied neurosurgical conditions. Due to the recent recommendation by CLOTS-1 and 2 trial, randomized clinical trial with GCSg have become difficult. However, this being a novel idea of preventing DVT we wanted to test the hypothesis first. A randomized clinical trial is recommended to find the risk reduction with the WeMPiC protocol.

Besides, graduated compression stockings (GCSg) used in the study was not of a specific company and hence could have possibly affected the results.[42] According to recommendation of Surgical Materials Testing Laboratory of United Kingdom and Sigel et al, GCSg should deliver 18-14-8-10-8 mmHg profile as endorsed by the National Institute for Health and Clinical Excellence's (NICE) clinical guideline.[38,43]

Staff and attendants were not blinded to the delivery and effect of the treatment protocol. CLOTS collaborators have identified incorrect use and poor compliance with GCSg with reduced effectiveness.[9]

We have not evaluated the effect of the ability of patient to raise the legs off the bed on the occurrence of DVT.

Since this study involves physical therapy both care provider as well as patient attendants needs to be enthusiastic. Adherence to such mechanical therapy is difficult, with CLOTS-3 trial showing only 26.3% perfect adherence even on automatic IPC devices.[11]

Conclusion

We studied a novel approach of mechanically preventing DVT in neurosurgical patients by use of early weaning off of ventilator, early mobilization, limb physiotherapy and intermittent application of thigh length graduated compression stockings (or WeMPiC protocol) and found it easily replicable and cost effective.

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