Evaluating the Role of Lower Extremity Elastic Bandage in Patients with Diuretic-Resistant Heart Failure

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Background: Inadequate response to diuretics is associated with high morbidity and mortality during acute decompensation of heart failure (ADHF). Lower extremity compression therapy has been proposed as an adjunct to mitigate diuretic resistance. We evaluated the effect of lower leg compression with elastic bandages on diuretic efficiency in patients with diuretic-resistant ADHF.

Methods

Historical cohort study enrolling adult cardiac ICU admissions with ADHF who used elastic bandages (EB) at Mayo Clinic Rochester from 2007 to 2017. The diuretic efficiency, total urine output (ml) per diuretic dose, standardized to a 40-mg furosemide equivalent, before and after applying EB, was the primary outcome.

Figure 1. Flowchart of patient recruitment

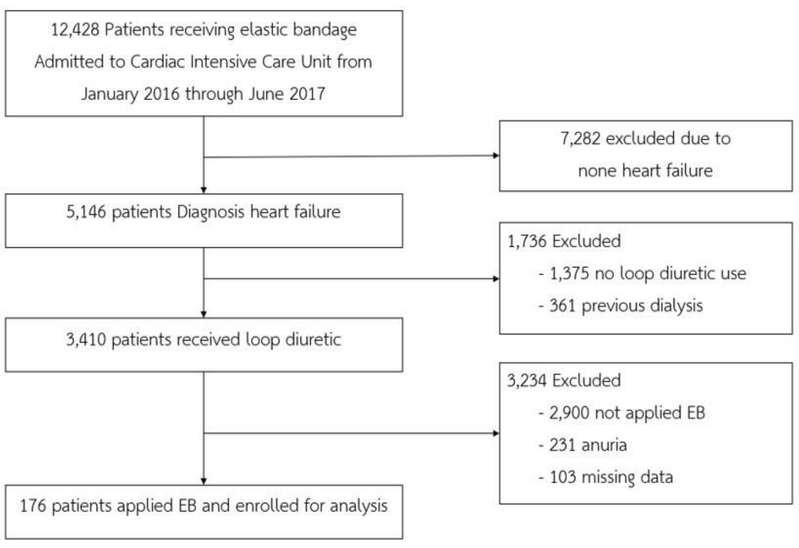

Table 1. Baseline characteristics of heart failure patients with diuretic resistance.

Characteristic (total population 176)	All EB participants, n (%)
Age, years, median, IQR	69.4 (57, 80)
Male, n (%)	108 (61.4)
White Race, n (%)	156 (88.6)
BMI at ICU admission, kg/m2, mean, SD	32.5±9.0
Comorbidities, n (%)	
Diabetes Mellitus	65 (37.1)
Myocardial infarction	30 (7)
Chronic kidney disease	74 (41.5)
Lung disease	45 (25.6)
Malignancy	38 (21.5)
Clinical Scoring, mean, SD	
Charlson Comorbidity Index	6.8±3.5
Apache III score in ICU	69.5± 19.1
1st Braden score	16.3±3.0

Diagnosis ICD 9,10, n (%)	
Coronary artery disease	98 (55.7)
Mod-severe RV dysfunction	77 (47.8)
Mod-severe LV dysfunction	87 (54.7)
Sepsis	32 (11.2)
Shock	40 (22.7)
-Cardiogenic shock	35 (19.9)
-Septic shock	19 (10.8)
Multiple organ failure	83 (47.2)
Acute Kidney Injury	62 (35.2)
-AKI stage 1	50 (80.6)
-AKI stage 2	9 (14.5)
-AKI stage 3	3 (4.8)
Medication, n (%)	
Loop diuretic	
-Torsemide	11 (6.3)
-Bumetanide	24 (13.6)
-Furosemide	170 (96.6)
Non-loop diuretic	92 (52.3)
Laboratory, median (IQR)	
Baseline Creatinine, mg/dL	1.3 (1.0, 1.9)
Baseline eGFR, ml/min/1.73m2	55 (36, 73)
Baseline LVEF, %	40±20, 39 (21, 60)

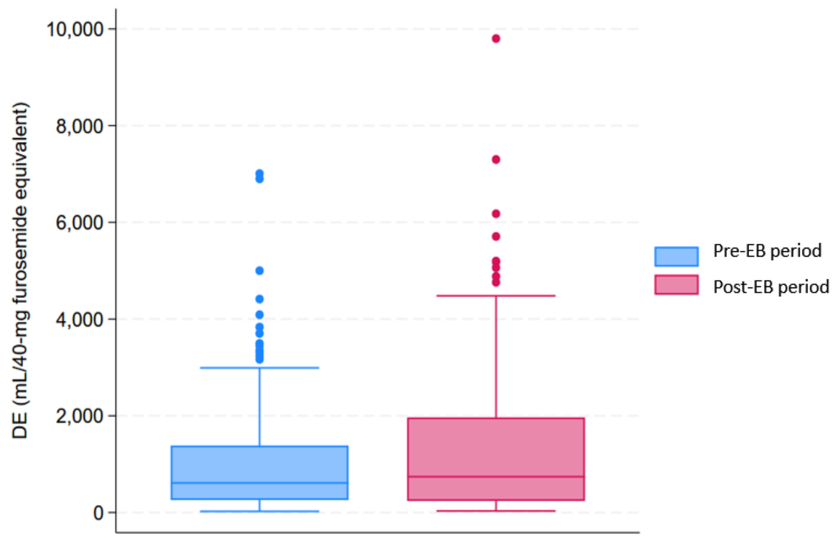

Figure 2. Diuretic efficiency (ml of urine generated for each 40 mg of furosemide or its equivalent) before and after application of the lower extremity elastic bandage

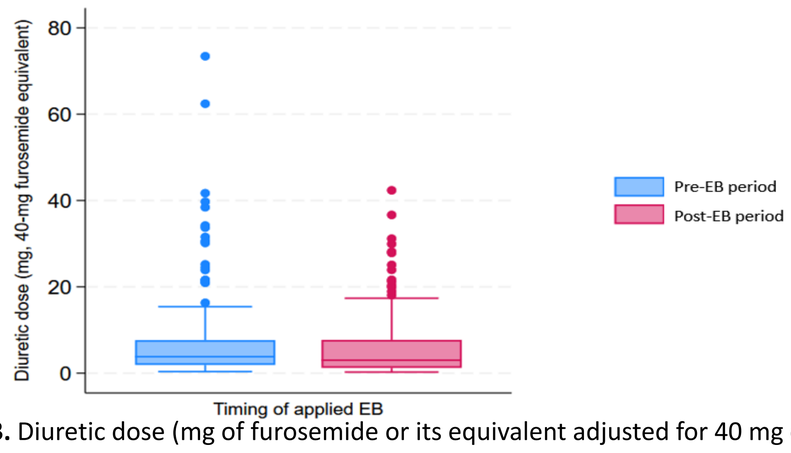

Figure 3. Diuretic dose (mg of furosemide or its equivalent adjusted for 40 mg of furosemide or its equivalent) before and after application of lower extremity elastic bandage

Results

A total of 176 heart failure patients receiving elastic bandages were included. The in-hospital mortality rate, the median hospital length of stay, and 30-day hospital readmission were 9.7%, 11.4 days (IQR 7.1–19.0), and 11%, respectively. When EB was applied, the average daily loop diuretic dosage was decreased by a mean difference of 1.19 mg per 40 mg furosemide equivalent (95% CI: 0.22 to 2.2; p=0.016). The average post-EB diuretic efficiency was 1,355 mL per 40-mg furosemide equivalent (IQR 1119, 1590), which was significantly higher than before EB application with the mean difference of 340 mL per 40-mg furosemide equivalent (95% CI: -554, -125; p=0.002). As a result of higher diuretic efficiency and lowered doses of diuretics, average daily urine output before and after EB application was not different (2,642 pre-EB vs. 2,792 post-EB mL/day; 95% CI: -455 to 154; p = 0.33).

Table 2. The outcomes prior to and after applying the Elastic Bandage for lower extremity compression.

	Pre-EB Mean (SD)	Post-EB Mean (SD)	Mean difference (95% CI)	P-value
Diuretic Efficiency				
Diuretic Efficiency (mL/40mg furosemide equivalent)	1,015 (1,168)	1,354.7 (1,585)	-339.6 (-554.5 to -124.7)	0.002
Loop diuretic dosage				
Loop diuretic dose 1-day prior-after (mg, 40-mg furosemide equivalent)	7.45 (10.6)	6.7 (8.9)	0.75 (-0.02 to 1.53)	0.056
Average daily loop diuretic dose (mg, 40-mg furosemide equivalent)	7.2 (10.4)	6.0 (7.4)	1.19 (0.22 to 2.2)	0.016
Adjusted diuretic dose (40-mg furosemide equivalent/min/1.73 m^2)	0.22 (0.61)	0.19 (0.47)	0.02 (-0.01 to -0.05)	0.18
Net fluid balance				
Net fluid balance (ml)	-1,059 (-1,773)	-1,280 (1,641)	221 (-58 to 499)	0.12
Average net fluid balance (ml/day)	-782.8 (1,588)	-709.8 (1,206)	-73 (-334.0 to 188.0)	0.58
Weight-adjusted net fluid 1-day prior-after (ml/kg/day)	-11.5 (20.9)	-14.3 (17.7)	2.8 (-0.6 to 6.1)	0.11
Weight-adjusted average net fluid (ml/kg/day)	-8.7 (19.5)	-7.6 (11.2)	-1.1 (-4.2 to 2.0)	0.48
Urine output				
Average daily urine output (ml/day)	2,642 (1,432)	2,792 (1,869)	-150 (-455 to 154)	0.33
Urine output (m/day)	2,579 (1,524)	2,668 (1,797)	-87 (-358 to 182)	0.52
Weight-adjusted urine output (ml/kg)	29.7 (17.1)	31.0 (19.6)	-1.3 (-4.6 to 2.0)	0.43

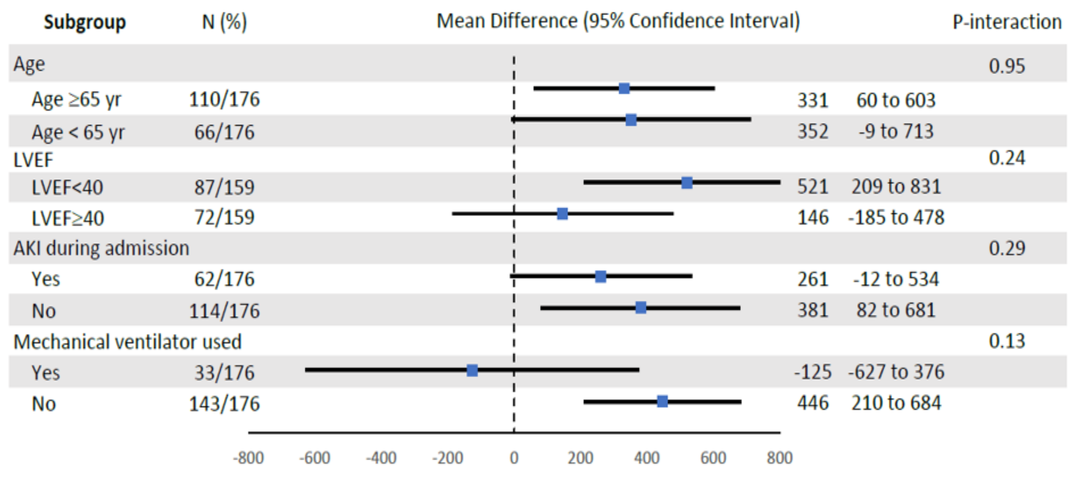

Figure 4. Subgroup analysis of the mean difference in diuretic efficacy following leg compression by elastic bandage

Conclusion

Leg compression therapy using EB enhances urine output and reduces diuretic requirements, resulting in improved diuretic efficiency during ADHF with diuretic resistance. Further studies are needed to determine the potential clinical benefits and risks of applying EB compression treatment in ADHF.

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