A Feasibility Study Comparing Current Endoscopic Vein Harvesting Training With A Structured Training Programme

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Background

Endoscopic Vein Harvesting (EVH)(Figure 1a) has demonstrated a reduction in wound complications and increased patient satisfaction compared to traditional open vein harvesting. This feasibility study aims to assess whether a structured comprehensive keyhole removal training programme enhances the quality of the vein harvested by improving the harvester's skills and confidence.

Methods

Two hospitals participated, each with two trainees (Figure 1). Trainees T1 and T2 underwent Structured Training (ST) using Manchester Endoscopic Learning Tool (MELT), while T3 and T4 received Conventional Training (CT). The recruitment target was 20 patients per trainee (n=80). ST was delivered by an experienced EVH harvester, and CT by a commercial proctor. Current CT involves limited leg model practice and intermittent operating room exposure over 2–3 weeks. The ST programme included four phases: theoretical instruction, simulation-based training with hand-eye coordination exercises, surgical video analysis and hands-on vein harvesting. Trainees were required to score at least 80% in each section. Pre- and post-training questionnaires were completed, with vein endothelial integrity assessed using CD34 immunohistochemistry. Blindly scored and ratified by histopathologist. Patients were followed at five time points over 12 months, with CT angiograms conducted between 12–24 months post-surgery. Due to limited CT data, no post-training comparative analysis was possible. Descriptive statistics (median [IQR]) were calculated.

Figure 1a: Illustrates Endoscopic Vein Harvesting with harvested three lengths of long saphenous vein

Figure 2: Illustrates the CD34 staining of H1, H2, H3 sections. a) represents full intact endothelium to minimal disruption indicated with black arrows; b) represents more than 50% loss of endothelium; c) represents 90 to 100% loss of endothelial layer with muscle migration towards lumen

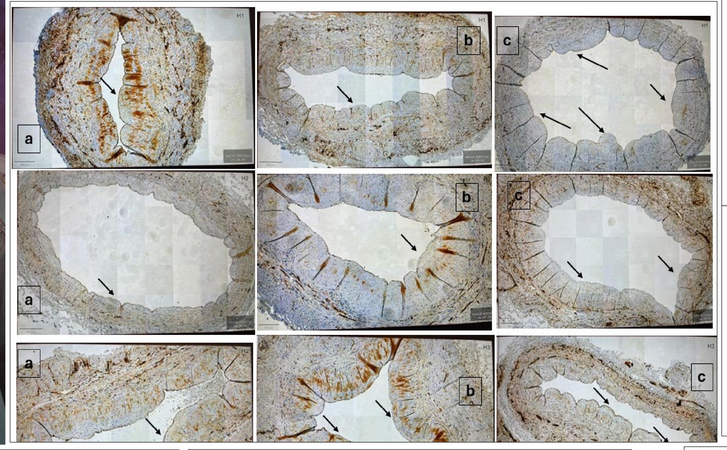
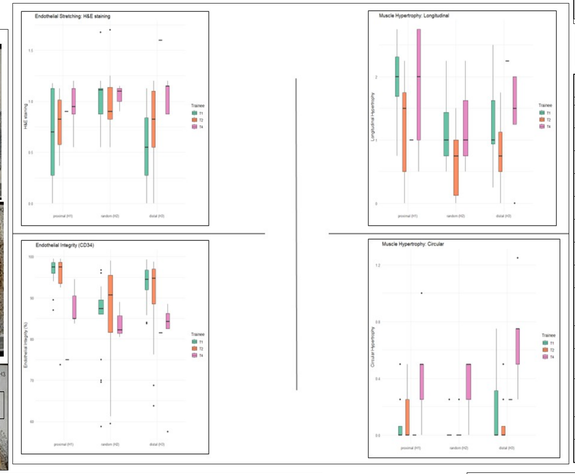


Figure 3: illustrates of the median % of endothelial integrity on proximal, random and distal vein samples



Results

Two male and female trainees were recruited. CT trainees completed 39 cases over 9 months of intermittent training, while ST trainees completed 36 cases over continuous 4-week period(Table 1). Post-training, CT trainees performed 1 (T3) and 5(T4) cases respectively before withdrawing due to anxiety. ST trainees completed 20 cases each. Due to insufficient data from the CT group, no comparative analysis was possible. Descriptive statistical analysis (median [IQR] or count [%]) was performed.

Endothelial integrity (CD34 staining) scores showed higher preservation in ST trainees: (Figure 2 & Figure 3)(Table 2)

- H1: T1-97.5 [95.9, 98.6], T2-97.5 [93.5, 98.8], T3-75, T4-85.0 [85.0, 90.5]
- H2: T1-87.4 [86.0, 89.8], T2-90.8 [79.5, 95.5], T4-82.3 [80.5, 89.0]
- H3: T1-94.5 [90.8, 97.0], T2-94.8 [87.3, 97.3], T3-81.5, T4-84.3 [82.5, 86.3]

Among 46 patients, adverse outcomes included angina (2.2%), myocardial infarction (2.2%), re-intervention (6.5%), and death (2.2%). CT angiography was performed in 23 patients (20 ST group, 3 CT), assessing 37 grafts (Table 3). Of these, 11 grafts were blocked: 3/37 were flow-limiting (2 RCA, 1 OM2) and 8/37 were completely occluded (6 D1, 2 OM2), primarily in small-calibre diabetic vessels. Among affected patients, 60% had four vein lengths harvested and 40% had three. Graft occlusions were more common in patients with diffuse diabetic coronary disease.

Post-training anxiety scores, as measured by the Global Operative Assessment of Laparoscopic Skills (GOALS): (Table 4)

- GOALS: T1-23.0 (22.5, 23.5), T2-23.0 (23.0, 23.0), T3-25.0 (25.0, 25.0), T4-25.0.
- Beck's Anxiety: T1-0.0 (0.0, 1.0), T2-1.0 (1.0, 1.3), T3-3.0 (1.0, 4.8), T4-1.0 (0.0, 1.0).

Conclusion

Due to the COVID-19 pandemic and associated backlog, the study was halted. Despite multiple rounds of intermittent training over 12 months, the CT trainees withdrew due to anxiety and lack of support. In contrast, ST trainees successfully completed training and performed over 400 cases post-study demonstrating the programme's effectiveness.

References:

1. Krishnamoorthy, B et al., (2015). Does the introduction of a comprehensive structured training programme for endoscopic vein harvesting improve conduit quality? A multicentre pilot study. Interact Cardiovasc Thorac Surg. Feb;20(2):186-93.
2. Le Bras A. Endoscopic versus open vein-graft harvesting. Nat Rev Cardiol. 2019 Jan;16(1):3.

Figure 1: CONSORT (Consolidated Standards of Reporting Trials) diagram demonstrating the detailed enrolment, consented, treatment and analysis of trainees and patients.

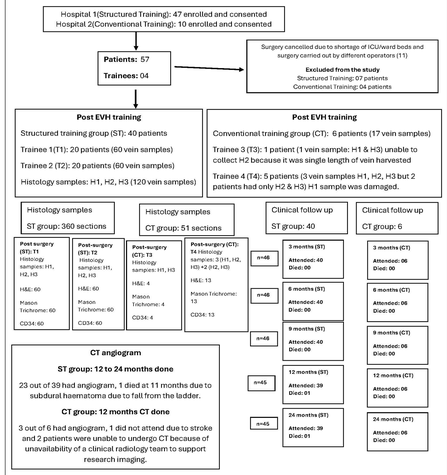


Table 1: Illustrates the demographic variables

Demographic variables	T1 (ST, n=20)	T2 (ST, n=20)	T3 (CT, n=01)	T4 (CT, n=05)
Age	62.0 [54.5, 68.0]	68.5 [59.0, 76.0]	NA	68.0 [56.0, 76.0]
M/F, n(%)	17.0 / 3.0 (85.0 / 15.0)	17.0 / 3.0 (85.0 / 15.0)	1.0 / 0.0	5.0 / 0.0
Body mass index Median [IQR]	28.5 [25.7, 31.6]	26.9 [25.4, 30.5]	30.0 [30.0, 30.0]	29.0 [28.0, 29.0]
Surgery, n(%)				
Elective	8.0 (40.0)	6.0 (30.0)	0.0 (0.0)	3.0 (60.0)
Urgent-in-patient	12.0 (60.0)	14.0 (70.0)	1.0 (100.0)	2.0 (40.0)
Diabetes mellitus, n(%)				
Diet controlled	9.0 (45.0)	12.0 (60.0)	0.0	2.0 (40.0)
Tablet controlled	6.0 (30.0)	8.0 (40.0)	0.0	0.0
Insulin controlled	4.0 (20.0)	2.0 (10.0)	0.0	0.0
Smoking, n(%)				
Never smoked	9.0 (45.0)	9.0 (45.0)	0.0	2.0 (40.0)
Previous smoker	7.0 (35.0)	8.0 (40.0)	1.0 (100.0)	2.0 (40.0)
Current smoker	4.0 (20.0)	3.0 (15.0)	0.0	1.0(20)
Left ventricular ejection fraction, n(%)				
>50%	13.0 (65.0)	16.0 (80.0)	1.0 (100.0)	3.0 (60.0)
30%-50%	6.0 (30.0)	4.0 (20.0)	0.0 (0.0)	2.0 (40.0)
<30%	1.0 (5.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Logistic Euroscore Median [IQR] Missing data	2.5 (1.6, 3.1) 0	3.4 (2.2, 5.7) 0	NA 1	NA 5
STEMI n(%)	5.0 (25.0)	2.0 (10.0)	0.0 (0.0)	0.0 (0.0)
NSTEMI n(%)	7.0 (35.0)	11.0 (55.0)	1.0 (100.0)	5.0 (100.0)
Previous PTCA, n(%)	5.0 (26.3)	4.0 (20.0)	0.0 (0.0)	0.0 (0.0)
Presence of Q wave	13.0 (65.0)	5.0 (25.0)	0.0 (0.0)	0.0 (0.0)
Multivessel coronary disease, n(%)	19.0 (95.0)	20.0 (100.0)	1.0 (100.0)	5.0 (100.0)
Left main stem disease, n(%)	6.0 (30.0)	3.0 (15.0)	1.0 (100.0)	2.0 (40.0)
Hypercholesterolemia n(%)	19.0 (95.0)	13.0 (65.0)	1.0 (100.0)	4.0 (80.0)
Hypertension, n(%)	16.0 (80.0)	17.0 (85.0)	1.0 (100.0)	5.0 (100.0)
Peripheral vascular disease, n(%)	1.0 (5.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Intraoperative variables				
Number of grafts Median [IQR]	3.0 [2.0, 4.0]	3.0 [2.0, 4.0]	2.0 [2.0, 2.0]	3.0 [2.0, 3.0]
Number of vein grafts Median [IQR]	2.0 [1.0, 2.5]	2.0 [1.5, 3.0]	1.0 [1.0, 1.0]	2.0 [1.0, 2.0]
Vein graft not used for surgery, n(%)	2.0 (10.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Leg drain inserted, n(%)	18.0 (94.7)	20.0 (100.0)	0.0 (0.0)	0.0 (0.0)
Bypass time, Median[IQR]	101.0 [84.0, 137.0]	99.0 [83.0, 127.0]	51.0 [51.0, 51.0]	78.0 [69.0, 108.0]
X Clamp time, Median[IQR]	62.0 [53.0, 86.0]	67.0 [52.0, 85.0]	30.0 [30.0, 30.0]	66.0 [49.0, 93.0]
Vein harvesting time (min)	55.0 (48.5, 67.0)	54.5 (43.0, 68.0)	NA	65.0 (60.0, 66.0)
Total surgery time (min)	245.0 (221.3, 278.5)	260.0 (202.5, 292.5)	NA	220.0 (205.0, 246.0)
Leg surgery (min)	98.0 (76.0, 114.5)	94.0 (78.1, 96.5)	NA	71.0 (65.0, 90.0)
2500 IU systemic Heparin given before starting EVH	16.0 (80.0)	19.0 (95.0)	1.0 (100.0)	5.0 (100.0)

Table 4: Illustrates Trainee performance, vein quality, anxiety outcomes and Kirkpatrick evaluation outcomes

Measurement	Structured Training		Conventional Training	
	During training n=36	Post training n=40	During training n=39	Post training n=8
Total GOAL score (Scored by independent expert assessor)				
Median [IQR] Mean (SD) Missing	21.0 [15.0, 23.0] 18.7 (5.2) 3	23.0 [23.0, 23.0] 22.9 (1.5) 0	15.0 [15.0, 25.0] 18.7 (5.1) 0	25.0 [25.0, 25.0] 25.0 (0.0) 1
Total quality of harvested vein score (Consultant surgeon score)				
Median [IQR] Mean (SD) Missing	2.0 [1.0, 2.0] 2.0 (1.3) 3	1.0 [1.0, 3.0] 1.9 (1.6) 0	0.0 [0.0, 2.0] 1.1 (1.4) 0	2.0 [2.0, 2.0] 2.0 (1.3) 2
Total Beck Anxiety Inventory Score (Self-reported)				
Median (IQR) Mean(SD) missing	1.0 [0.0, 3.0] 1.9 (2.6) 0	1.0 [0.0, 1.0] 0.8 (0.8) 0	1.0 [0.0, 3.5] 2.4(2.8) 0	1.0 [0.3, 1.0] 0.8(0.8) 2

Table 2: Illustrates the endothelial integrity (CD34), Mason Trichrome and H&E

	T1(n=20)	T2 (n=20)	T3 (n=1)	T4 (n=5)
Endothelial Integrity (CD34 staining)				
H1 sample Median [IQR] Missing sample	97.5 [95.9, 98.6] 0	97.5 [93.5, 98.8] 1	75.0 0	85.0 [85.0, 90.5] 0
H2 sample Median [IQR] Missing	87.4 [86.0, 89.8] 2	90.8 [79.5, 95.5] 1	Not Available(NA) 1	82.3 [80.5, 89.0] 2
H3 sample Median [IQR] Missing	94.5 [90.8, 97.0] 1	94.8 [87.3, 97.3] 0	81.5 0	84.3 [82.5, 86.3] 0
Endothelial stretching (H&E staining)				
H1 sample Median [IQR] Missing sample	0.7 (0.3, 1.1) 0	0.8 (0.6, 1.1) 1	0.9 0	1.0 (0.9, 1.1) 0
H2 sample Median [IQR] Missing	1.1 (0.9, 1.1) 2	0.9 (0.8, 1.2) 1	NA 1	1.1 (0.9, 1.2) 2
H3 sample Median [IQR] Missing	0.6 (0.3, 0.9) 1	0.8 (0.6, 1.1) 0	1.6 0	1.2 (0.9, 1.2) 0
Smooth muscle hypertrophy (Mason Trichrome staining				
H1 Longitudinal hypertrophy (LH) Median [IQR] Missing sample	2.0 (1.6, 2.4) 0	1.5 (0.5, 1.8) 1	1.0 0	2.0 (1.0, 2.8) 0
H2 (LH) Median [IQR] Missing sample	1.0 (0.8, 1.5) 2	0.8 (0.0, 1.0) 1	NA 1	1.0 (0.5, 2.3) 2
H3 (LH) Median [IQR] Missing sample	1.0 (0.9, 1.8) 1	0.8 (0.5, 1.3) 0	2.3 0	1.5 (1.3, 2.0) 0
H1 Circular hypertrophy (CH) Median [IQR] Missing sample	0.0 (0.0, 0.1) 0	0.0 (0.0, 0.3) 1	0.0 0	0.5 (0.3, 0.5) 0
H2 (CH) Median [IQR] Missing sample	0.0 (0.0, 0.0) 2	0.0 (0.0, 0.0) 0	NA 1	0.5 (0.0, 0.5) 2
H3 (CH) Median [IQR] Missing sample	0.0 (0.0, 0.4) 1	0.0 (0.0, 0.1) 0	0.3 0	0.8 (0.5, 0.8) 0

Table 3: Illustrates the incidence of postop complications and investigations

Variable	T1 (n-20)	T2 (n=20)	T3 (n=1)	T4 (n=5)
Leg wound numbness, n(%) 6 weeks	8 (40.0)	5 (25.0)	1 (100.0)	5 (100.0)
Leg wound tenderness, n(%) 6 weeks	13 (65.0)	5 (25.0)	1(100.0)	3 (60.0)
Arrythmias, n(%) missing	4 (21.0) 0	1 (5.0) 1	NA 1	NA 5
Atrial fibrillation, n(%) missing	5 (25.0) 0	1 (5.0) 0	NA 0	1 (20.0) 0
Post- surgery coronary angiogram, n(%)	1 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)
Investigations done for non-cardiac surgery, n(%)	5 (26.0)	4 (20.0)	0 (0.0)	0 (0.0)
Repeat angina, n(%)				
1 month	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
3 months	1 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)
6 months	1 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)
9 months	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
12 months	0 (0.0)	1 (5.0)	0 (0.0)	0 (0.0)
Missing data	1	1		0
Breathlessness, n(%)				
1 month	5 (25.0)	5 (25.0)	0 (0.0)	4 (80.0)
3 months	3 (15.0)	4 (20.0)	NA	1 (20.0)
6 months	3 (15.0)	3 (15.0)	NA	0 (0.0)
9 months	0 (0.0)	3 (15.0)	NA	0 (0.0)
12 months	1 (5.0)	1 (11.0)	NA	0 (0.0)
Missing data	1	2	1	0
Re-intervention, n(%)				
1 month	1 (5.0)	1 (5.0)	0 (0.0)	0 (0.0)
3 months	0 (0.0)	0 (0.0)	NA	0 (0.0)
6 months	0 (0.0)	0 (0.0)	NA	0 (0.0)
9 months	1 (5.0)	0 (0.0)	NA	0 (0.0)
12 months	0 (0.0)	0 (0.0)	NA	0 (0.0)
Missing data	1	0	1	0
Myocardial infarction, n(%)				
1 month	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
3 months	0 (0.0)	0 (0.0)	NA	0 (0.0)
6 months	0 (0.0)	0 (0.0)	NA	0 (0.0)
9 months	1 (5.0)	0 (0.0)	NA	0 (0.0)
12 months	0 (0.0)	0 (0.0)	NA	0 (0.0)
Missing data	1	0	1	0
Survival, n(%)				
1 month	20 (100.0)	20 (100.0)	1 (100.0)	5 (100.0)
3 months	20 (100.0)	20 (100.0)	NA	5 (100.0)
6 months	20 (100.0)	20 (100.0)	NA	5 (100.0)
9 months	20 (100.0)	20 (100.0)	NA	5 (100.0)
12 months	19 (96.0)	20 (100.0)	NA	5 (100.0)
24 months	19 (95.0)	20 (100.0)	NA	5 (100.0)
Missing data	0	0	1	0
Cause of Major Adverse Cardiac Events (MACEs) at 24 months				
CT contrast angiography (n=24/45)	7/20	14/20	NA	3 / 5
Total number of vein grafts assessed (n=38)	13	23	NA	2
Vein graft patent	10/13	11/23		2/2
Flow-limiting (n=5/36)	1/13	4/23	NA	0
Completely blocked (n=10/36)	2/13	8/23	NA	0
Diagonal graft (n=7/36)	2/13	5/23	NA	0
Obtuse Marginal graft (OM2)(n=4/36)	1/13	3/23	NA	0
Right Coronary Artery (Posterior Descending Artery) (n=4/36)	0/13	4/23	NA	0
ACC/AHA scoring for coronary artery stenosis: Type C (diffuse >2cm) lesion	7 patients	14 patients	NA	0
Small-calibre diabetic vessels	7 patients	14 patients	NA	0