Obesity-related decrease in intraoperative blood flow is associated with primary failure of radiocephalic arteriovenous fistula

Young Su Kim[1], Jeon Yong Deok[2], Jwa-Kyung Kim[1], Hyung Jik Kim[1], Sung Gyun Kim[1]
[1]Department of Internal Medicine & Kidney Research Institute, Hallym University Sacred Heart Hospital, Korea
[2]Department of Internal Medicine, National Medical Center

Objectives

•Current practice guideline emphasized the use of arteriovenous fistula (AVF) as the preferred type of vascular access for hemodialysis patients.
•However, fistulas are superior to grafts only if they mature. Therefore, determining risk factors associated with AVF failure emerges as an important issue.
•In recent years, the obesity epidemic is growing both in the general population and in hemodialysis patients. However, the vascular access effects of the high BMIs remain unclear, yet. Furthermore, there has been lack of consensus whether different guidelines for fistula placement should be applied in the obese hemodialysis population.
•In this cohort study of incident Korean hemodialysis patients, we evaluated the effects of obesity on the primary maturation failure of AVF by assessing its association with intraoperative blood flow (IOBF).

Methods

•Patients who newly created radiocephalic AVF were included (n=252).
•Obesity was defined as a baseline BMI ≥25 kg/m2, according to the Asian International Obesity Task Force (IOTF)
•The IOBF volume of the fistula was immediately measured systematically after construction of the AVF by placing a 3–4 mm handheld flowprobe (MediStim, Oslo, Norway) around the draining vein 1–2 cm downstream from the anastomosis. using IOBF was measured immediately after construction.
•Early and late primary maturation failure was defined as the failure to use AVF successfully by 3 months and 6 months after its creation, despite radiological or surgical interventions.

Results

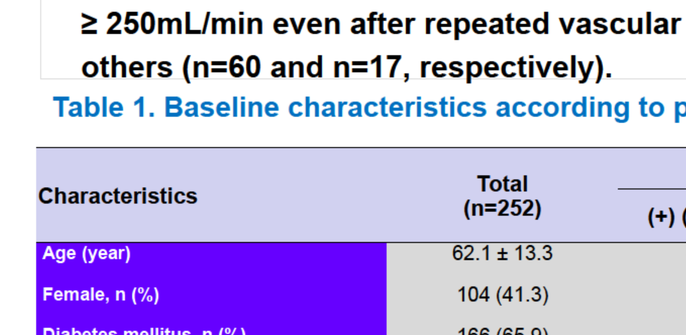
•The mean BMI was 24.1 ± 3.9 kg/m2, and the prevalence of BMI ≥25 kg/m2 was 31.3% (79 patients). Particularly, 8.3% (21 patients) were BMI ≥ 30 kg/m2 (mean 32.7 ± 2.60 kg/m2).
•Early and late primary maturation fa 1 ilure occurred in 100 (39.7%) and 35 (13.9%) patients, respectively. The reasons for early and late maturation failure were 1) inadequate size (n=26 and n=6), inability to attain blood flow of ≥ 250mL/min even after repeated vascular interventions (n=14 and n=12), and others (n=60 and n=17, respectively).

Table 1. Baseline characteristics according to primary maturation failure.

Characteristics	Total (n=252)	Early primary maturation failure		
		(+) (n=100, 39.7%)	(-) (n=152, 60.3%)	p
Age (year)	62.1 ± 13.3	-63.5 ± 13.5	61.1 ± 13.1	0.168
Female, n (%)	104 (41.3)	49 (49.0)	55 (36.2)	0.029
Diabetes mellitus, n (%)	166 (65.9)	71 (71.0)	95 (62.5)	0.104
Body mass index (kg/m²)	24.1 ± 3.9	25.2 ± 4.5	22.3 ± 3.33	0.011
≥ 25 (n, %)	79 (31.3)	48 (48.0)	31 (20.4)	0.001
Cardiovascular disease, n (%)				
Coronary artery disease	54 (21.4)	29 (29.0)	25 (16.4)	0.010
Cerebrovascular disease	28 (11.1)	17 (17.0)	11 (7.2)	0.014
Peripheral vascular disease	17 (6.8)	13 (13.0)	4 (2.6)	0.002
Albumin (g/dL)	3.50 ± 0.62	3.38 ± 0.59	3.60 ± 0.63	0.017
hs-CRP (mg/L)*	1.17 ± 1.15	1.49 ± 1.21	0.97 ± 1.08	0.001
Pre-operative finding				
Radial a. diameter, mm	2.64 ± 0.65	2.62 ± 0.69	2.64 ± 0.65	0.820
Cephalic v. diameter, mm	2.66 ± 0.62	2.50 ± 0.61	2.78 ± 0.60	0.001
Operative findings				
Atheroma or calcification of radial a.	31 (12.3)	16 (16.0)	15 (9.8)	0.044
Postoperative thrill score	3.36 ± 0.76	3.11 ± 0.94	3.53 ± 0.57	<0.001
IOBF (mL/min)	256.5 ± 104.6	221.4 ± 109.2	272.7 ± 98.4	<0.001

*** Log transformed.**

Figure 1. ROC curves for IOBF for the prediction of primary maturation failure.



With the IOBF only, the area under the ROC curve was 0.768. The cut-off value was 190 mL/min, and the sensitivity and specificity were 0.82 and 0.61, respectively (Figure 1, left). In a full adjusted model, the AUC increased to 0.825 (Figure 1, right).

Table 2. Differences in clinical and perioperative findings by the presence of obesity

	BMI (kg/m²)			
	≥ 25			
	≥ 30 (n=21, 8.3%)	25 - 29.9 (n=58, 23.0%)	<25 (n=173, 68.7%)	P
Age (years)	55.4 ± 13.6	61.5 ± 12.9	63.2 ± 13.2	.023
Gender, female, n (%)	11 (52.3)	27 (46.6)	66 (38.4)	.109
Diabetes	17 (80.9)	47 (81.0)	102 (59.0)	.003
Comorbidities				
Coronary artery disease	6 (28.6)	13 (22.4)	35 (20.3)	.390
Cerebrovascular disease	2 (9.5)	8 (13.8)	18 (10.4)	.763
Peripheral vascular disease	3 (14.3)	4 (6.9)	10 (5.8)	.185
hs-CRP level[a, b]	1.36 ± 1.06	1.28 ± 1.04	1.01 ± 1.17	.063
Pre-operative finding				
Radial a. diameter, mm	2.72 ± 0.73	2.67 ± 0.76	2.60 ± 0.64	.381
Cephalic v. diameter, mm	2.67 ± 0.54	2.51 ± 0.67	2.69 ± 0.61	.252
Operative findings				
Location, left (n %)	16 (76.2)	37 (63.8)	134 (77.5)	.057
Radial a. diameter, mm	2.70 ± 0.72	2.66 ± 0.58	2.60 ± 0.68	.235
Cephalic v. diameter, mm	2.56 ± 0.66	2.52 ± 0.67	2.68 ± 0.62	.167
Atheroma/calcification of radial a.	4 (19.0)	10 (17.2)	17 (9.8)	.076
Postoperative thrill score	3.09 ± 0.99	3.27 ± 0.83	3.43 ± 0.57	.050
Intraoperative blood flow (mL/min)	197.5 ± 74.8	226.8 ± 80.1	263.5 ± 96.7	.001

- the prevalence of radial artery atheroma or calcification became increased (19.0% vs.17.7% vs. 9.8%, p= .076) and IOBF became much lower (197.5 ± 74.8 vs. 226.8 ± 22 80.1 vs. 263.5 ± 96.7 mL/min, p = 0.001) with the higher BMI group.

Figure 2. Kaplan-Meier estimates for the occurrence of primary maturation failure according to IOBF and obesity (number of patients with with standard error).

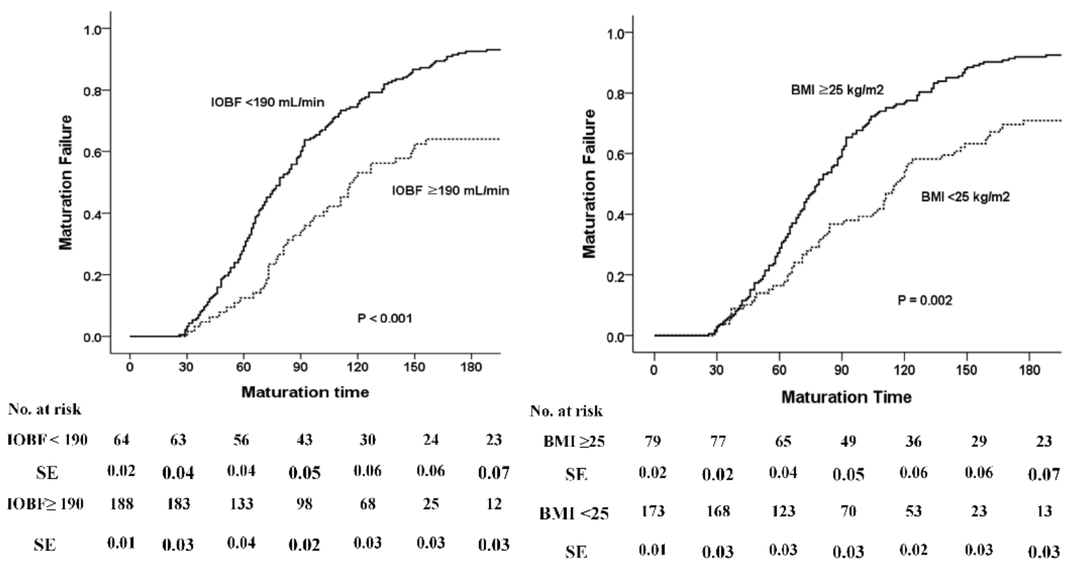


Table 3. Fistula outcomes according to BMI and intraoperative blood flow

		BMI			Intraoperative blood flow		
	Total	≥25 (n=79, 31.3%)	<25 (n=173, 68.7%)	P	≥190 (n=188, 74.6%)	<190 (n=64, 25.4%)	P
Primary failure							
Early primary failure, n (%)	100 (39.7)	48 (60.8)	52 (30.1)	<0.001	60 (31.9)	40 (62.5)	<0.001
Late primary failure, n (%)	35 (13.9)	22 (27.8)	13 (7.5)	<0.001	12 (6.4)	23 (35.9)	<0.001

The mean duration until the first use of radiocephalic AVF was 90.3 ± 44.2 days. Obese patients needed a significantly longer maturation time (103.7 ± 50.9 days vs. 85.2 ± 40.3 days, p= .004), and had a higher early maturation failure rate compared to non-obese subjects (60.8% vs. 30.1%, respectively, p<0.001). When the patients were divided into 3 groups according to the BMI <25, 25- 29.9, and ≥30 kg/m2, the difference in maturation failure rate was more clearly showed.

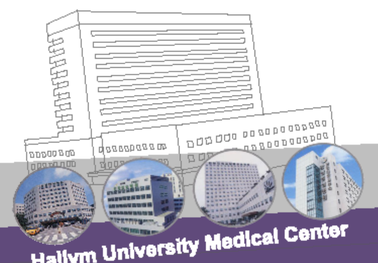
Table 4. Predictors of primary maturation failure of radiocephalic AVF

	Univariate analysis		Multivariate analysis*	
	OR (95% CI)	P	OR (95% CI)	P
Age ≥70 years	1.96 (1.15-3.34)	0.014	1.86 (0.99-3.49)	0.051
Female	1.91 (1.14-3.19)	0.013	1.86 (0.99-3.48)	0.051
BMI ≥ 25	2.60 (2.06-4.28)	<0.001	2.34 (1.71-4.16)	0.001
Previous vascular disease	2.61 (1.51-4.53)	0.001	3.08 (1.63-5.82)	0.001
ln-CRP (per 1 mg/dL increase)	1.42 (1.12-1.78)	0.003	1.33 (1.02-1.72)	0.036
Vein diameter < 2.5 mm	1.80 (1.03-3.15)	0.038	1.05 (0.54-2.04)	0.886
IOBF <190 mL/min	3.58 (1.98-6.42)	<0.001	3.05 (1.52-6.11)	0.001

According to multivariate analysis, the statistically significant variables that determined maturation failure were obesity, previous vascular disease, increased hs-CRP levels, and IOBF <190 mL/min. Also, old age ≥70 years and a female gender were marginally significant predictors.

Conclusions

- **Obese patients had a significantly lower IOBF, and both obesity and low IOBF contributed to the primary maturation failure of AVF.**
- **Obesity-associated inflammation and atherosclerosis might play roles in this association.**



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