Lösningar för högflödesfistlar

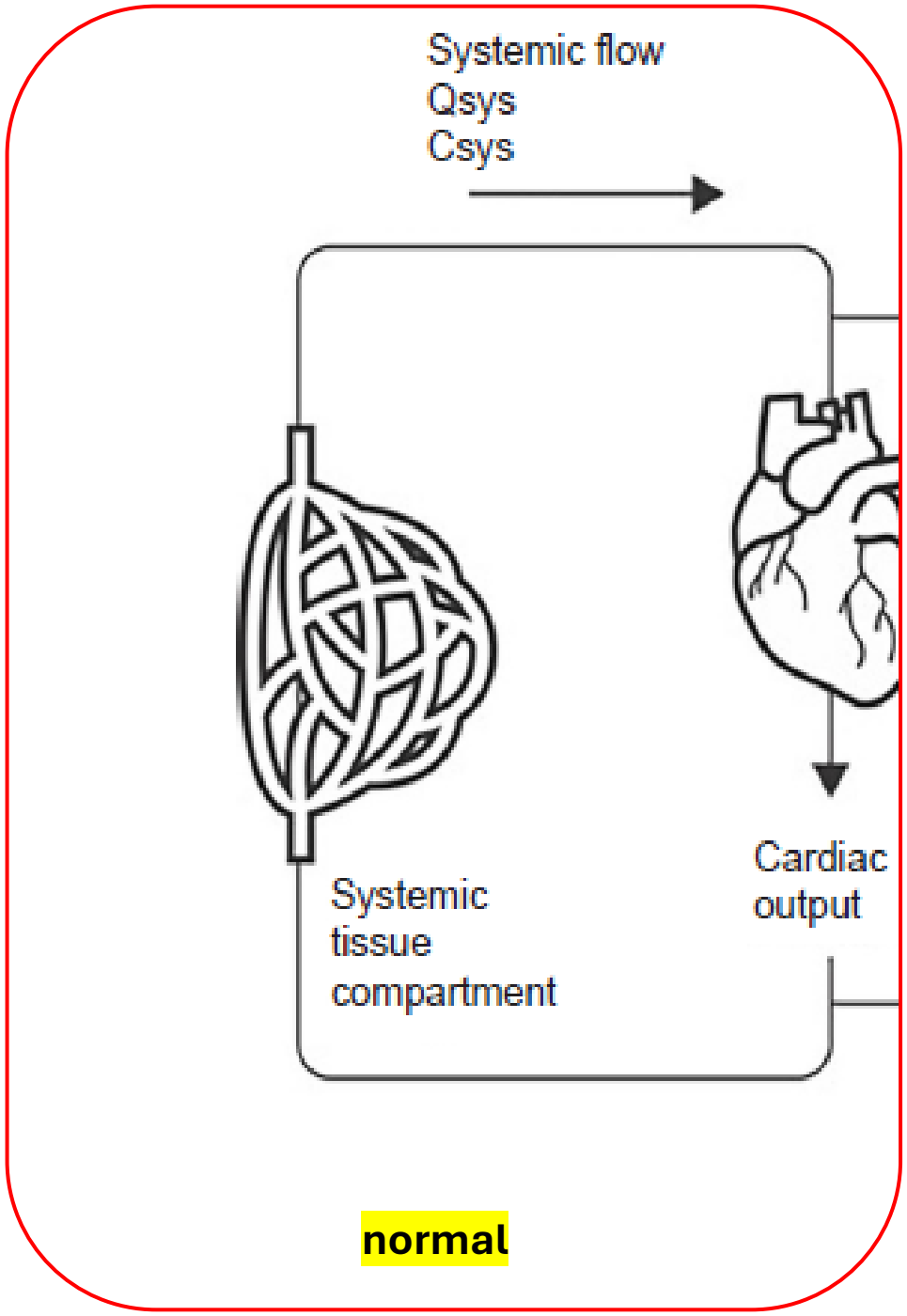
Solutions in high-flow fistulas

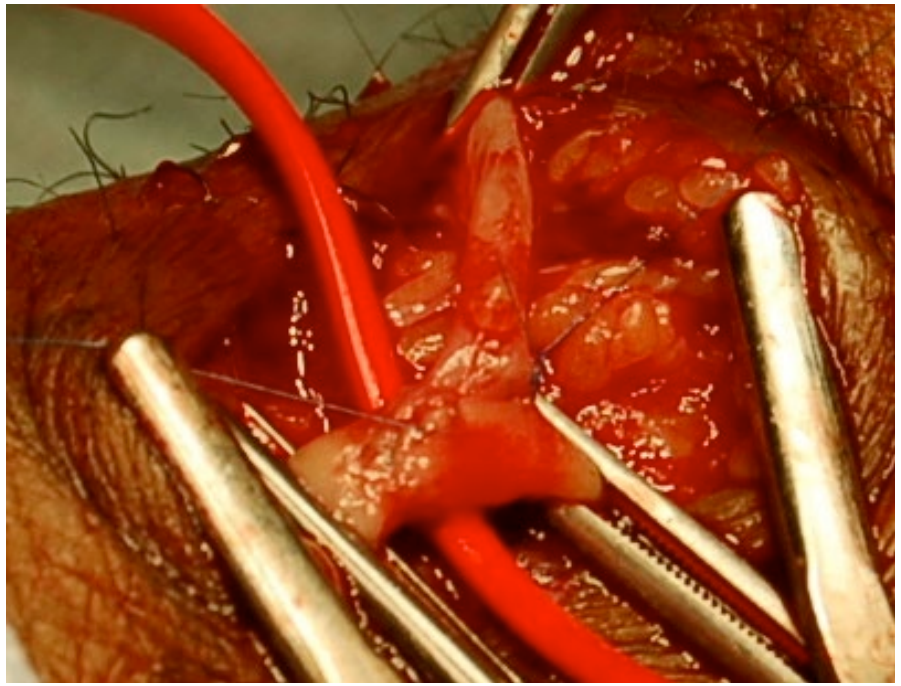
Nick Inston PhD FRCS

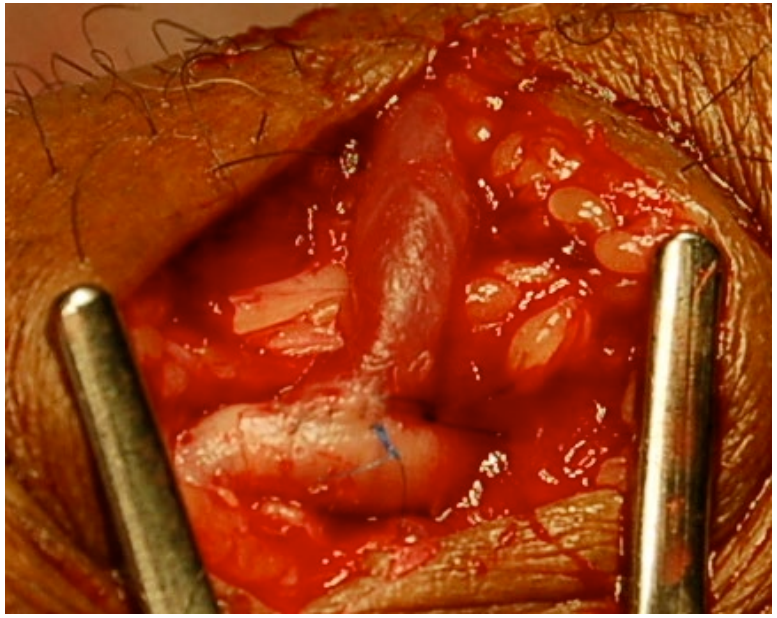
Queen Elizabeth Hospital

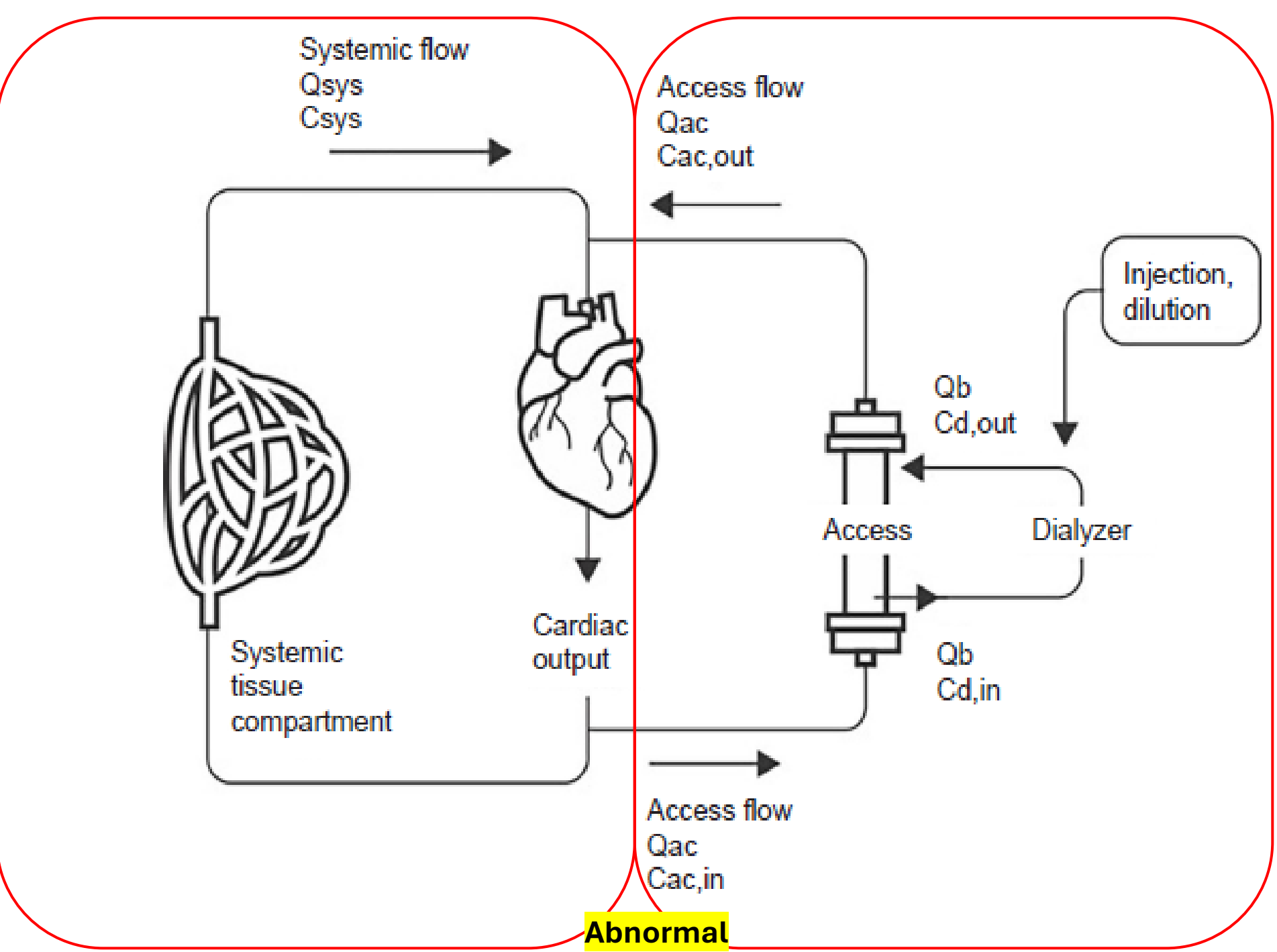
Birmingham

UK


Systemic flow
Qsys
Csys
Systemic
tissue
compartment
Cardiac
output
normal







All working fistulas create a high flow situation

=

Left to right shunt from the high-resistance arterial circulation to the low-resistance venous system,

=

hyperdynamic circulatory state.

Creation of an AVF

Drop in systemic vascular resistance

adaptive increase in CO

higher stroke volumes (SV),
ejection fraction (EF)
cardiac index (CI)

Enlargement of both atria and ventricles, elevated left ventricular end-diastolic volume (LVEDV) and increased wall tension

These structural adaptations can be detected as early as days 3-14 post-AVF creation, with notable increases in left atrial diameter (LAD) and brain natriuretic peptide (BNP) levels

Atrial natriuretic peptide (ANP) rises in response to atrial stretch due to increased venous return

With prolonged exposure, the heart develop eccentric hypertrophy and impaired diastolic filling.

In severe cases, these changes may evolve into impaired systolic function and overt HOCF, even in patients with an initially preserved EF

What is a high flow fistula?

Definitions and thresholds for high-flow access lack consensus.

Vascular Access Society & KDOQI guidelines

- Flow (Qa) between 1–1.5 L/min or a Qa >20% of the cardiac output (CO)

European Society for Vascular Surgery (ESVS) guidelines 2018

- recommend close surveillance for any AVFs with a Qa >1.5L/min

Spanish guidelines

- Qa >2L/min or Qa >30% of cardiac output

Incidence

Incidence has been reported as low as 4% in general haemodialysis cohorts by Gerrickens

But reported as high as 25.7- 31.4% by other authors

Gerrickens MW, Yadav R, Vaes RH, Scheltinga MR. A scoping review on surgical reduction of high flow arteriovenous haemodialysis access. J Vasc Access. 2024;25(3):728-44
Shah NA, Byrne P, Endre ZH, Cochran BJ, Barber TJ, Erlich JH. Predicting high-flow arteriovenous fistulas and cardiac outcomes in hemodialysis patients. J Vasc Surg. 2025;81(3):751-8.e8.
Schier T, Göbel G, Bösmüller C, Gruber I, Tiefenthaler M. Incidence of arteriovenous fistula closure due to high-output cardiac failure in kidney-transplanted patients. Clin Transplant. 2013;27(6):858-65

Prevention

The Journal of Vascular Access
Volume 22, Issue 5, September 2021, Pages 697-700

https://doi.org/10.1177/1129729820959930

Original research articles

Feasibility of a 3 mm arteriotomy for brachiocephalic fistula formation

Jeremy Crane, Safa Salim, and Rowland Storey

Secondary patency at 6 and 12 months was 94% and 91%, respectively.

Steal in 5.4%

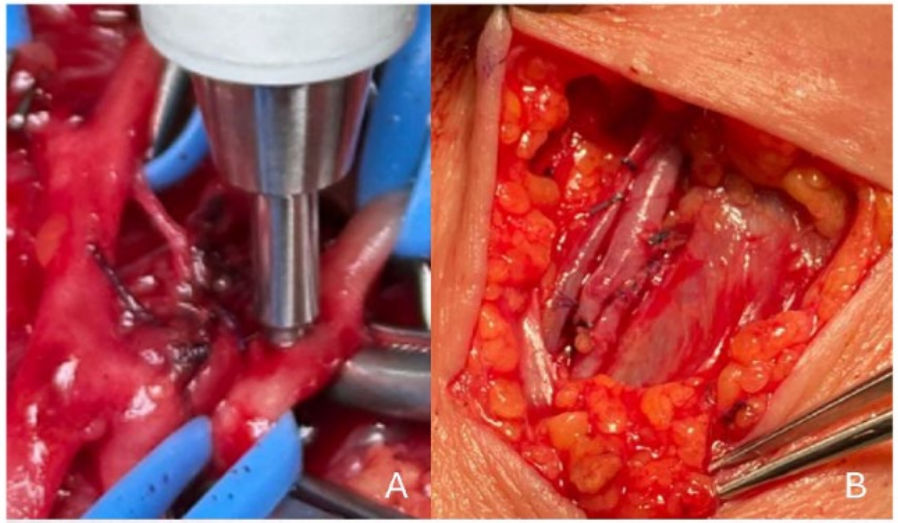
No incidences of high flow fistula

FULL TEXT ARTICLE

Small Arteriovenous Anastomosis in Fistula Creation: Establishing a Functional Vascular Access while Minimizing Steal Syndrome

Michael A. Turner, Asma Mathlouthi, Rohini J. Patel, Mark Perreault, Mahmoud B. Malas and Omar Al-Nouri
Annals of Vascular Surgery, 2024-02-01, Volume 99, Pages 142-147, Copyright © 2023

	Small	Regular
Anastamosis size	5-6mm	8-10mm
Primary patency	46.9%	67.9%
Functional patency, *N (%)*	82.2%	87.7%
Steal	0%	9%



The Journal of Vascular Access
OnlineFirst

https://doi.org/10.1177/11297298251352476

Sage Journals

Original research article

Sizing matters not: Technical standardization of small anastomoses in AVF surgery for complex patients

Marco Franchin, Maria Cristina Cervarolo, Alessandra Bandiera, Sara Monteleone, Alberto Inguscio, Gabriele Piffaretti, and Matteo Tozzi

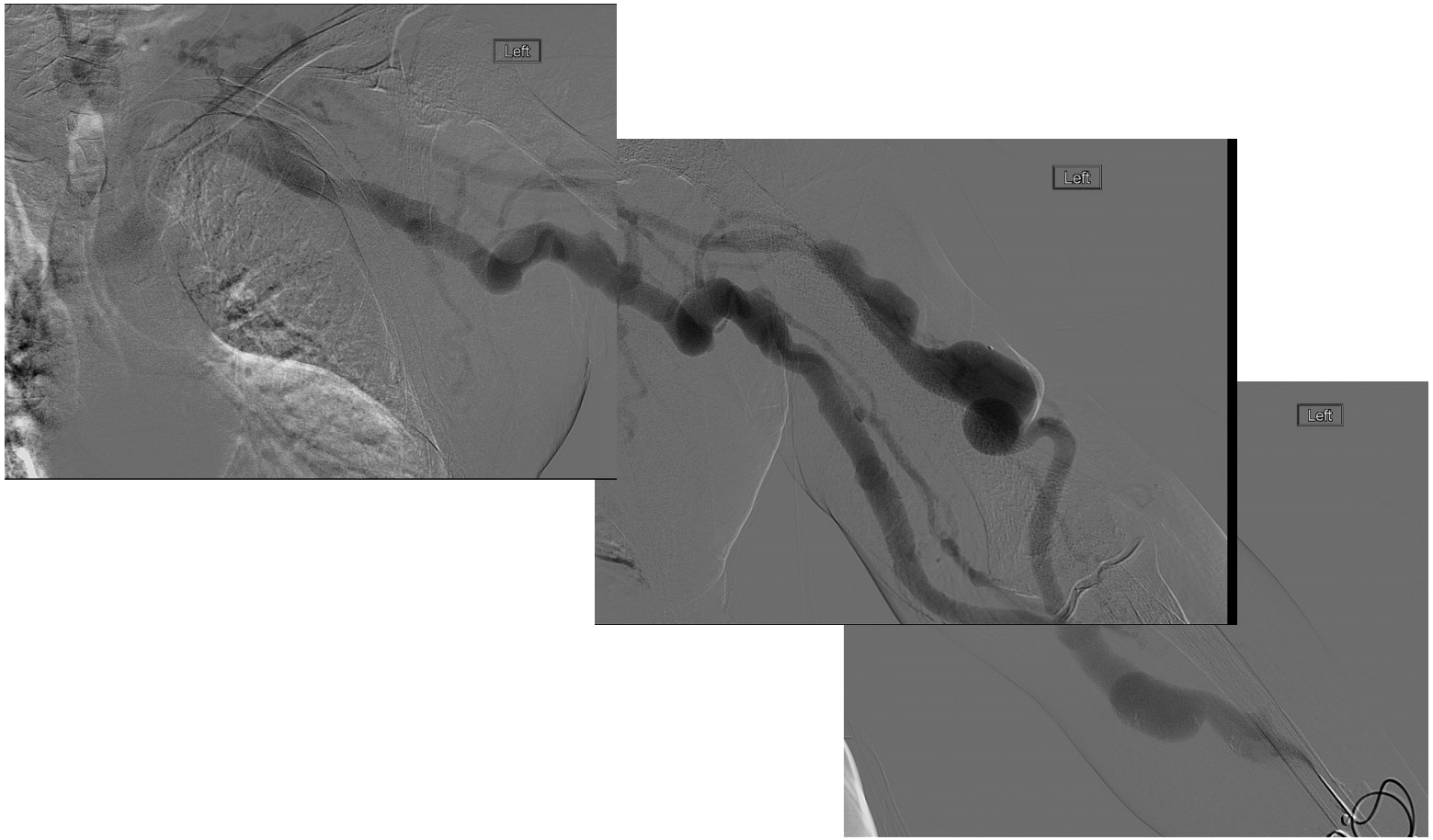
3.6mm Punch
Maturation was achieved in 98.2% of cases.

Mean AVF flow at 12 months was 1080 ± 170 mL/min (range: 920–1460 mL/min)

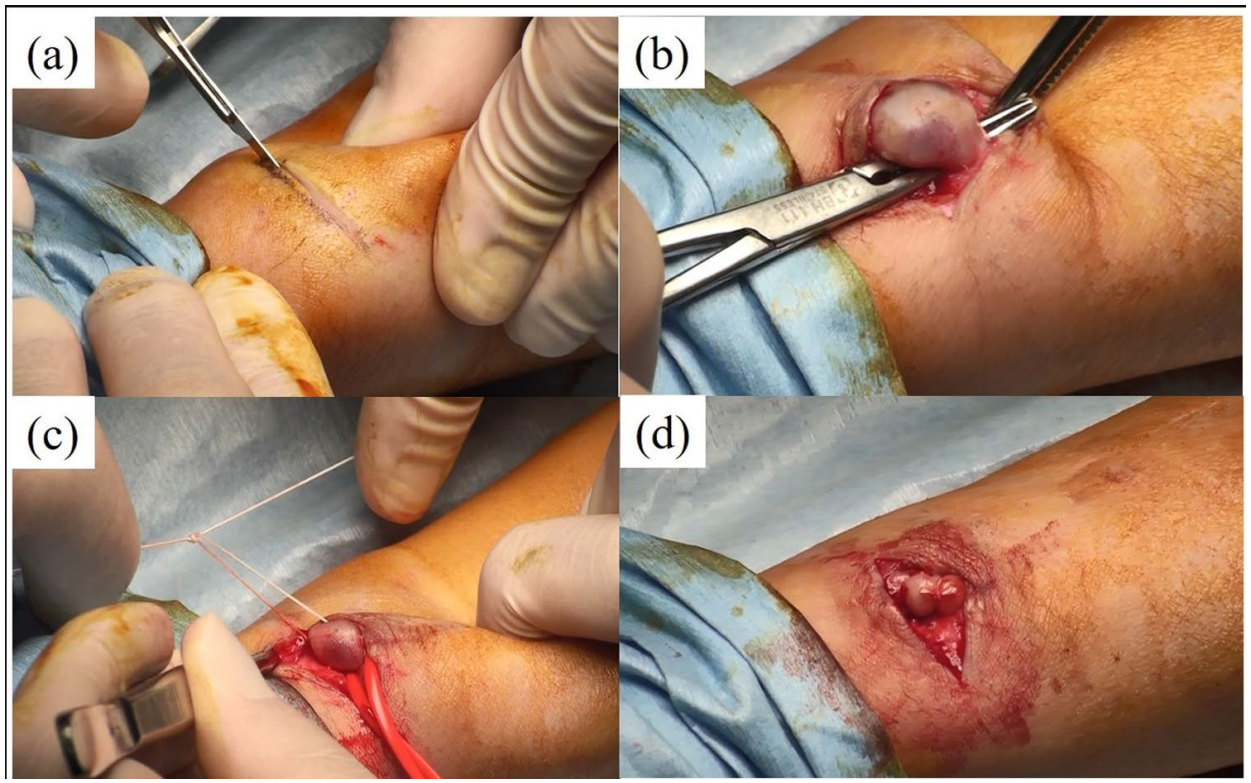
Prevention

“High Flow” access with outflow stenosis

Treat the inflow not balloon the outflow



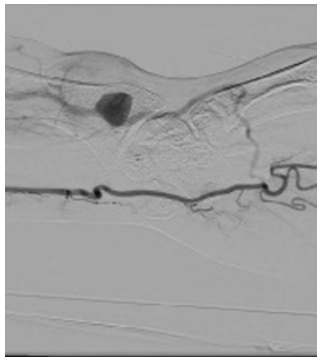
Treatment - Ligation



Naganuma T. Arteriovenous Fistula Closure Using a Simple Ligation Technique After Kidney Transplantation, Transplantation Proceedings, Volume 56, Issue 3, 2024, Pages 526-529, ISSN 0041-1345

100% effective in reducing high flow

Risks = stump aneurysm



Among 60 kidney transplant patients after AVF closure, **8% of patients had symptomatic arterial thrombosis** and 5% had a symptomatic feeding artery aneurysm.
Prospective ultrasound revealed additional asymptomatic **arterial complications** in nine patients (**18% incidence**). The incidence of **asymptomatic arterial thrombosis was 14%** and some extended up to the axillary artery. The incidence of brachial artery aneurysms was 6%.

Zrimšek M et al Complications on the feeding artery after an arterio-venous fistula closure in patients after kidney transplantation – a national cohort study, *Clinical Kidney Journal*, Volume 18, Issue 1, January 2025,

Treatment – Flow reduction - Banding

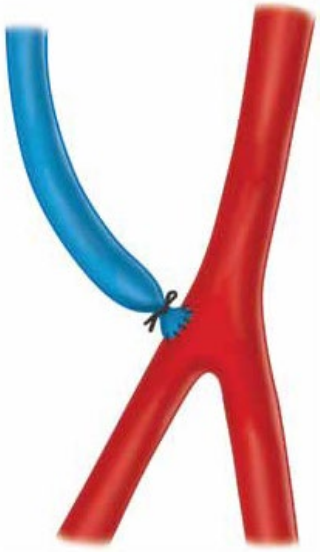


TABLE I - Characteristics of patients undergoing banding because of hand ischaemia and high flow access

	All patients (n = 119)	HAIDI (n = 64)	HFA (n = 55)	p value
Age (y)	61 (21-90)	65.5 (22-90)	56.4 (21-87)	0.001*
Gender, n (%)				
Male	72 (60.5%)	37 (57.8%)	35 (53.6%)	0.575
Comorbid conditions, n (%)				
Diabetes	49 (41.2%)	36 (56.3%)	13 (23.6%)	0.004*
Hypertension	19 (15.9%)	9 (14.1%)	10 (18.2%)	0.620
Peripheral artery disease	18 (15.1%)	12 (18.8%)	6 (10.9%)	0.307
Medications, n (%)				
Antiaggregation	61 (51.3%)	34 (53.1%)	27 (49.1%)	0.715
Anticoagulation	15 (12.6%)	9 (14.1%)	6 (10.9%)	0.783
Vascular access, n (%)				
Forearm	8 (6.7%)	5 (7.8%)	3 (5.5%)	-
Upper arm		55 (85.9%)	52 (94.5%)	-
Graft	4 (3.4%)	4 (6.3%)	-	-
Fistula flow ± SD (mL/min)	2073 ± 820	1689 ± 721	2435 ± 744	0.001*

HAIDI = haemodialysis access-induced distal ischaemia; HFA = high flow access.
* Indicates statistically significant difference.

95% = upper arm AVFs

TABLE III - Number of patients with banding-related complications. Technical failure, recurrence of symptoms, requiring new banding. Excessive banding, access with inappropriate access flow caused by banding

Complications	All patients (n = 119)	HAIDI (n = 64)	HFA (n = 55)
Technical failure	20	10	10
Excessive banding	4	4	-
Thrombosis	6	4	2
Rupture	3	-	3
False aneurysm	1	-	1
Total	34 (28.6%)	18 (28.1%)	16 (29.1%)

HAIDI = haemodialysis access-induced distal ischaemia; HFA = high flow access.

20% = technical failure

“Precision” Banding

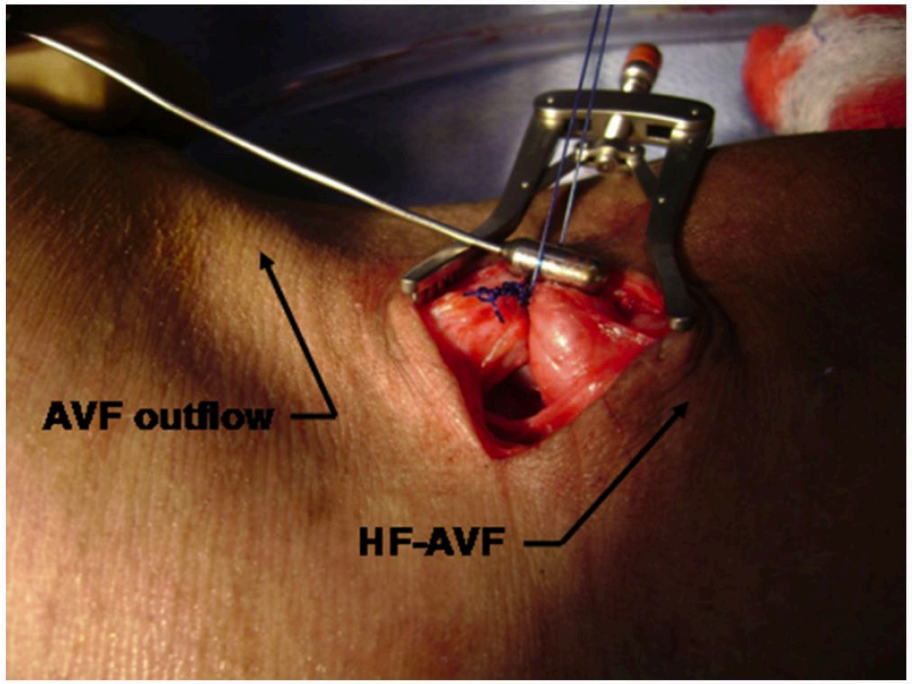
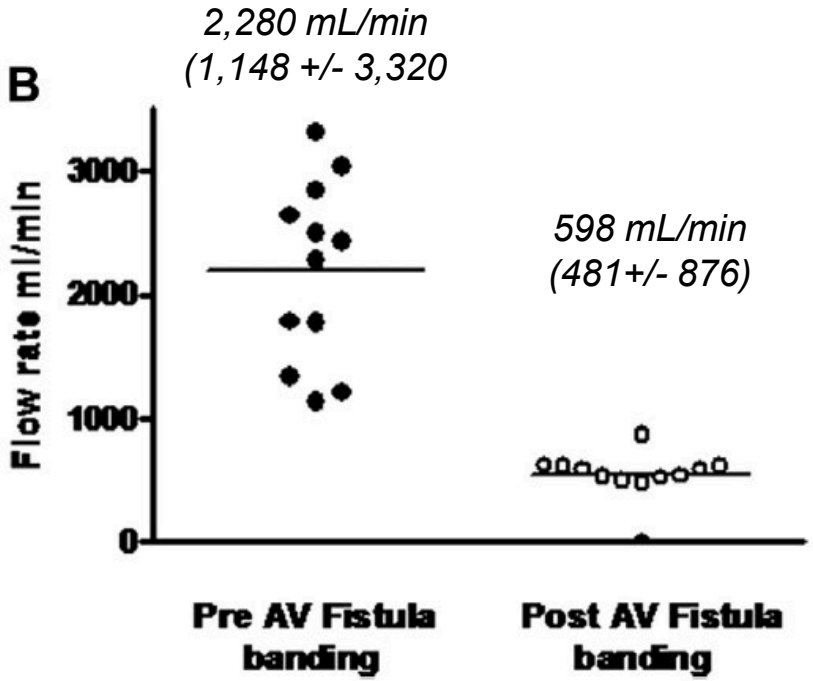


Fig. 1. The photo shows a precise banding of a HF—AVF using a coronary dilator as a dowel for reliable sizing of the restriction site. This simple flow restriction is created adjacent to the AVF anastomosis using polypropylene suture and sized in 0.5-mm increments. AVF flow rates are remeasured until the target access flow is achieved (500—800 mL/min). A second suture was placed at the same site for security.



N= 12
Resolution of cardiac symptoms in 100%
1 thrombosis

Gkotsis, G. · Jennings, W.C. · Malik, J. et al Treatment of high flow arteriovenous fistulas after successful renal transplant using a simple precision banding technique Ann Vasc Surg. 2016; 31:85-90

Treatment – Flow reduction - Banding

Teixeira et al

TABLE VI - Study results for banding procedure

First author	Clinical	Number of patients	Free of symptoms (%)
Odland (18)	HAIDI	16	100
DeCaprio (5)	HAIDI	11	91
Morsy (19)	HAIDI	6	100
Aschwanden (20)	HAIDI	3	100
Zanow (21)	HAIDI (n = 78)	95	86 (HAIDI)
	HFA (n = 17)		96 (HFA)
van Hoek (15)	HAIDI (n = 9)	17	88
	HFA (n = 8)		
Gupta (22)	HAIDI	21	52
Jennings (23)	HFA and central stenosis	22	100
Vaes (16)	HFA	50	48
Leake (6)	HAIDI	38	75

AVF = arteriovenous fistula; AVG = arteriovenous graft; HAIDI = haemodialysis access-induced distal ischaemia; HFA = high flow access

Most reports are HAIDI not HFA

Results variable

Jennings 100% success

Zanow 96% success HFA

Vaes 48% success HFA

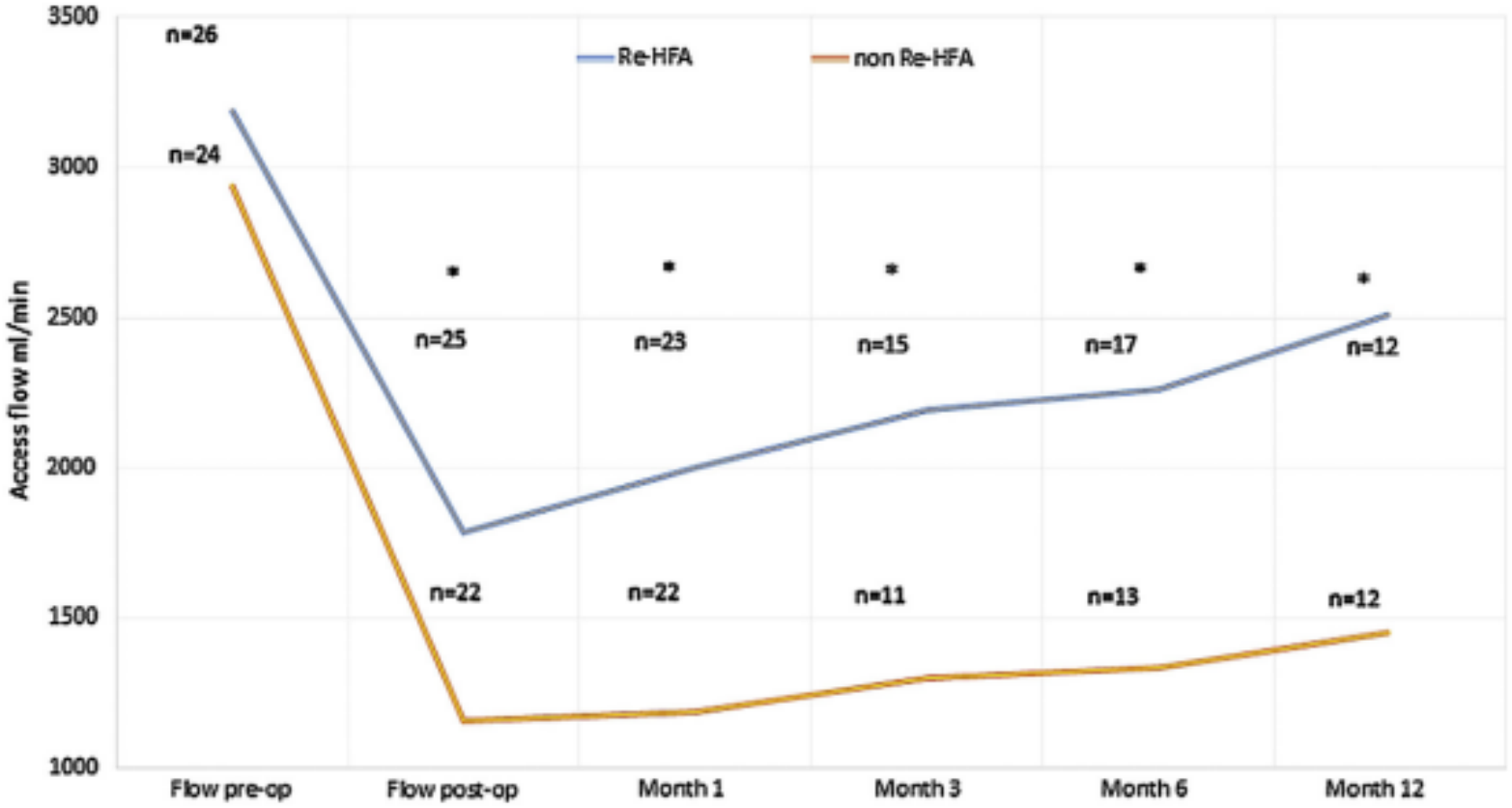


Fig 1. Access flow (mL/min) is plotted during 12 months of follow-up after banding. The *upper curve* reflects patients developing recurrent high-flow access (*HFA*; >2000 mL/min). The *lower curve* illustrates patients with access flow that remained <2000 mL/min. $^{*}P < .05$.

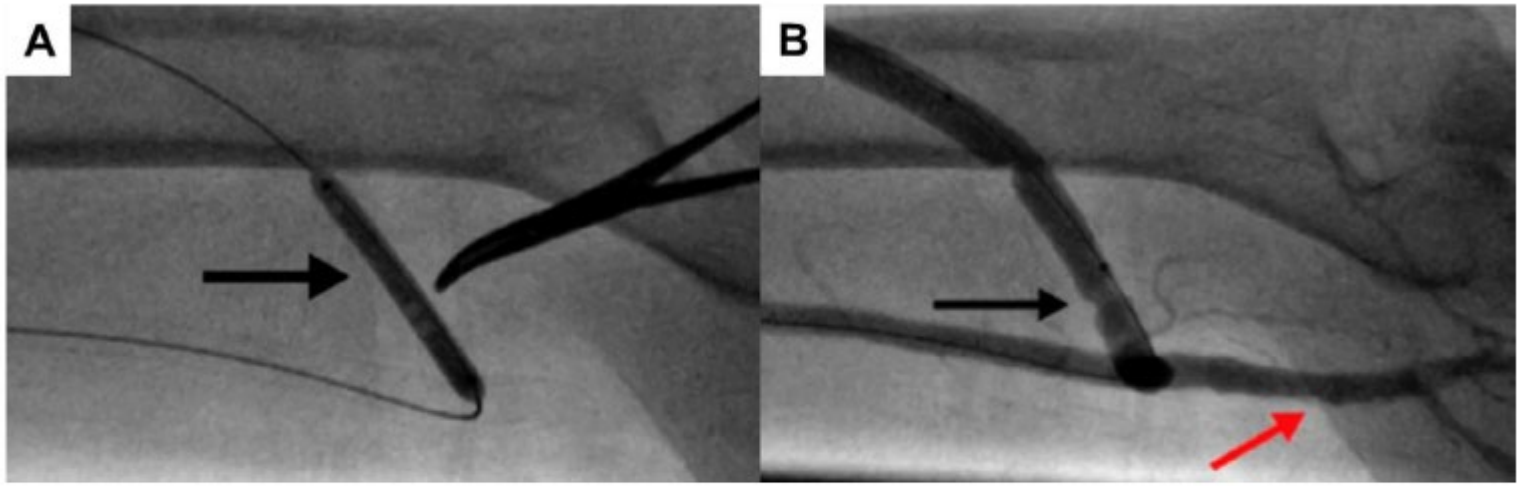
Post op flow predicts recurrence

BUT

Rebound flow increase occurs in all

Vaes, R.H. et al **Effectiveness of surgical banding for high flow in brachial artery-based hemodialysis vascular access** *J Vasc Surg.* 2015; **61**:762-766

Minimally invasive limited ligated endoluminal assisted revascularisation (MILLER) procedure



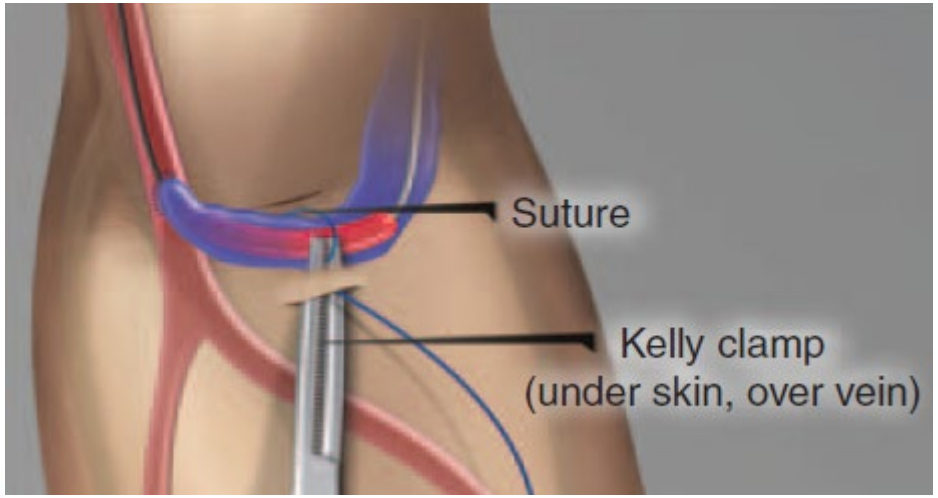


Figure 5. Angiography during minimally invasive limited ligated endoluminal-assisted revascularization (MILLER) procedure. (A) An inflated 5 mm angioplasty balloon (black arrow) is guided to the proximal arteriovenous graft (AVG) site. A hemostat is used to designate the area for skin incisions. (B) Post-procedure imaging demonstrates a waist in the AVG (black arrow) and distal flow in the brachial artery (red arrow).

Table 1. Comparison of available MILLER procedure series

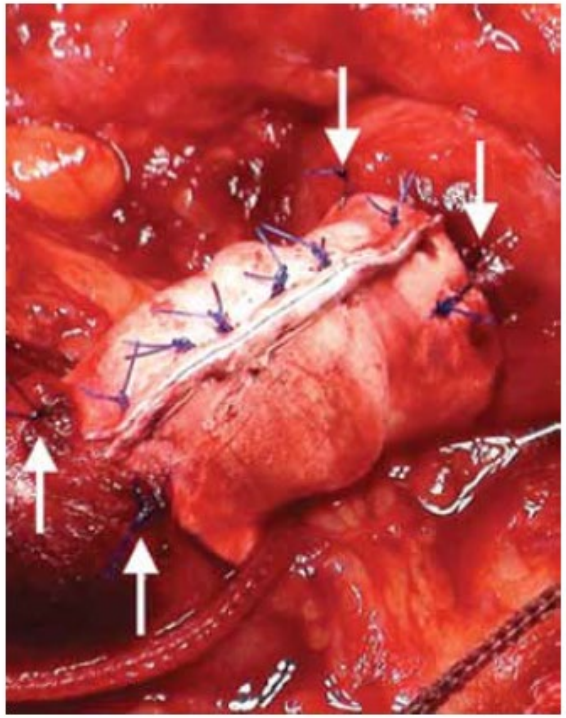
Group	Presentation	No. Patients	Clinical Success		Band Patency	Primary Access Patency	Secondary Access Patency	Follow Up (Months)
			One Banding	Multiple Bandings				
Goel et al. [5]	Steal	16	N/A	N/A	100% [1]	100% [1]	77%	3, 36
Miller et al. [7]	HF	69	94%	100%	85% [2]	63% [1]	89% [4]	11
	Steal	114	89%	96%	75% [2]	52% [1]	90% [4]	
Shukla et al. [26]	Steal	20	75%	95%	77% [2]	95% [1,*]	86% [1,‡]	18
Shintaku et al. [27]	HF	7	N/A	N/A	N/A	N/A	83% [3]	46
	Steal	5	0%	0%	N/A	N/A	25% [3]	

HF = High-Flow; N/A = not available; [1] 3 months; [2] 6 months; [3] 12 months; [4] 24 months. * Post intervention assisted primary patency. ‡ Low follow-up limited long term secondary patency data.

High patency
Success 94-100% in HF

Flow reduction – external Wrap

Kanno et al



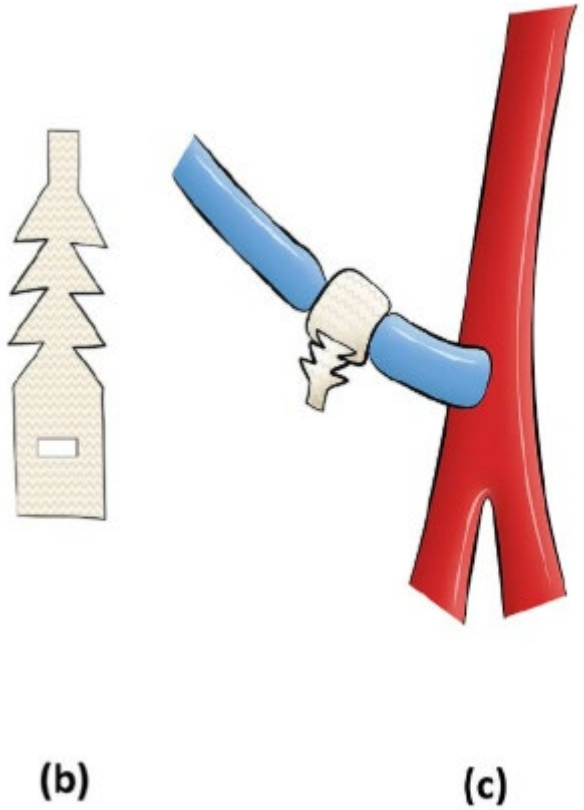
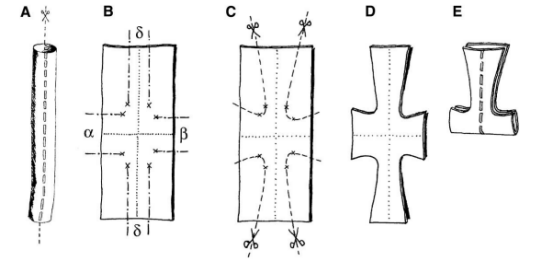


Fig. 1 - Site of banding with a vascular graft. In order to prevent slippage at the banding site, the vascular graft is turned inside out and wrapped around the blood vessel. Both ends of the vascular graft are fixed by two Z-sutures on the proximal and distal sides (arrow). The tightness of the banding is adjusted to the target FV according to blood flow volume measurement by ultrasound.

J Vasc Access 2015; 16 (Suppl 10): S28-S33



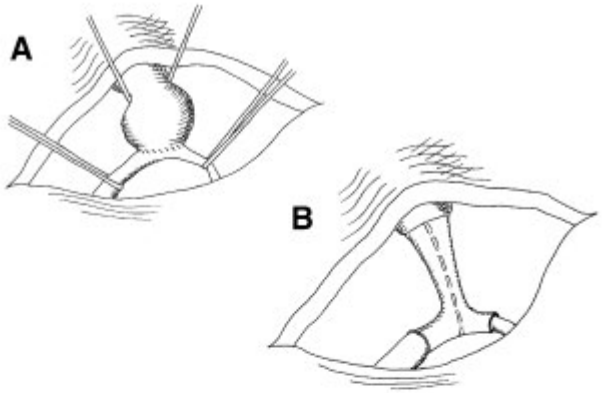


Fig 2. The enlarged anastomosis and dilated shunt vein before **(A)** and after T-banding **(B)**.

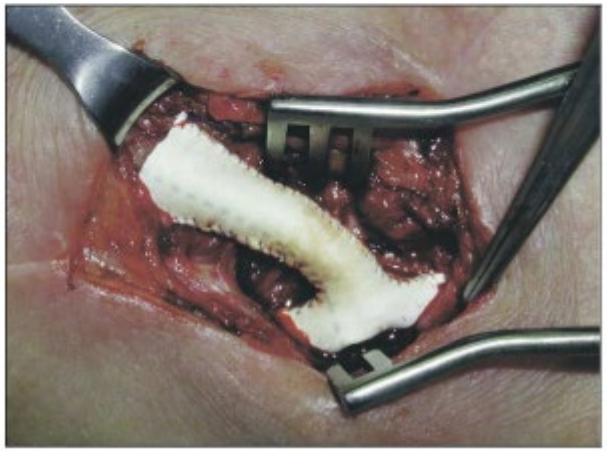


Fig 3. T-band in situ covering the anastomosis of an upper arm fistula.

Flow reduction - External Wrap

Table II. Pre- and postoperative fistula flow and outcome

Initial	*Flow before T-banding (mL/min)*	*Flow 1-3 months after T-banding (mL/min)*	*Percent reduction*	*Primary success*	*Complications*	*Reoperation*
A. F.	1.600	900	44	Yes		No
S. T.	2.300	1.100	52	Yes	Hematoma	No
A. G. G.	2.100	600	71	Yes	Thrombosis	Yes
D. G.	3.200	1.400	56	No		Yes
S. T.	1.800	ND	—	Yes		No
G. H.	1.600	700	56	Yes		No
A. S.	2.300	1.000	56	No		Yes
N. T. G.	2.100	1.200	43	No		No
T. Z.	ND	800	—	No		No
U. K.	2.500	ND	—	Yes		No
B. D.	1.300	700	46	Yes		No
S. D.	1.800	900	50	Yes	Thrombosis	Yes
D. O.	1.600	900	44	Yes		No
E. K.	2.300	1.400	39	No		Yes
E. N.	2.100	1.200	43	No		Yes
A. E.	2.200	800	64	Yes		No
R. G.	1.500	1.100	27	Yes	Hematoma	No
H. J. K.	1.300	800	39	Yes		No
T. S.	2.500	1.100	56	Yes		No
K. G.	1.300	ND	—	Yes		No
C. S.	1.800	1.000	44	Yes		No
W. S.	1.600	900	44	Yes		No
N = 18	1956 ± 482	983 ± 228	44			

Primary success, Relief of symptoms.
Mean ± SD for flow measurements, and median for percent flow reduction.

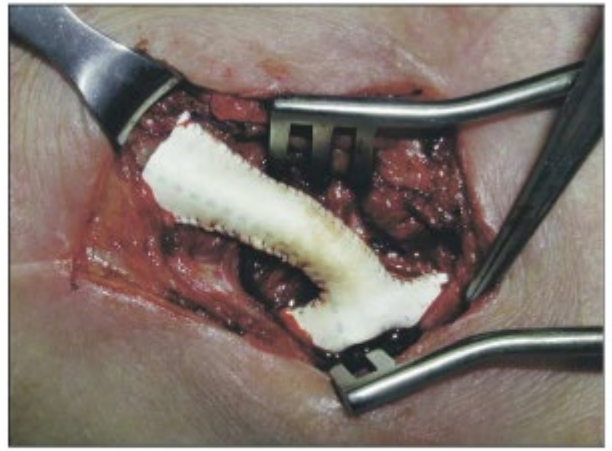


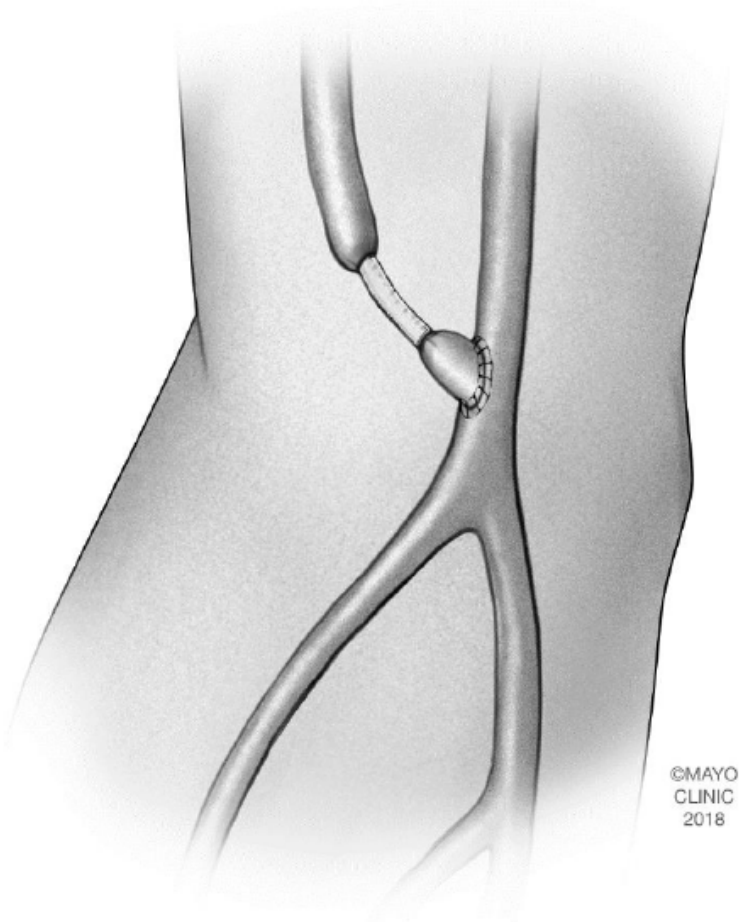
Fig 3. T-band in situ covering the anastomosis of an upper arm fistula.

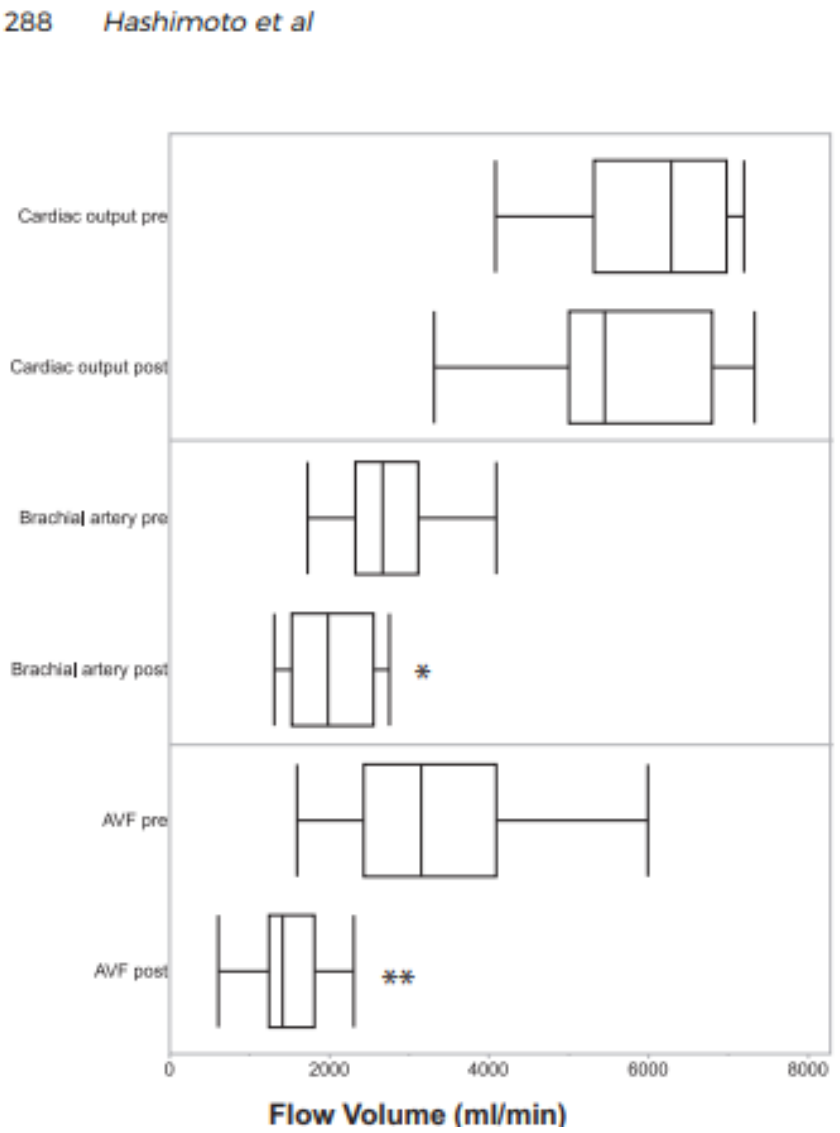
Success = 16/22 = 72%

(95% for flow reduction)

But FLOW RATES low
1956m/min (1300 to 3200)

Treatment – Flow reduction – interposition graft





Flow reduction
52.7% to 67.8%

(3446 +/- 1489 mL/min vs
1502 +/- 527 mL/min;
52.4% decrease

Mean access flow
volume at 2 years =1623
+/- 320 mL/min

Hashimoto, Takuya et al . Journal of Vascular Surgery, Volume 73, Issue 1, 285 - 290

Revision using Distal Inflow (RUDI)

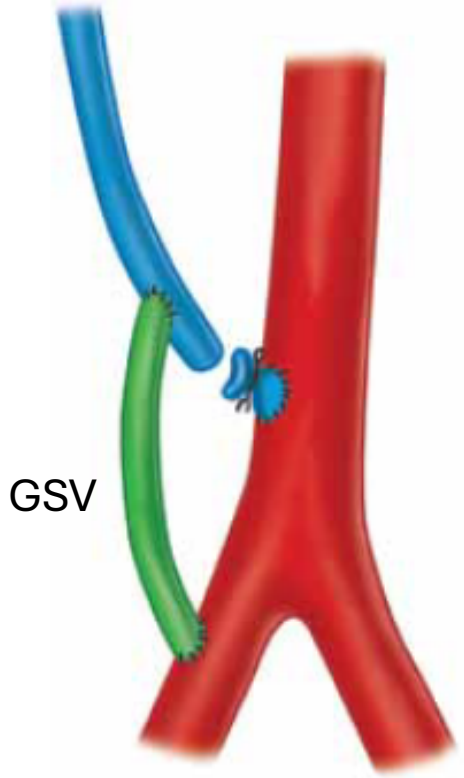


Fig. 4 - RUDI - the fistula is supplied from the more distal vessel below the arterial bifurcation, which restores normal direction blood flow in the partnering forearm artery.

Gerrickens, M.W.M. et al **3- year patency and recurrence rates of revision using distal inflow with a venous interposition graft for high flow brachial artery based arteriovenous fistula**
Eur J Vasc Endovasc Surg. 2018; **55**:874-881

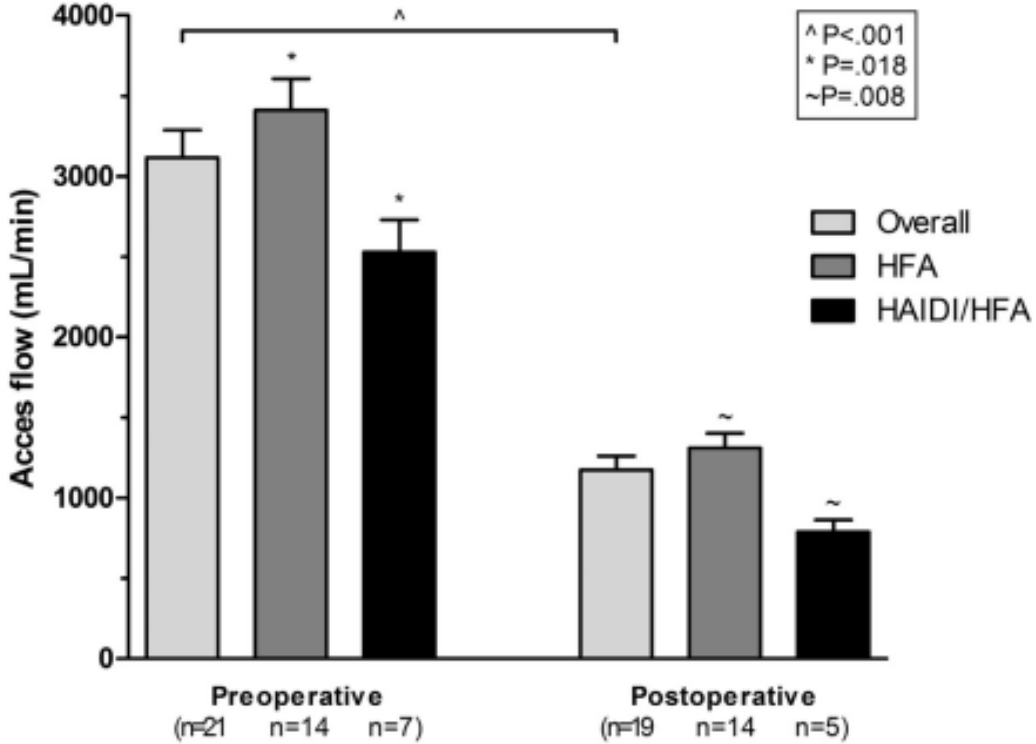
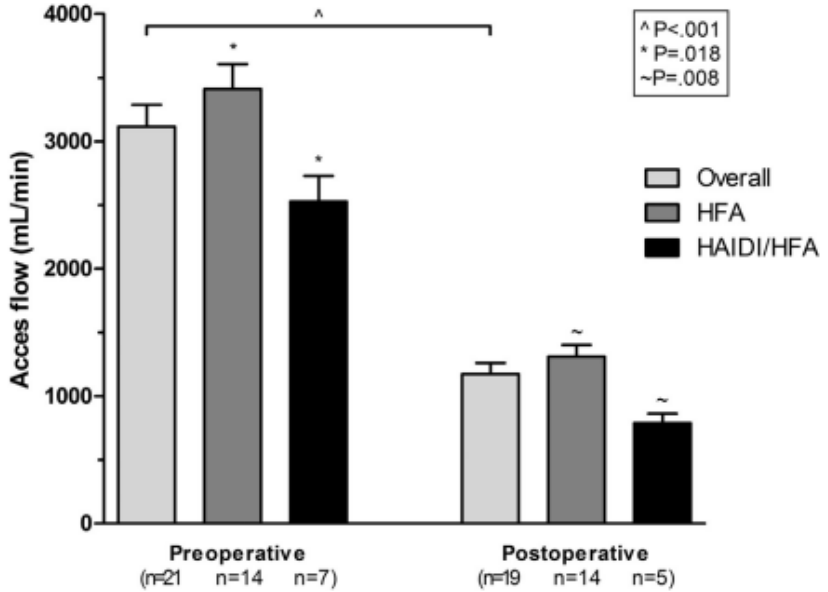


Figure 1. Mean access flows prior to revision using distal inflow (RUDI) and within 1 week after RUDI for high flow access (HFA, $n = 14$) and high flow access with concurrent haemodialysis access induced distal ischaemia (HAIDI/HFA, $n = 7$). Missing post-operative flows HAIDI/HFA group: failed RUDI, $n = 1$; pre-dialysis patient $n = 1$.

Immediately post-operatively, flows were 2 L/min lower (3120 mL/min 186 vs. 1170 87 mL/min, p < .001).



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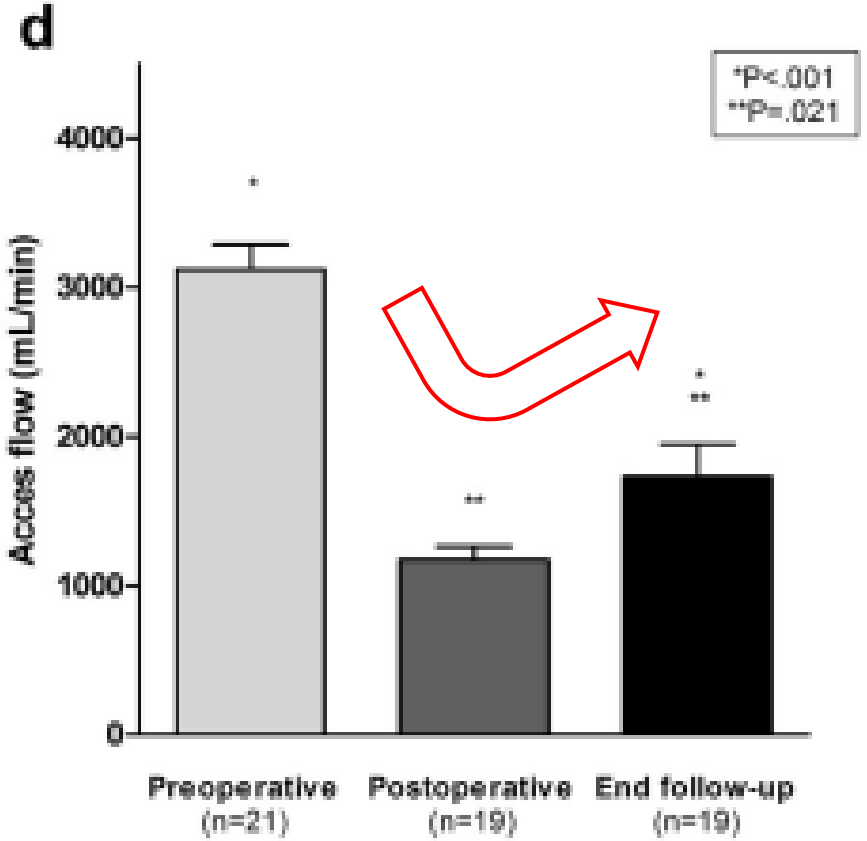
Three accesses (14%) occluded in the first post-operative week.



After 3 years, 51% were free of high flow

Gerrickens, M.W.M. et al **3- year patency and recurrence rates of revision using distal inflow with a venous interposition graft for high flow brachial artery based arteriovenous fistula** *Eur J Vasc Endovasc Surg.* 2018; **55**:874-881

Post transplant high flow

From the Eastern Vascular Society

Practice patterns in arteriovenous fistula ligation among kidney transplant recipients in the United States Renal Data Systems

Caitlin W. Hicks, MD, MS,[a] Sunjae Bae, MD, MPH,[b] Marcos E. Pozo, MD,[b] Sandra R. DiBrito, MD, PhD,[b] Christopher J. Abularrage, MD,[a] Dorry L. Segev, MD,[b,c] Jacqueline Garonzik-Wang, MD, PhD,[b] *and* Thomas Reifsnyder, MD,[a] *Baltimore, Md*

- Very variable practice
- No impact on allograft failure
- No impact on all cause mortality

- Reserve for symptomatic Access

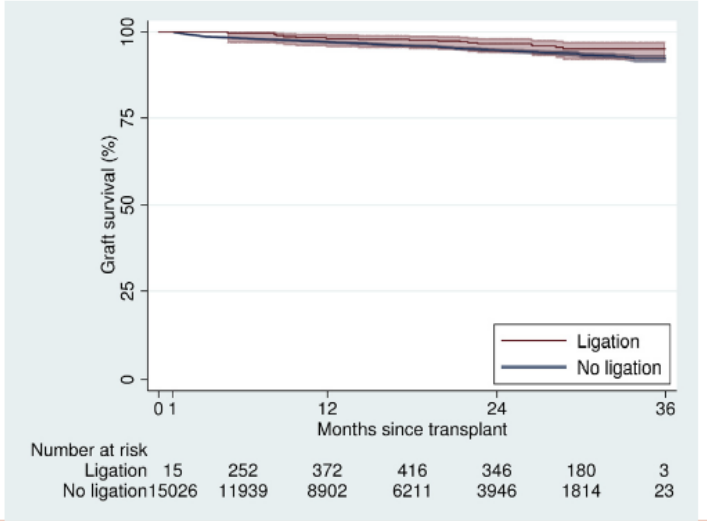


Fig 3. Association of arteriovenous access ligation with allograft failure. Three-year allograft failure occurred in 4.9% ± 1.3% of kidney transplant recipients who underwent arteriovenous access ligation vs 9.5% of kidney transplant recipients who did not undergo ligation (log-rank, $P = .30$). The *shaded bars* represent 95% confidence intervals for both curves; the differentiation between the two highlights the significant overlap between ligation and no ligation.

Hicks et al Journal of Vascular Surgery Volume 70, Number 3

Flow 3.5L/min

Flow 4L/min

6 years post transplant
GFR 55 and stable

Exercise tolerance – 3m
SOB at rest

Left r/c AVF revised 3 months pre-transplant

Right BC created with a view of ligating left

Follow up = maintain fistula if needed for future use.

Picture used with patient's permission

High flow Access - Summary

- Definitions are inconsistent
  - >1500ml should warrant surveillance and investigation
- High flow >2000ml/min
  - Consider intervention

- Interventions – evidence is low
  - Flow reduction by banding/RUDI — recurrence an issue
  - Wraps, grafts and MILLER — evidence is low