Endovascular Repair For Popliteal Artery Aneurysm: Pitfalls And Complications: When Is Open Surgery Best?

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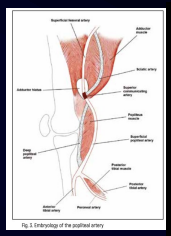
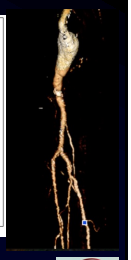
I have no disclosures

The Popliteal Artery – Unique in the Human Body

- The popliteal artery behaves as a central elastic artery and differs fundamentally from other muscular arteries of the lower limbs by its embryological development, which predetermines propensity for specific pathologies.
- Unique biomechanical forces influence the popliteal artery during movement (important when considering EPAR).
- The popliteal artery demonstrates "hinge points" during knee flexion.
- Biomechanical stresses between the host artery and an implanted stent may occur as a result of this arterial mobility.





Kuznetsov M.R., et al. Embryology, anatomy and rare pathologies of the popliteal artery: peculiarities of surgical treatment. Angiol Sosud Khir. 2018;24(2):146-157.

WHY REPAIR Popliteal Artery Aneurysms (PAA)???

- Avoid Complications
  - Occlusion
  - Compression symptoms
  - Distal embolization
  - Rupture
- Main Aim of treatment is to Prevent Limb loss!!

Mohan IV, EJVES 2006; 32:149-54,

Options for Treatment

Open Surgery (OPAR)
vs
Endovascular (EPAR)

Results of a large Swedish Series

Table 5. Outcome after treatment of asymptomatic popliteal aneurysm depending on treatment modality.

Total no. 300	Open repair (245) N/Total[a]	%	Stent graft (55) N/Total[a]	%	p
Primary patency, 30 days	232/244	95.1	50/53	94.3	.823
Secondary patency, 30 days	242/245	98.8	52/55	94.5	.043
Amputation within 30 days	0/245	0	1/55	1.8	.035
Death within 30 days	[illegible]	[illegible]	0/55	0	—
Amputation-free survival, 30 days	245/245	100	54/55	98.1	.035
Primary patency, 1 year	186/209	89.0	31/46	67.4	[illegible]
Secondary patency, 1 year	200/214	93.5	41/49	83.7	.026
Amputation within 1 year	2/220	0.9	1/50[b]	2.0	.507
Death within 1 year	3/242	1.2	3/55	5.4	.048
Amputation-free survival, 1 year	216/221	97.8	48/52	92.3	.048

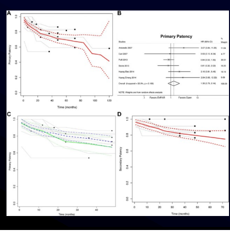
[a] The total number varies because of some missing data.
[b] The total number of amputations did not increase between 30 days and 1 year, but three patients died, and two were lost to follow up.

Cervin A, Tjärnström J, Ravn H, Acosta S, Holtgren R, Wanhainen A, Björck M. Treatment of Popliteal Aneurysm by Open and Endovascular Surgery: A Contemporary Study of 592 Procedures in Sweden. Eur J Vasc Endovasc Surg (2015) 50, 342-350

Meta-Analysis Data (514 PAA)

No difference was found in primary patency for OPAR or EPAR on evidence synthesis.

(hazard ratio 1.30, 95% CI 0.79 to 12.14, p=0.189).



Pooled primary patency rates in endovascular popliteal aneurysm repair (EVPAR).

[Solid line, pooled estimate of primary patency; dotted lines, 95% confidence intervals (CIs); gray lines, primary patency survival curves from original studies].

A Systematic Review and Meta-analysis of Endovascular Popliteal Aneurysm Repair Using the Hemobahn/Viabahn Stent-Graft
Shaneel R. Patel et al. J Endovasc Ther 2015;22:330-337

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A Report from the Vascunet Collaboration of Registries. Contemporary Treatment of Popliteal Artery Aneurysm in Eight Countries

M. Björck, B. Beiles G. Menyhei, I. Thomson, P. Wigger, M. Venermo, E. Laxdal, G. Danielsson, T. Lees, T. Troëng.
European Journal of Vascular and Endovascular Surgery 2014; 47:164-171

- 1471 popliteal aneurysms
- The overall **major amputation rate** was 2.0%.
- Amputation in 6.5% after emergency procedures for thrombosis.
- Amputation rate with surgical technique:
  1.0% after endovascular(307), 1.8% after open (1145).
- **26.3% after hybrid repair, (19 patients, p < .0001).**

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Vascular Quality Initiative (VQI) Medicare-linked VISION database (2010-2019) Propensity-matched data for patients undergoing OPAR and EPAR to compare outcomes

Long-term outcomes of elective endovascular vs open repair of popliteal artery aneurysms in the VISION database

Keyuree Satam, MD, MHS,[a] Anand Brahmandam, MBBS,[b] Xinyan Zheng, MS,[c] Jialin Mao, MD, PhD,[c] Philip Goodney, MD, MS,[d] and Cassius Iyad Ochoa Chaar, MD, MPH, MS,[e] *Stanford, CA; Evanston, IL; New York, NY; Lebanon, NH, and New Haven, CT*

ABSTRACT

Background: The best modality for elective popliteal artery aneurysm repair (PAR) remains controversial. Most single-center studies suggest that open popliteal aneurysm repair (OPAR) is more durable than endovascular PAR (EPAR), but large, randomized, multicenter studies are lacking. This study compares long-term outcomes of EPAR and OPAR in the Vascular Quality Initiative—Vascular Implant Surveillance and Interventional Outcomes Network (VISION) database.

Methods: VQI Medicare-linked VISION database (2010-2019) for peripheral vascular interventions and infrainguinal bypass were reviewed for elective PAR. Patients undergoing OPAR and EPAR were propensity matched to compare outcomes.

Results: There were 1159 PARs (65.1% open). EPAR patients were older (77 years vs 73 years; $P < .001$) and more likely to be on P2Y12 inhibitors (26.5% vs 17.0%; $P < .001$). After matching, there were 396 patients in each group with similar baseline characteristics. EPAR patients were more likely to be discharged home (87.6% vs 48.5%; $P < .001$) and have a shorter hospital length of stay (1 day vs 3 days; $P < .001$). Kaplan-Meier curves showed no difference in mortality, reintervention, or major amputation at 1, 3, and 5 years. Cox proportional hazards regression showed no significant association between revascularization strategy and mortality, reintervention, or major amputation. Subgroup analysis of patients undergoing OPAR with great saphenous vein (GSV) bypass compared with EPAR showed that OPAR with GSV bypass was associated with lower mortality without difference in reintervention or major amputation.

Conclusions: Elective EPAR is durable and comparable with OPAR in terms of limb outcomes, even when GSV is used as conduit. However, bypass with GSV was associated with increased survival after open PAR compared with endovascular therapy. (J Vasc Surg 2024;■:1-10.)

Keywords: Popliteal artery aneurysm; Endovascular repair; Open bypass; Elective repair

Satam K, Brahmandam A, Zheng X, Mao J, Goodney P, Ochoa Chaar CI. Long-Term Outcomes of Elective Endovascular versus Open Repair of Popliteal Artery Aneurysms in the VISION Database. J Vasc Surg. 2024 Oct 23:S0741-5214(24)01982-7. doi: 10.1016/j.jvs.2024.10.026. Epub ahead of print. PMID: 39454844.

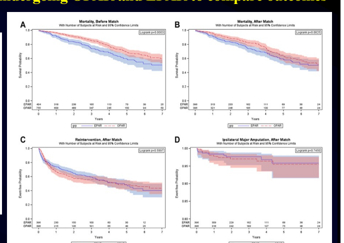

Fig 2. Kaplan-Meier curves for long-term outcomes between open popliteal artery aneurysm repair (*OPAR*) and endovascular popliteal artery aneurysm repair (*EPAR*). **(A)** The higher mortality seen in the EPAR group at 5 years before matching. **(B)** No difference in mortality between the two groups after matching. **(C)** No difference in reintervention at 1, 3, and 5 years **(D)** No difference in major amputation at 1, 3, and 5 years.

Femoro-Popliteal Arterial Segment. (Morphological changes with functional Flexion-Extension of the knee joint.)

Observe the Hinge Points – Superior Genicular Artery and Anterior Tibial Artery

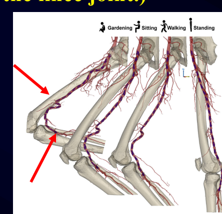

Figure 3.
Three-dimensional reconstructions of femoropopliteal artery deformations due to limb flexion derived from CT imaging of the limb in standing, walking, sitting, and gardening postures.

Desyatova A, Poulson W, MacTaggart J, Maleckis K, Kamenskiy A . Cross-sectional pinching in human femoropopliteal arteries due to limb flexion, and stent design optimization for maximum cross-sectional opening and minimum intramural stresses. J. R. Soc. Interface 15: 2018, 0475.

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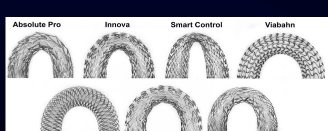
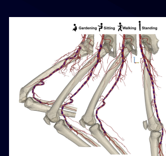
Stent / Stent Designs Needs to Adapt to Femoro-Popliteal Artery Conformational Changes.



MacTaggart J, Poulson W, Seas A,et al . STENT DESIGN AFFECTS FEMOROPOPLITEAL ARTERY DEFORMATION. Ann Surg. 2019 July ; 270(1): 180–187.



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Endovascular Popliteal artery Aneurysms Repair (EPAR)and Stent graft considerations

- **Adequate proximal and distal landing zone.**
- **Patency of at least one tibial vessel.**
- **Oversized 10% (1mm diameter).**
- **Adequate overlap (approx. 2cm).**
- **Avoid diameter mismatch of overlapping grafts of > 2mm.**
- **Angiography in neutral and flexed knee views.**
- **Completion Angiography in neutral and flexed knee views.**
- **Antiplatelet agents.**

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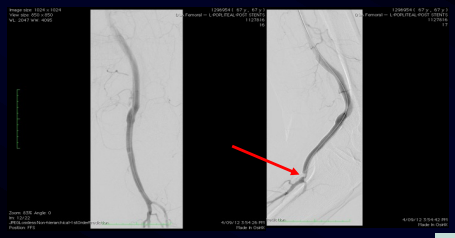
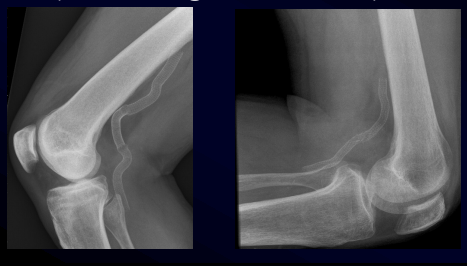
Graft Deployment Technique



Stent Fractures
(Related to graft occlusions)



Stent Fractures in EPAR

- Haemobahn/Viabahn stent fractures occurred in 28% of the cases.
- The 5-year and 10-year fracture-free survival rate was 78% and 54%, respectively.
- 13/21 (62%) stent fractures occurred at the level of the overlap zone of different endografts.
- Associated with stent graft occlusion in one-third of the cases with a fractured stent.
- Younger age and multiple stent grafts could lead to stent fractures.
- Younger age may be a factor because of a increased physical activity.

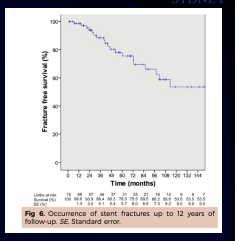


Fig 6. Occurrence of stent fractures up to 12 years of follow-up. SE, Standard error.

Goichtir B, et al. Long-term outcome of endovascular popliteal artery aneurysm repair. Journal of Vascular Surgery, 2018; Volume 67, Issue 6: 1797 – 1804.
Tellis H, et al. Stent fractures in the remodelin/Viabahn stent graft after endovascular popliteal aneurysm repair. J Vasc Surg. 2020 Oct;S1062-1410-4.

Runoff Vessels?

Table IV. Multivariate analysis of selected variables on primary patency

	Primary patency					
	OR cohort		ER cohort		Overall	
Variable	*P* value	95% CI	*P* value	95% CI	*P* value	95% CI
Diabetes	.06	0.89-235.46	.63	0.22-12.17	.10	0.82-12.37
≥2 Runoff vessels	.22	0.05-1.98	**.01**	0.01-0.45	**.01**	0.01-0.05

CI, Confidence interval; *ER*, endovascular repair; *OR*, open repair.
Boldface *P* values represent statistical significance.

Shah NG, Rakesh RS, Garg K, Safian R, Beckman CR, Maldonado TS, Sadek M, Lamparello P, Jacobowitz GR, Rayfield MG, Veith F, Coyne NS. Endovascular treatment of popliteal artery aneurysms has comparable long-term outcomes to open repair with shorter lengths of stay. J Vasc Surg. 2021 Nov;74(5):1565-1572.

Timing of Occlusions

42% within 1 month, 75% within 6 months.

Reintervention

Migration, Stent fractures, Graft collapse,

(Kinking/Stiff Grafts, Prosthetic material)

Antiplatelet non-compliance

Prolonged knee flexion

Tiellia I, J Vasc Surg 2005; 41: 561-7, Mohan IV, EJVES 2006; 32:149-54

Occluded Popliteal Stent – Not the worst thing!

Runoff vessels seem to be preserved.

Amputations rarely Necessary.

Promising results for newer thrombolytic systems.
(Ekos/Angiojet/Penumbra/JETi).

Bypass surgery bailout not usually compromised (if needed).

Adjunctive Therapy

Antiplatelet agents essential!!!!

Monotherapy or combination therapy with clopidogrel

Regression analysis (by Groningen group) demonstrated graft occlusion related to Non-use of Clopidogrel.

Tielliu I. J Vasc Surg 2005; 41: 561-7

Open Popliteal Aneurysm Repair

Patient for OPAR

Age: EPAR not recommended for young patients with suitable vein; < 50 years.

? Comorbidities: Renal, Cardiac.

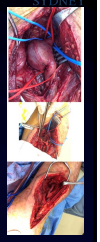
Extensive aneurysms, with Severe Angulation and distortion may complicate stent delivery and placement.

Contraindications to antiplatelet agents.

Open Popliteal Aneurysm Repair

Patient to include

- Patients with Acute limb ischaemia .
- PAA rupture ?
- Fewer or Occluded Runoff vessels.
- Very elongated and tortuous aneurysms ?



*Fargion A, Masciello F, Pratesi G, Giacomelli E, Dorigo W, Pratesi C. **Endovascular treatment with primary stenting of acutely thrombosed popliteal artery aneurysms**. Ann Vasc Surg. 44 (2017), pp. 421e5–421e8.*
Cervin A, Ravn H, Björck M. Ruptured popliteal artery aneurysm. Br J Surg. 2018 Dec;105(13):1753-1758.

Summary

- EPAR has come of age.
- Popliteal aneurysm stenting can deliver results comparable to open bypass with vein grafts.
- Procedural technique must include a flexed knee completion angiogram.
- Medically unfit patients are not good candidates for EPAR (or OPAR).

Thank you