

Wow! That Dialysis Needle is Sharp! What Damage Can it do?

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Disclosure

Shawn M. Gage, PA-C

I have the following potential conflicts of interest to report:

- ✓ Co-inventor of InnAVasc technology
- ✓ Owner of InnAVasc
- ✓ Shareholder in InnAVasc
- ✓ Employed by InnAVasc
- ✓ Receipt of grants/research support from NIH and NSF



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Graft Failure/Abandonment: How does it happen?

Occlusion (cessation of blood flow)

- thrombosis

Other (blood flow continues)

- Infection
- Bleeding
- Hematoma
- Pseudoaneurysm
- Steal Syndrome
- Venous Hypertension
- Neuropathy
- Low flow
- Inability to cannulate



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Ischemia
(Steal Syndrome)

Pseudoaneurysm

Thrombosis

Stenosis

Inability to
Cannulate

Common AV Access Complications

Neuropathy

Hematoma

Venous
Hypertension

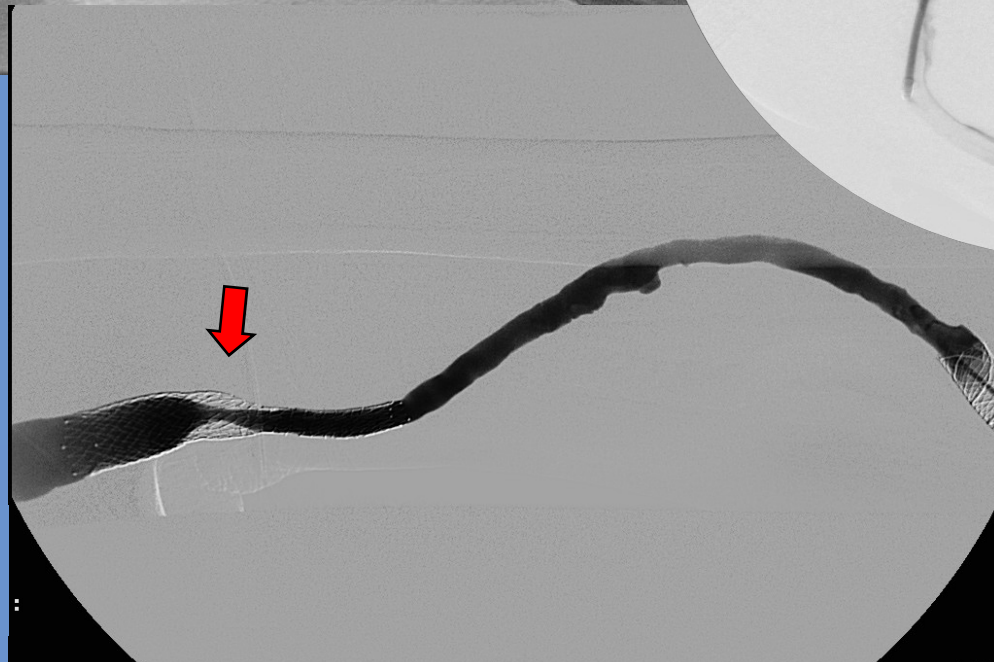
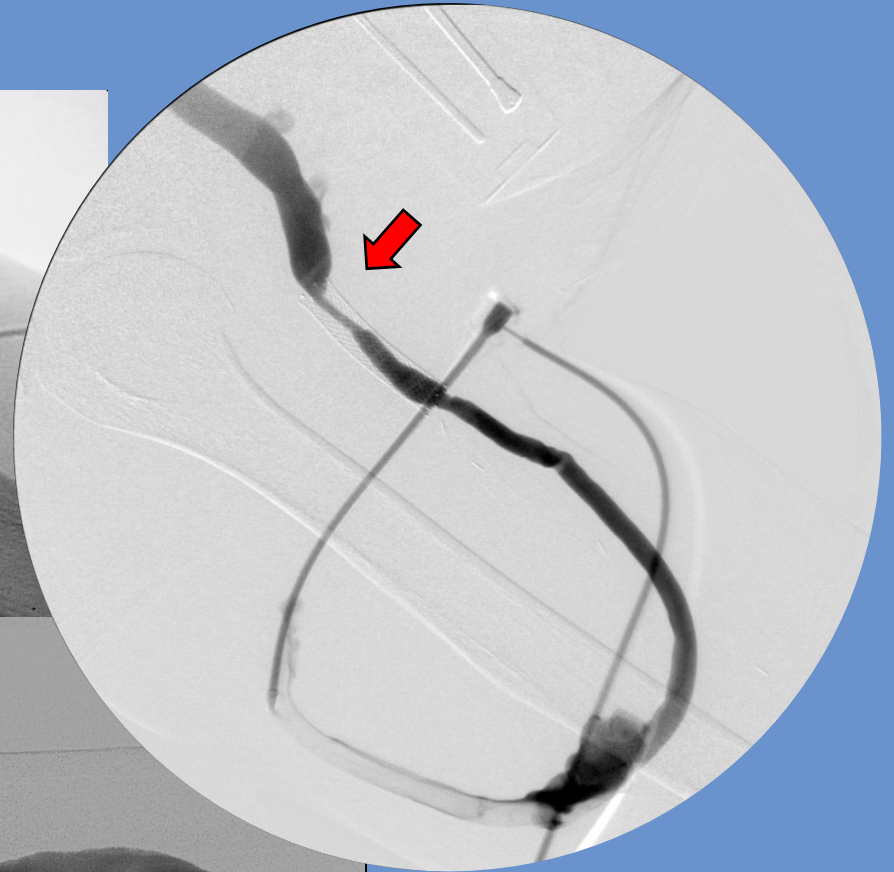
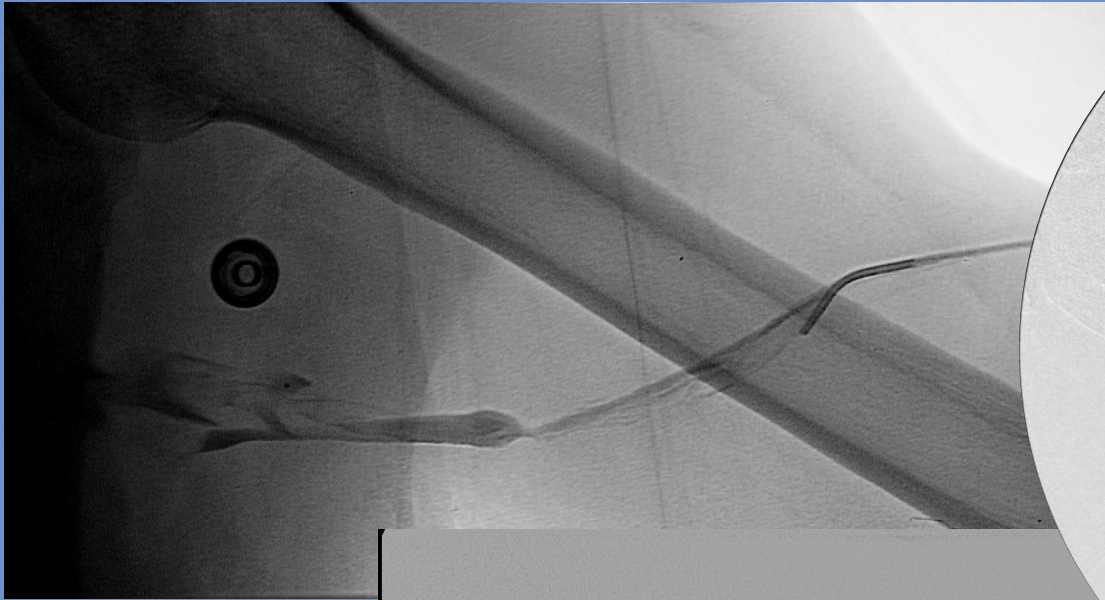
Bleeding

Stenosis
(venous intimal hyperplasia)



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The constant battle



Graft Failure: How much is cannulation to blame?



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Hypothesis

- Needle cannulation is responsible for greater percentage of AV Access complications, failure and abandonment than what is currently documented.



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Common AV Access Complications

- Hematoma
- Bleeding
- Pseudoaneurysm
- Stenosis
- Infection
- Thrombosis
- Steal Syndrome
- Venous Hypertension
- Neuropathy
- Inability to cannulate



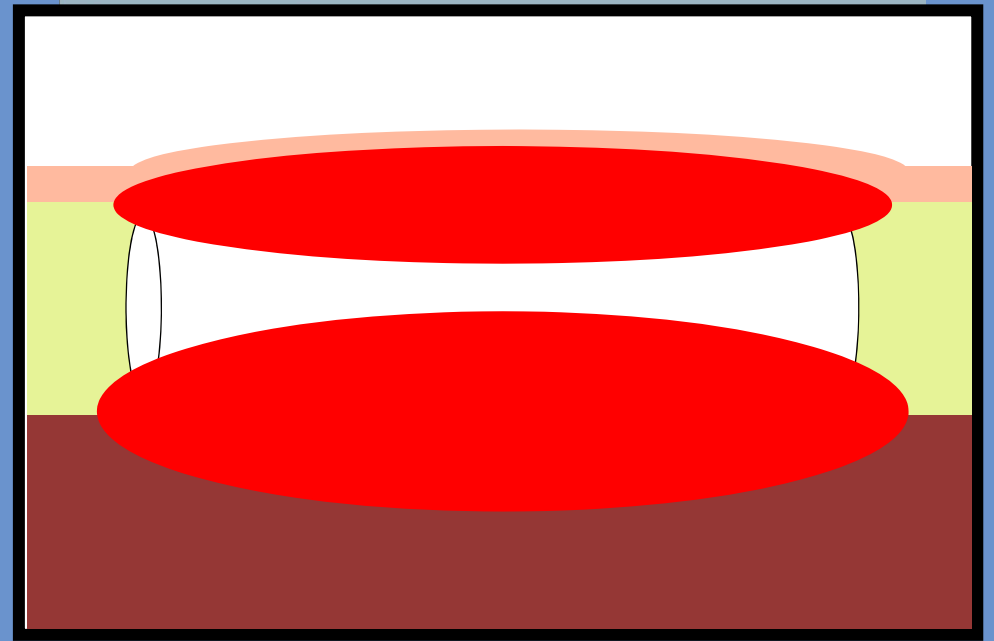
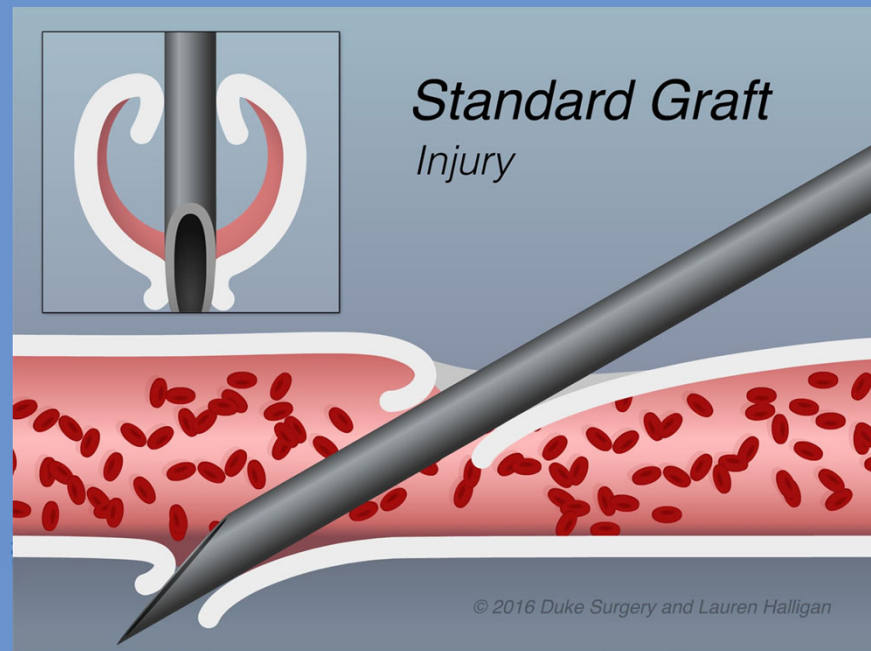
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Hematoma



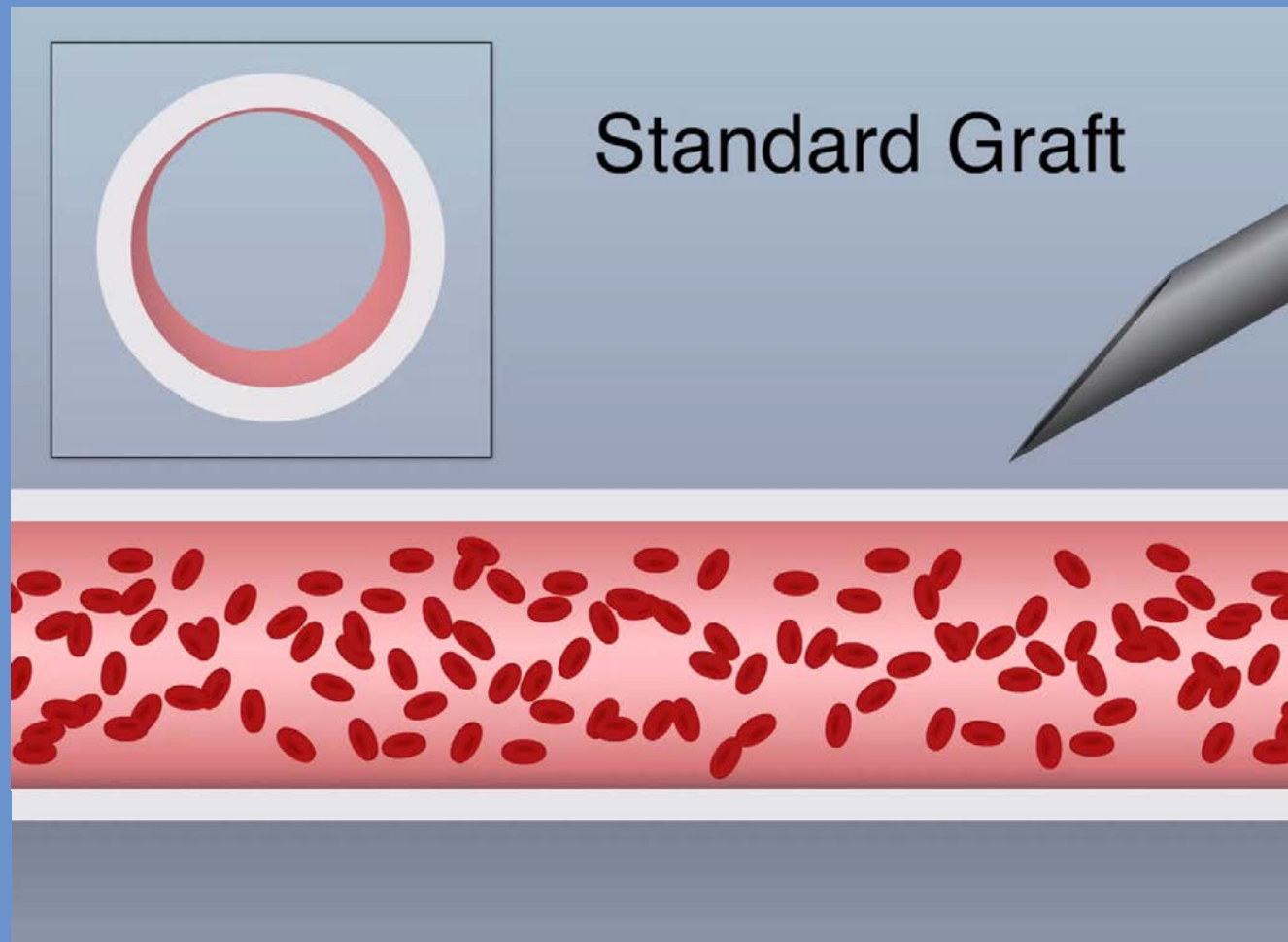
Hematoma

- Poor hemostasis technique at decannulation
- Access posterior and side wall trauma and degradation
 - Inadvertent **NEEDLE** injury (more common)
 - Repetitive **NEEDLE** injury



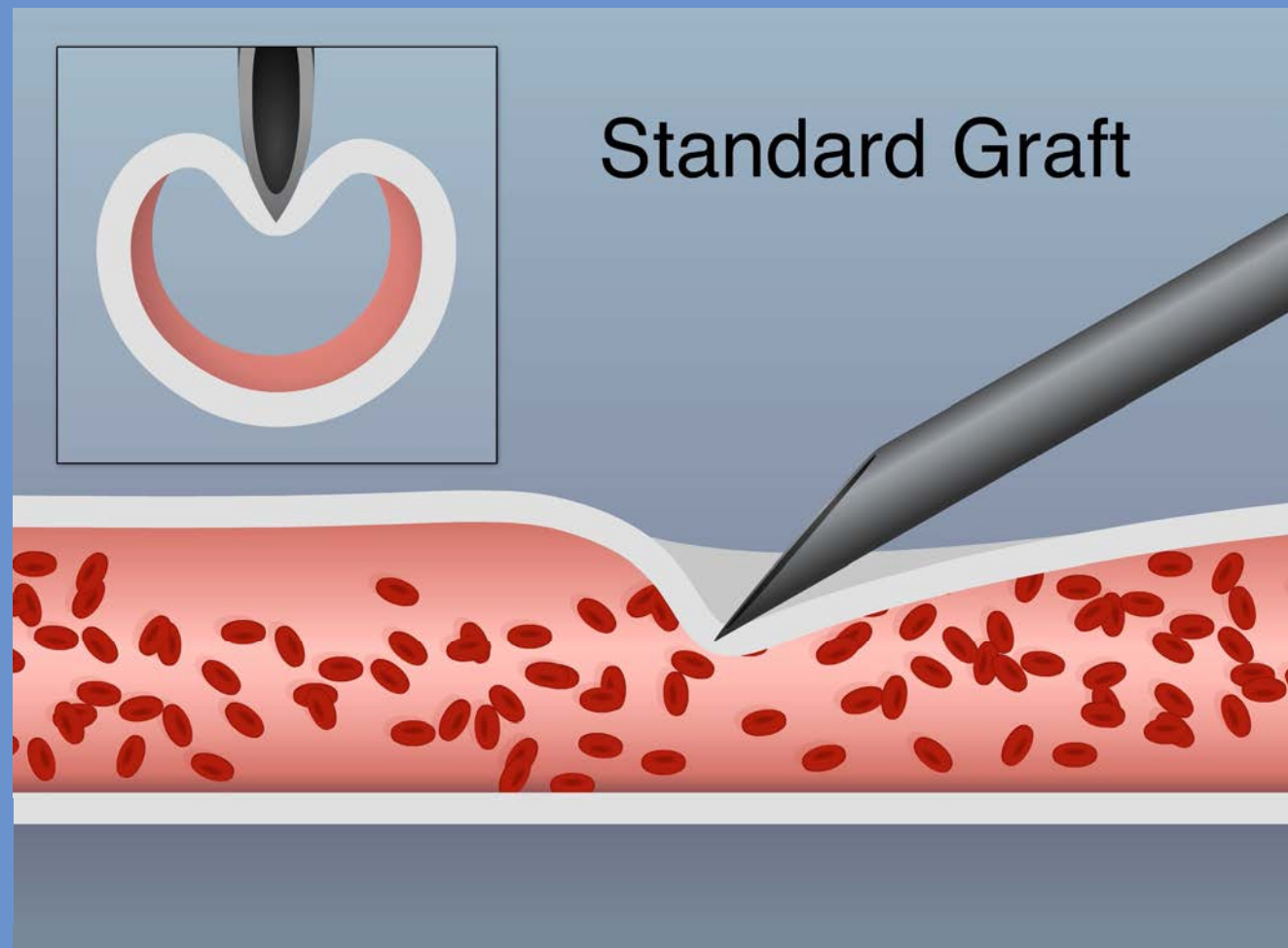
Back/Side Wall Injuries

- These injuries occur as a result of the front wall collapsing down on the back wall during needle puncture



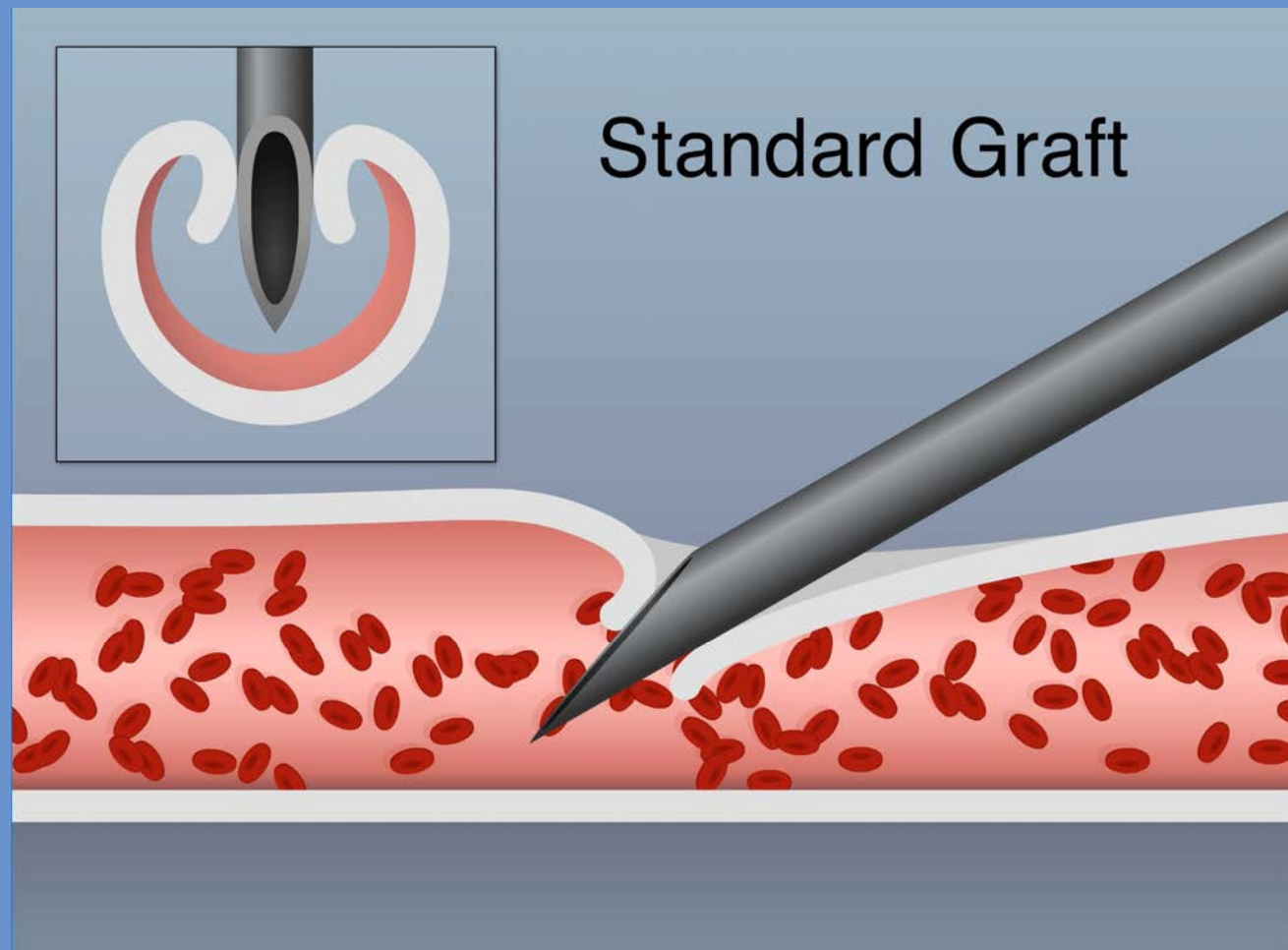
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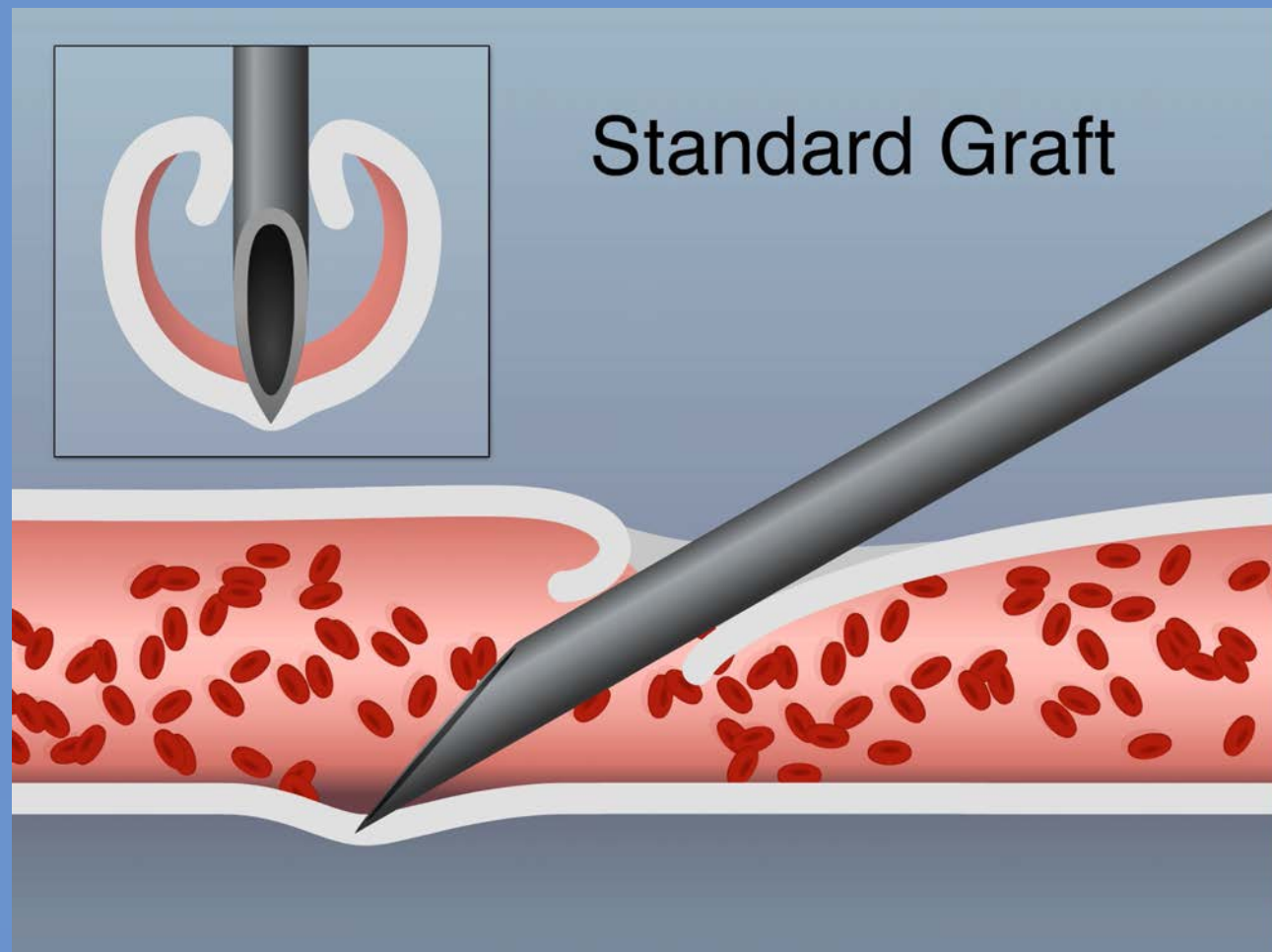
Back/Side Wall Injuries

- When the needle finally punctures the front wall, the force can accidentally propel the needle tip through the back wall.



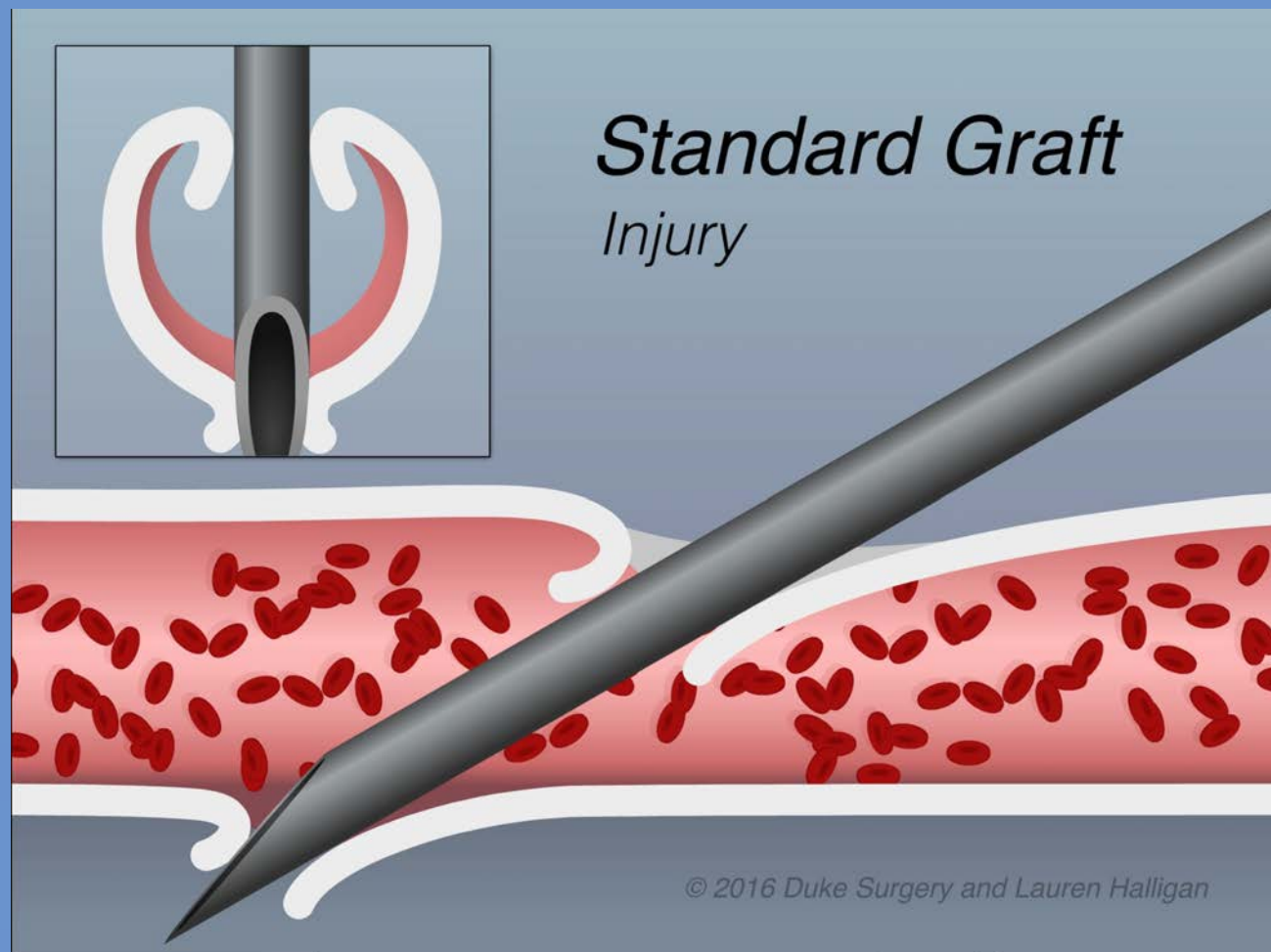
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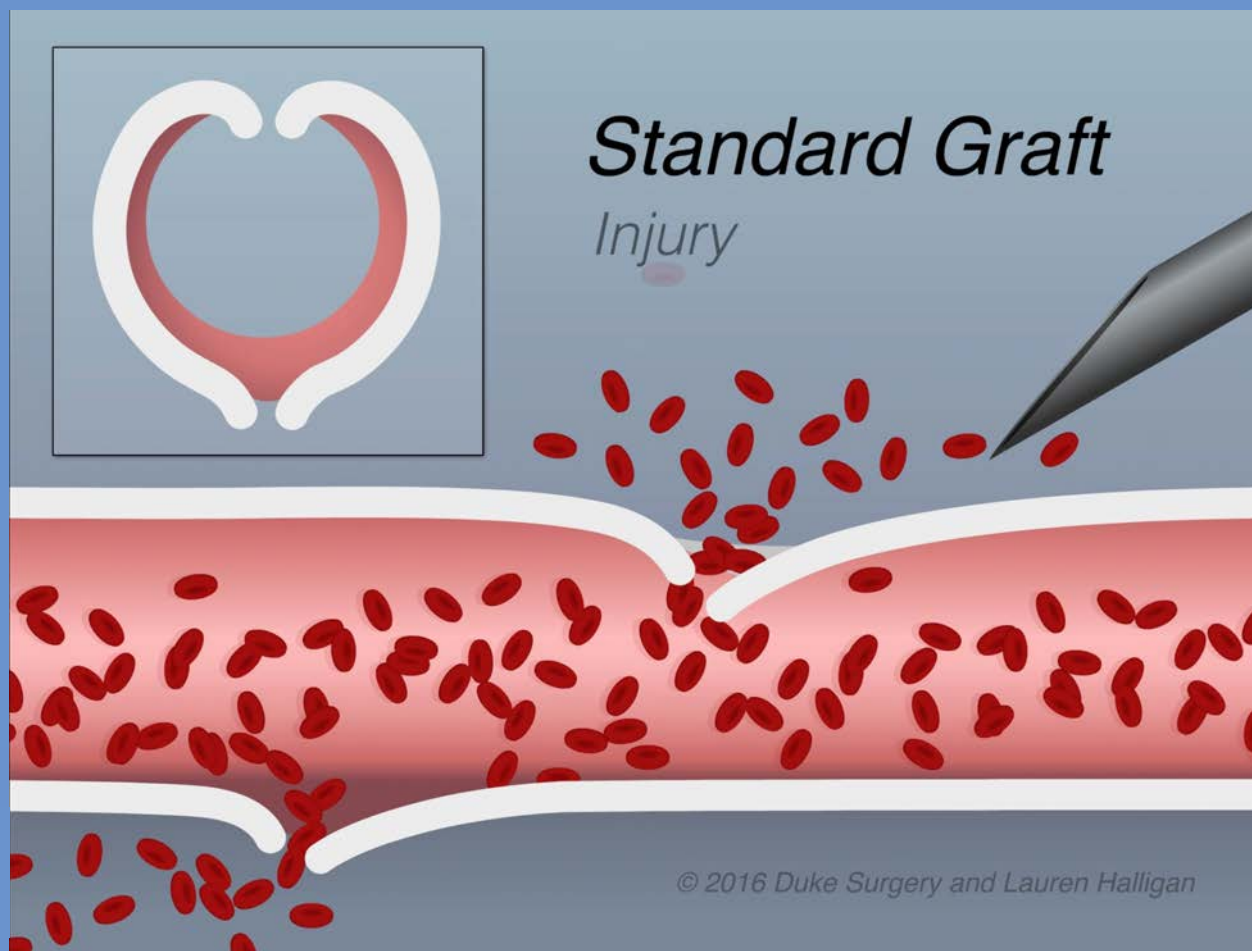
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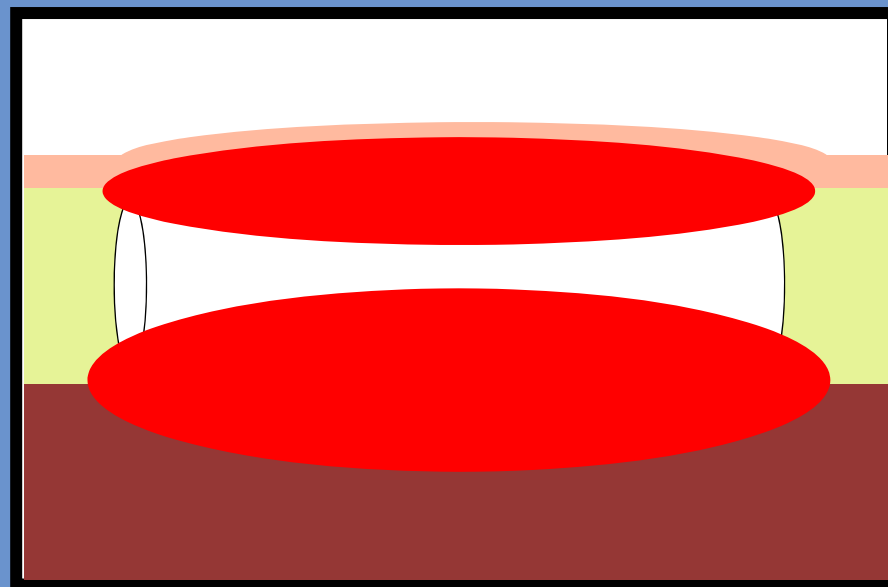
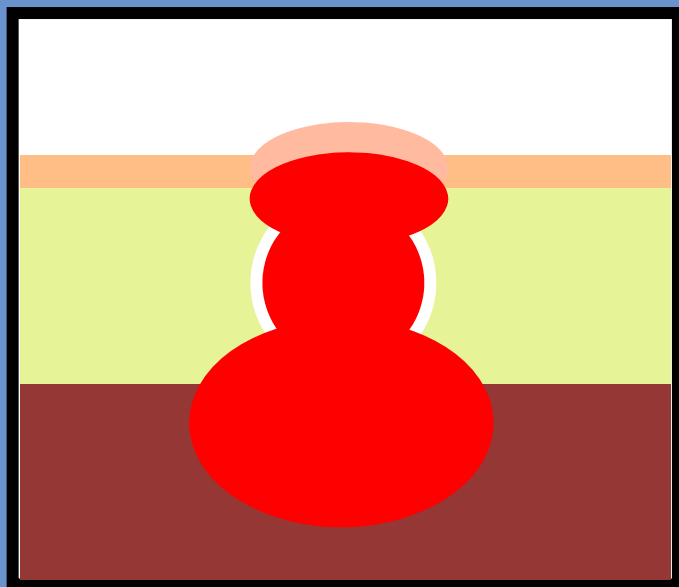
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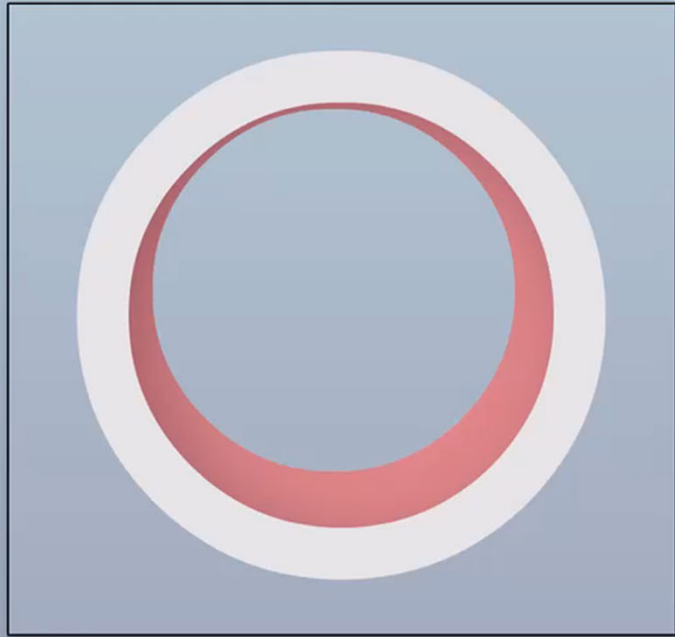
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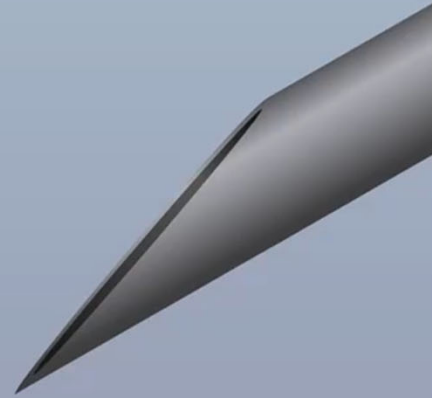
Back/Side Wall Injuries

- Blood fills the posterior space (inability to provide pressure)
- Blood can fill the anterior and perigraft space if adequate pressure/hemostasis is not administered



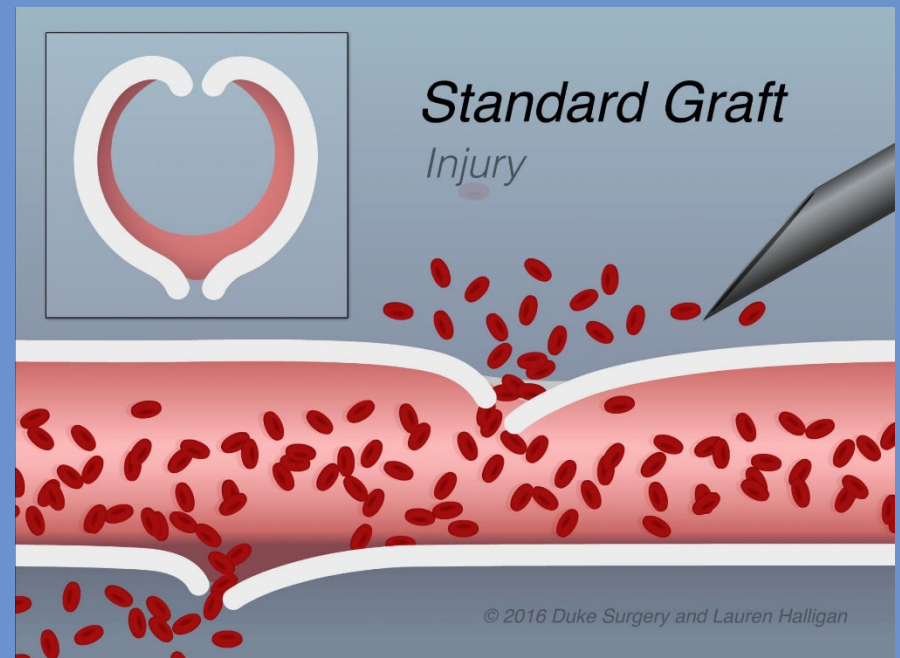
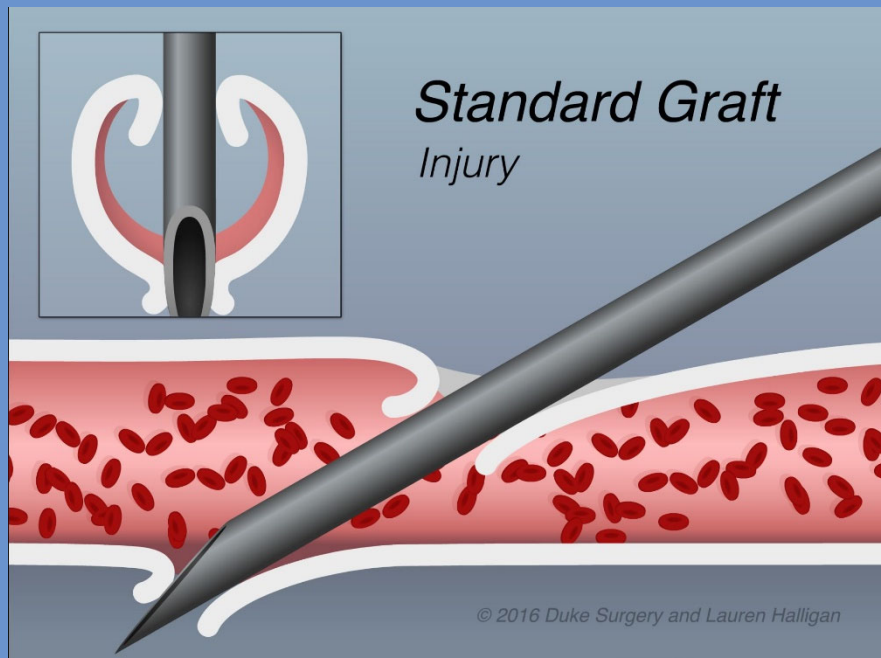


Standard Graft

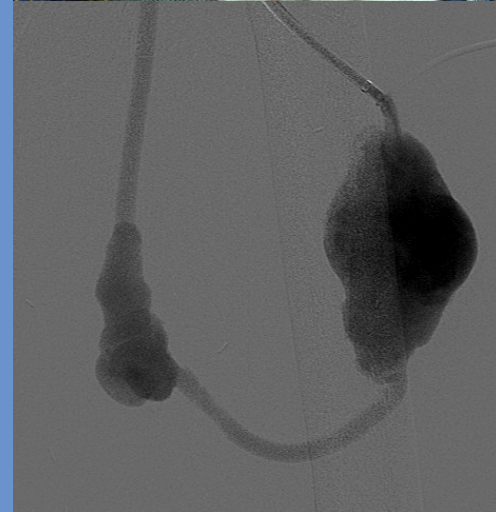
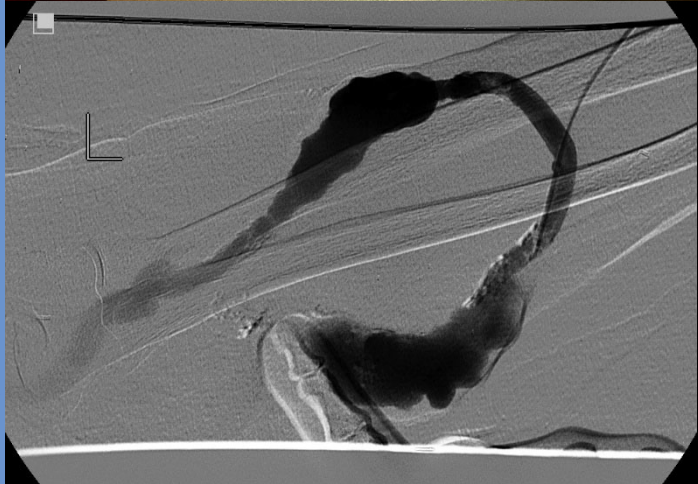


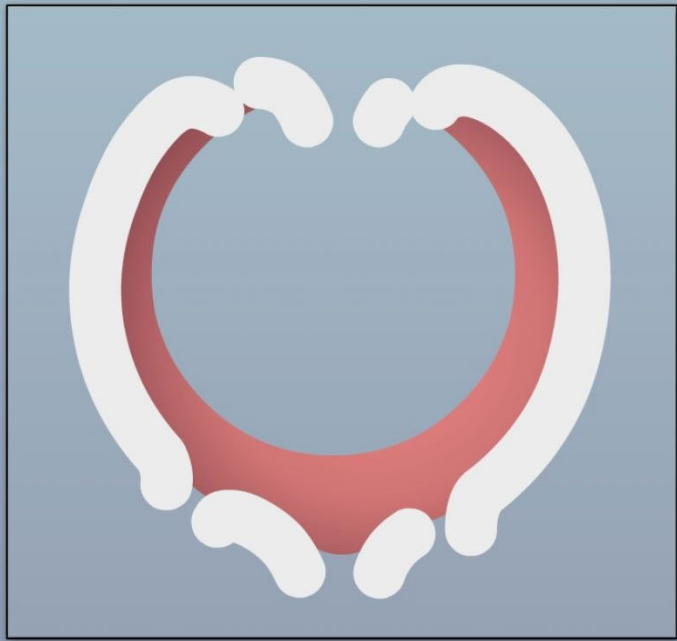
Bleeding

- Coagulopathy
- Down stream stenosis
 - Anastomotic or Central
- Inadvertent injury, or posterior and side wall injury and degradation
 - Secondary to repetitive **NEEDLE** injury



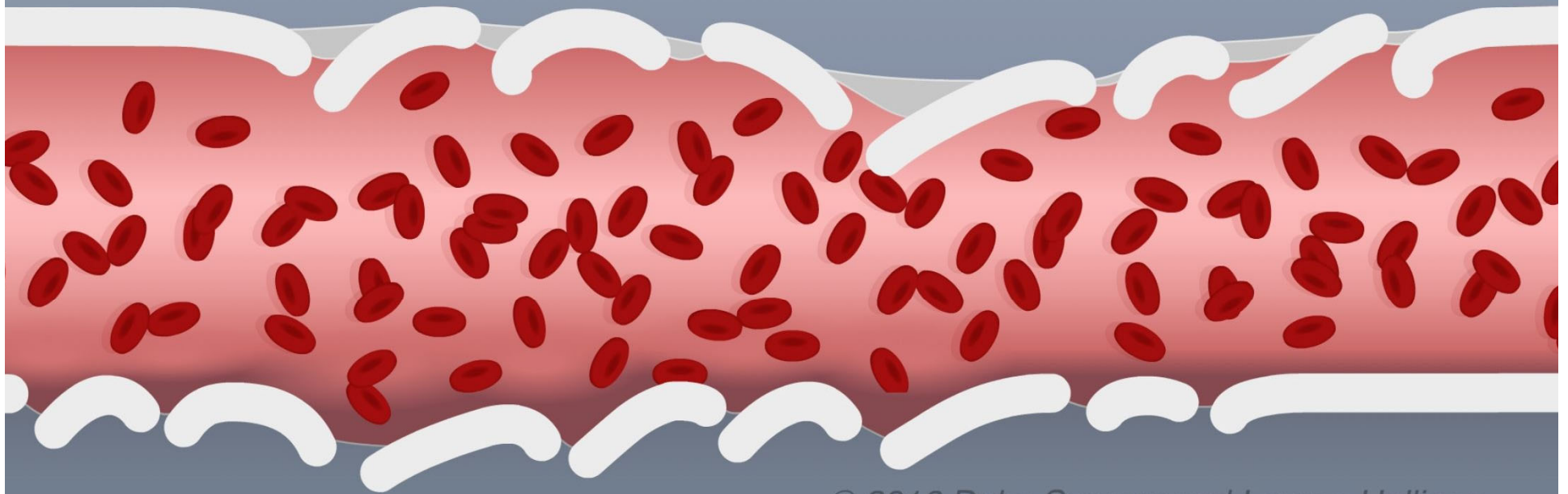
Pseudoaneurysm





Standard Graft

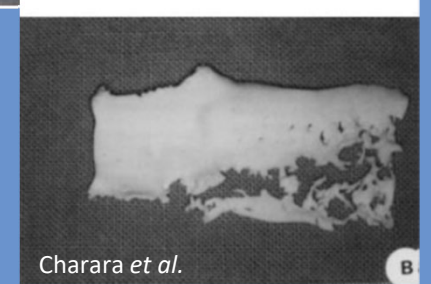
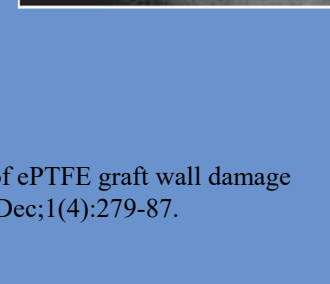
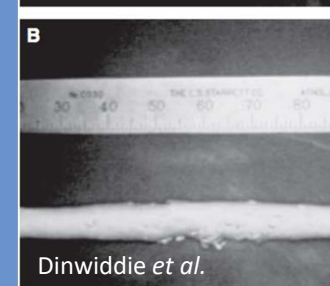
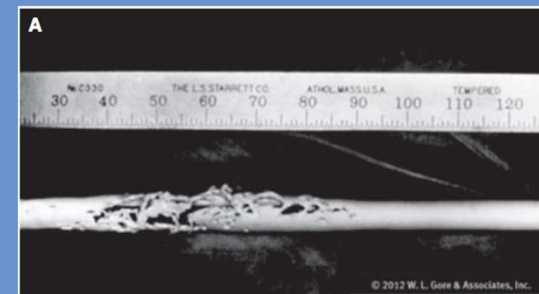
*Degradation
with use*



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Pseudoaneurysm - Graft Degradation

- Posterior and side wall trauma and degradation
 - Repetitive **NEEDLE** injury (more common)
 - Inadvertent **NEEDLE** injury
 - Sheath placement
- Worsened by downstream stenosis

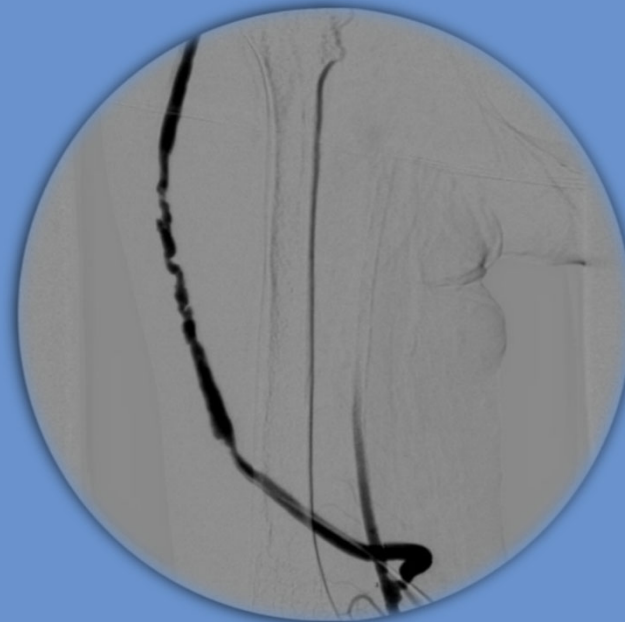
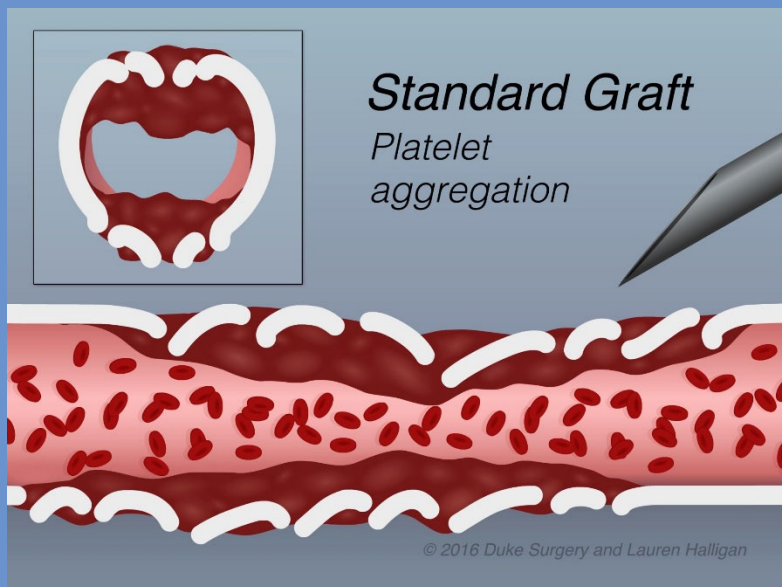
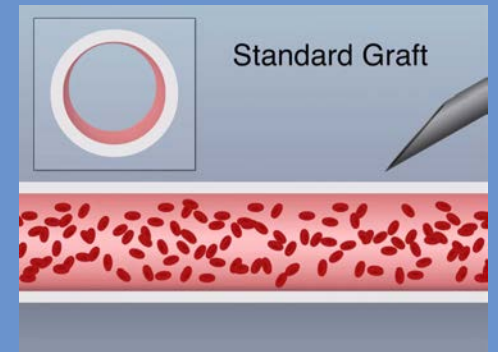


1. Delorme J, Guidoin R, Canizales S, *et al.* Vascular access for hemodialysis: pathologic features of surgically excised ePTFE grafts. *Ann Vasc Surg* 1992 Nov 1;6(6):517-24.
2. Dinwiddie LC, Ball L, Brouwer D, *et al.* What nephrologists need to know about vascular access cannulation. *Semin Dial* 2013 May 3;26:315-322.
3. Charara J, Guidoin R, Gill F, *et al.* Morphologic assessment of ePTFE graft wall damage following hemodialysis needle punctures. *J Appl Biomater* 1990 Dec;1(4):279-87.

Charara *et al.*

Stenosis

- Neointimal hyperplasia of the outflow vein
- Intragraft stenosis
 - Secondary to repetitive **NEEDLE** cannulation
 - Tissue ingrowth through puncture sites and ePTFE flaps
 - Irregular, foreign luminal surface
 - Leads to platelet aggregation and sclerosis
 - Difficult to Access graft (sclerotic, irregular lumen)



Local Infection



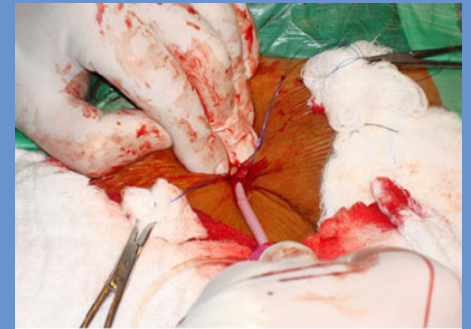
Infection

- Local Access infection
 - **NEEDLE** Inoculation (without fluid collection i.e. hematoma or seroma)
 - Infected Hematoma (caused by **NEEDLE** injury)
 - Infected pseudoaneurysm (caused by **NEEDLE** injury)
 - Skin ulcer/erosion/access exposure (**NEEDLE** injury)



Thrombosis

- Neointimal hyperplasia of the outflow vein
- Chronic hypotension
- Hypercoagulable syndrome
- Overly aggressive compression at decannulation
- Intragraft stenosis
 - Secondary to repetitive **NEEDLE** cannulation
 - Sclerotic, Irregular Lumen
- Hematoma
 - Impingement on access secondary to **NEEDLE** injury
- Pseudoaneurysm
 - Due to **NEEDLE** injury and causes turbulence and mural thrombus



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Adverse Event	6-month incidence estimate for ePTFE grafts	Literature Support and Estimate Calculation
Infection	5% - 20%	4% - 20% per year for prosthetic AV access with 7 sources cited, survey from Centers for Disease Control [CDC] - average of 3.2% of patients per month at dialysis centers¹
Pseudo-aneurysm	5 - 10%	range from 2-10% in ePTFE grafts with 3 sources cited, 0.049 to 0.1 per patient-year from two randomized trials¹ Note: (0.1 events per patient year [EPPY] * 30 patient years = 3 events, 3 events / 60 = 5%)
Hematomas	4-10%	Incidence ranges from 0.073 – 0.2 per patient year with 2 sources cited¹ Note: 0.2 EPPY * 30 patient years = 6 events, 6 events / 60 = 10%
Bleeding	12%	0.24 EPPY² Note: 0.24 EPPY * 30 patient years = 7.2 events, 7.2 events / 60 = <u>12%</u>

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2. Dixon BS, Beck GJ, Vazquez MA, Greenberg A, Delmez JA, Allon M, Dember LM, Himmelfarb J, Gassman JJ, Greene T, Radeva MK. Effect of dipyridamole plus aspirin on hemodialysis graft patency. New England Journal of Medicine. 2009 May 21;360(21):2191-201.

Reports from the Literature: Standard ePTFE

Reports from
the Literature:
Early
cannulation
grafts

Early Cannulation Grafts - Complication Rates							
Study	year	No. grafts	% Infection	% Pseudoaneurysm	% Thrombosis	% Hematoma	% Bleeding
Acuseal							
Aitken	2014	37	16	8	41	24.3	0
Tozzi	2014	30	0	0	27	0	0
Glickman	2015	138	11	0		4	4
Maytham	2015	55	16	14.5		5.4	
subtotal		260	10.8	5.6	34	8.425	1.3
Flixine/Rapidax							
Lioupis	2011	48	6.25	6.25	25	0	
Mistry	2013	12	8.3	8.3		8.3	
Chiang	2014	45	11		57.7		
Scarritt	2014	78	9	0	29	1.2	0
Berard	2015	46	4	2.1	23.9	13	
Hinojosa	2017	13	8	0	23	0	0
subtotal		242	7.8	3.3	31.72	4.5	0
AVFLO							
Wijeyaratne	2011	17	18	5.8	24		
Karatepe	2013	24	4	0	42	4.1	
Ferraresso	2013	10	0	0	20	20	
subtotal		51	7.3	1.9	28.7	12.1	
Vectra							
Glickman	2001	71	5.6	0	14		
Peng	2003	163	26.1	3.5	28.4		0.8
Kakkos	2007	190	3.2		23		3.2
Schild	2007	30	10		37		3
Kakkos	2008	76	7	2.6	34		2.6
Kakkos	2011	239	11	17			
subtotal		769	10.5	5.8	27.28		2.4
	Total/Avg	1322	9.2	4.3	29.9	7.3	1.5
		(range)	(0-26)	(0-15)	(14-57)	(0-24)	(0-4)

Big Data

- Problems with the Coding Data
 - Diagnosis codes vague
 - Coding poor
 - Require better reporting and coding structure in order to capture specific events



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Coding for AV Access Complications

- Previous System (**ICD-9 codes**)

- Complications

- **996.1** – Mechanical complication of other vascular device, implant, and graft
 - **996.73** – Other complications due to renal dialysis device, implant, and graft
 - **996.74** - Other complications due to other vascular device, implant, and graft

- Infection

- **996.62** - Infection and inflammatory reaction due to other vascular device, implant, and graft
 - 17 codes related to septicemia/bacteremia



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Coding for AV Access Complications

- **Current System (ICD-10 codes)**

- Pseudoaneurysm?

- T82.510 – Breakdown (mechanical) of AVF
 - T82.511 – Breakdown (mechanical) of AVG

- ?????

- T82.520 – Displacement of AVF
 - T82.521 – Displacement of AVG

- Seroma? Hematoma??

- T82.530 – Leakage of AVF
 - T82.531 – Leakage of AVG

- T82.590 – other mechanical complication of AVF

- T82.591 – other mechanical complication of AVG



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Coding for AV Access/Vascular Complications

- **Current System (ICD-10 codes)**
 - T82.7 – Infection and inflammatory reaction
 - T82.818 – Embolism
 - T82.828 – Fibrosis
 - T82.838 – Hemorrhage
 - T82.848 – Pain
 - T82.856 – Stenosis of stent
 - T82.858 – Stenosis of vascular graft
 - T82.868 – Thrombosis of vascular graft
 - T82.898 – other specified complication
 - T82.9 – unspecified complication



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Conclusion

- Numerous access complications result from needle injury
- This may be a bigger problem than is currently recognized
- Little data exists to fully describe these suspected complication and failure mechanisms
- Current coding systems have improved, but still lack granularity to accurately document these complications
- Prospective, observational studies will be required to better elucidate and describe these complications
- Safer, and more cautious cannulation practices
- Better/safer materials for AV access conduit



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Charge

- Consciously document cause for complication and abandonment
- Development of a multi-center, multi-national prospective database/registry to record AV access specific complications and patency
- Inform for better granularity in next generation of ICD coding system
- Inform better technology development around specific complications



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**2019 VASA HANDS-ON
PRACTICUM ON
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