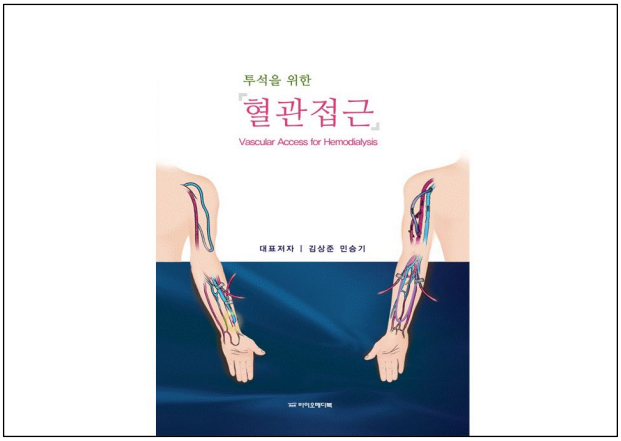
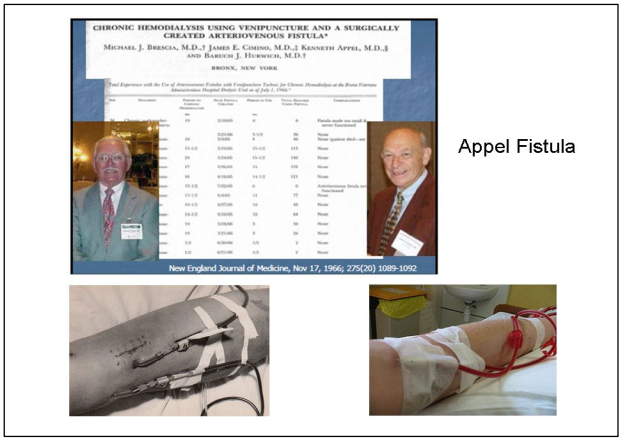
Mini-Lecture 3

Complications in Hemodialysis Access

Sang-Il Min, MD

Department of Surgery Seoul National University Hospital





Appel Fistula

Nomenclature

- Conduit: autogenous/prosthetic
- Inflow: radial/brachial/axillary/femoral
- Outflow: cephalic/brachial/basilic/axillary/great saphenous
- Location: forearm/upperarm/inguinal
- Configuration: direct/loop/straight

Autogenous	Autogenous posterior radial branch-cephalic direct wrist access	Snuff box fistula
	Autogenous radial-cephalic direct wrist access	Brescia-Cimino fistula
	Autogenous ulnar-basilic forearm transposition	Superficial venous transposition in the forearm, basilic vein to ulnar artery
	Autogenous radial-cephalic forearm transposition	Superficial venous transposition in the forearm, cephalic vein to radial artery
	Autogenous brachial-cephalic forearm looped transposition	Superficial venous transposition in the forearm, cephalic vein to brachial artery, looped
	Autogenous radial-brachial indirect saphenous vein transposition	Great saphenous vein reversed and translocated radial artery to brachial vein
Prosthetic	Prosthetic brachial-antecubital forearm loop access	ePTFE* forearm loop graft
	Prosthetic radial-median cubital forearm straight access	ePTFE forearm straight graft

동정맥루 수술 후 문제점, 합병증

- *Immaturation*
- **Stenosis/Thrombosis**
- **AV access Steal syndrome**
- **Venous hypertension**
- **Noninfectious fluid collections**

Maturation

- 3 – 4 months *(Update 2000)*
- 6 – 8 weeks *(Update 2006)*

Table 25–1
Objective fistula maturation criteria

Flow	>600 mL/min
Cannulation segment	>10 cm long or two 4-cm segments >6 mm in diameter <5 mm deep from skin surface

Clinical predictors of Fistula Maturation

- **No firm consensus exists**
  - Small vessels (arteries <1.6mm, veins <2-2.5mm)
  - Lower arm AVFs
  - Female gender
  - Obesity
  - Diabetes
  - Extensive vascular disease
  - **Lack of surgical experience**
  - Age
  - Ethnicity
- **Controllable parameters**
  - Site of the AVF (forearm versus upperarm)
  - Size of artery and vein

Riella MC. Nat Rev Nephrol 2012

Evaluation of Fistula Maturation

- **Postop. 1st evaluation: inspection, palpation**
  - 10 to 14 days after surgery
  - Infection, vascular or neurologic complication
  - Early identify stenotic problem
- **Postop. 2nd evaluation**
  - 4 weeks
  - Duplex ultrasound
    - Length, depth, diameter of the cannulation segment
    - Venous, arterial flow

Fistula Maturation Failure

- **Failure of Arterial Dilatation**
  - Calcified vessel
  - Vesodilatation mediators diminish
- **Failure of Venous Dilatation**
  - Recanalized veins
    - previous chronic thrombosed vein
  - Scarred valve leaflets
    - old needle stick injury
  - Genetic polymorphisms for mediators

→ *Preoperative ultrasound evaluation is needed!*

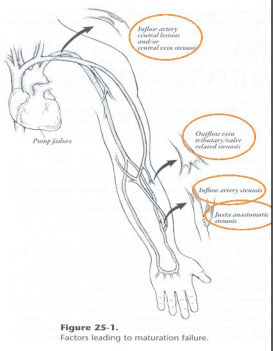
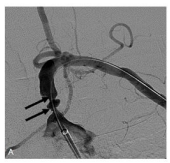


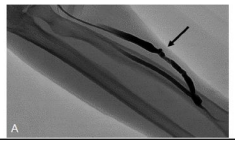
Figure 25-1.
Factors leading to maturation failure.

Treatment for maturation failure

- **Inflow artery stenosis**
  - Central artery
  - Balloon angioplasty or stenting
- **Juxta-anastomotic stenosis**
  - Early interveintion is most important
  - Balloon angioplasty or surgical repair
- **Vein segment stenosis**
  - Tx. : angioplasty or venoplasty
  - Peripheral vein stents should be avoided under all circumstances



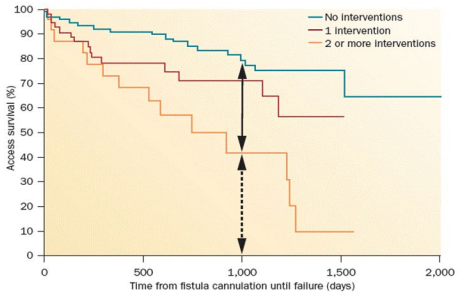




Decreased Cumulative Access Survival in Arteriovenous Fistulas Requiring Interventions to Promote Maturation

Timmy Lee,*† Ahsan Ullah,* Michael Allon,‡ Paul Succop,§ Mahmoud El-Khatib,*‖ Rino Munda,*¶ and Prabir Roy-Chaudhury*#

Clin J Am Soc Nephrol 6: 575–581, 2011.



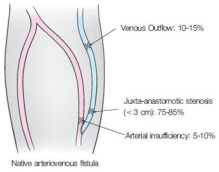
동정맥루 수술 후 문제점, 합병증

- Immaturation
- *Stenosis/Thrombosis*
- AV access Steal syndrome
- Venous hypertension
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AVF stenosis

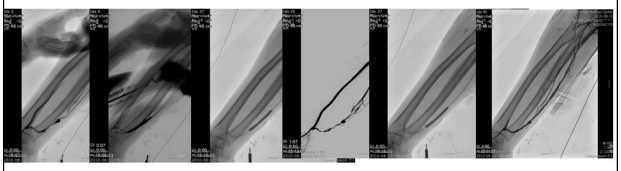
- Inflow
- Juxta-anastomotic
- Venous outflow

- P/E
  - weak thrill, pre-stenotic pulse, ↓ flow, ↑ 지혈시간
- Duplex



Stenosis: Endovascular Treatment (I)

- **Good technical success & immediate fistula use**
- **Preservation of venous real estate**



Stenosis: Endovascular Treatment (II)

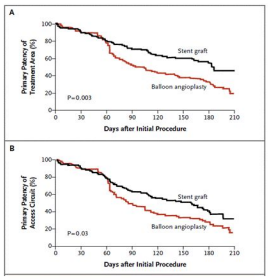
Stent Graft versus Balloon Angioplasty for Failing Dialysis-Access Grafts

Ziv J. Haskal, M.D., Scott Trerotola, M.D., Bart Dolmatch, M.D., Earl Schuman, M.D., Sanford Altman, M.D., Samuel Mietling, M.D., Scott Berman, M.D., Gordon McLennan, M.D., Clayton Trimmer, D.O., John Ross, M.D., and Thomas Vesely, M.D.

N Engl J Med 2010;362:494-503.

Table 3. Treatment Success and Patency End Points in the Intention-to-Treat Population, According to Treatment Group.*

End Point	Stent Graft	Balloon Angioplasty	P Value
	no. of patients/total no. (%)		
Anatomical success	91/97 (94)	68/93 (73)	<0.001
Hemodynamic success	97/97 (100)	93/93 (100)	
Clinical success	85/97 (88)	78/93 (84)	0.49
Procedural success	91/97 (94)	68/93 (73)	<0.001
Primary patency of treatment area			
2 mo	77/96 (80)	71/92 (77)	0.72
6 mo	46/91 (51)	20/86 (23)	<0.001
Primary patency of access circuit			
2 mo	76/96 (79)	71/92 (77)	0.86
6 mo	35/92 (38)	17/86 (20)	0.008

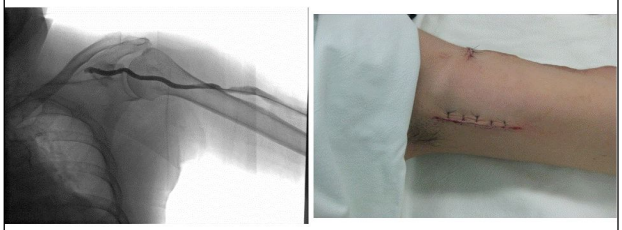


Cephalic arch stenosis

- The sole outflow of brachiocephalic AVF
- The most frequent location for stenosis of upper arm dysfunctional autogenous AVFs (30-55%)



Cephalic vein Turn-down



Recurrent AVF stenosis

- If angioplasty of the same lesion is required more than 2 times within a 3-month period, the patient should be considered for surgical revision

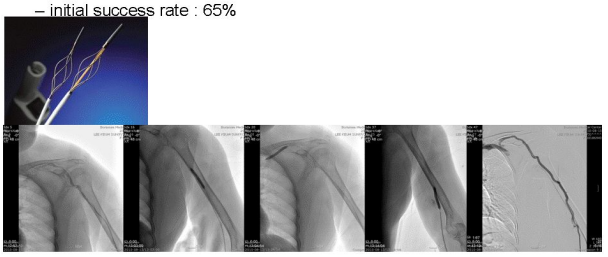
KDOQI guideline, 2006

AV access thrombosis

- Early (< 30 days)
  - technical
  - hypercoagulable
  - poor cardiac output
  - poor inflow
  - poor outflow
- Late (> 30 days)
  - progressive inflow stenosis
  - venous outflow stenosis (intimal hyperplasia)
  - poor cardiac output (hypotension)
  - nursing technique
    - poor puncture technique
    - excessive pressure
    - new early access grafts may require modified techniques

Treatment of AVF thrombosis

- Interventional thrombectomy and PTA of the underlying stenosis
  --- wide acceptance: initial success rate: 90%
- Fogarty thrombectomy catheter supported by retrograde digital expression of the thrombotic material & correction of the stenosis
  – initial success rate : 65%



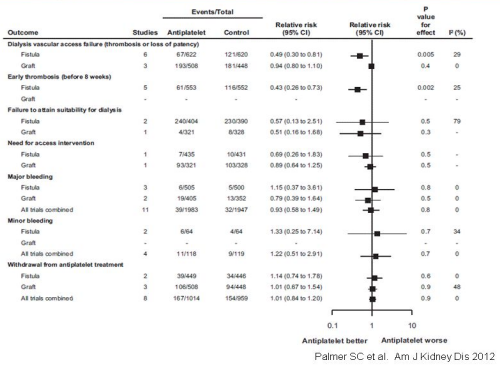
Treatment of AVF thrombosis

- Early thrombosis (Technical)
- Thrombosis with infection
- Thrombosis with AVF aneurysm

⇩

Hybrid surgery
(surgical thrombectomy + balloon angioplasty)

Antiplatelet agent



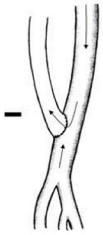
Palmer SC et al. Am J Kidney Dis 2012

동정맥루 수술 후 문제점, 합병증

- **Immaturation**
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- ***AV access Steal syndrome***
- **Venous hypertension**
- **Noninfectious fluid collections**

Steal syndrome

- Backflow of distal artery
- Distal ischemia
- complex interaction of high arterial flow and low resistance vein
  - Incidence
    - Radiocephalic Fistula (1-1.8%)
    - Forearm prosthetic fistula (4.3-6%)
    - Brachiocephalic and basilic fistula (10-25%)







Hemodialysis access-induced distal ischemia (HAIDI)

- Phenomenon of steal
  - Antegrade flow; arterial blood flow shunted directly into the fistula
  - Retrograde flow; collateral flow to the distal extremity is stolen by the AVF
- Incidence
  - 80% ; Physiologic steal (demonstrable reduction in distal perfusion pr.)
  - 6-8% ; true ISS
  - Compensation mechanism
    - Development of abundant arterial collaterals
    - Distal vasodilatation
- Symptoms
  - Pain on exertion of small muscles of the hand
  - Cold, clammy, and pale hand
  - Rest pain, Ischemic ulcer
  - The ischemic symptoms are most marked during hemodialysis.
  - High risk patient; diabetics with distal small vessel arteriosclerotic disease.
  - Risk factor ; female, age>60, brachial artery inflow

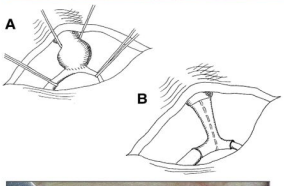
Treatment

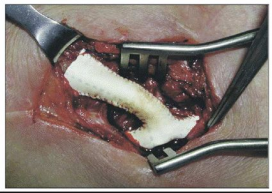
- **PTA: proximal, distal stenotic lesion**
- High flow AVF(1,000-1,500cc/min)
  - **Banding**, tapered graft, **RUDI**(revision using distal inflow)
- Normal flow AVF(500-800 cc/min) with deprivation of distal circulation
  - **Distal radial artery ligation**
  - **DRIL**(distal revascularizaton with interval ligation)

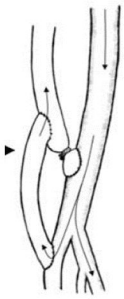
- **DDX.**
  - Carpal tunnel syndrome
  - Reflex sympathetic dystrophy syndrome
  - Edema due to venous hypertension
  - Ischemic monomelic syndrome

Banding

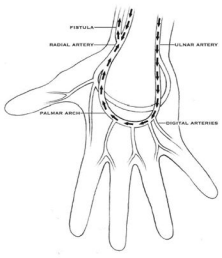
RUDI
(Revascularization using distal inflow)



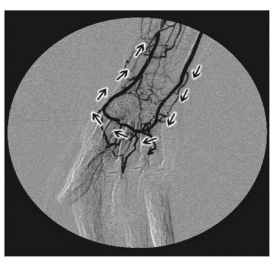




Distal radial artery ligation

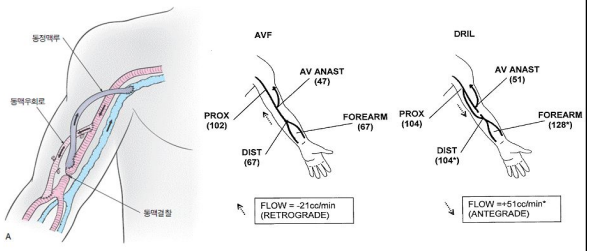


Miller GA. J Vasc Access 2008

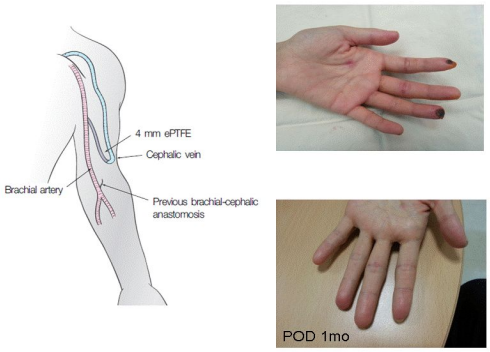


Pressure measurement of finger
Pulse waveform monitoring

DRIL procedures



PAI procedures



동정맥루 수술 후 문제점, 합병증

- **Immaturation**
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- ***Venous hypertension***
- **Noninfectious fluid collections**

Venous hypertension



- Pathophysiology
  - Central venous stenosis or occlusion
  - Valvular incompetence leading to retrograde venous flow
- Swelling of entire extremity after construction of AV fistula almost always indicates a previously unrecognized major central venous stenosis or occlusion.

Peripheral Venous hypertension

- Arterialization of vein
- Incompetence of valves
  - Swelling bluish discoloration, pigmentation of skin
- Side to side radiocephalic fistula
- Venous branch incompetence



Branch ligation

Central vein stenosis

- Occult stenosis
- Risk factor
  - Previous puncture
    - Puncture(-): 10% stenosis
  - Extrinsic compression
    - Thoracic outlet syndrome
    - Clavicular fracture
  - Pacemaker wires

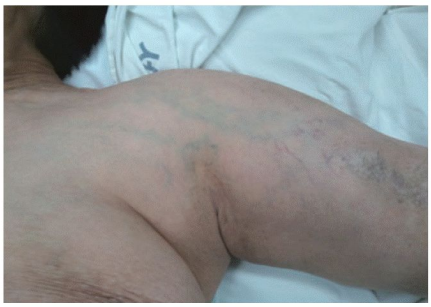
Internal jugular vein perm cath

	n	%
Normal	40	58
Angulation	10	14.5
Stenosis(>50%)	10	14.5
Angulation + stenosis	9	13
Total	69	100

29/69; 42%

- Catheter placement

Surratt RS et al. Am J Roentgenol 1991
Oguzkurt L et al. Eur J Radiol 2005

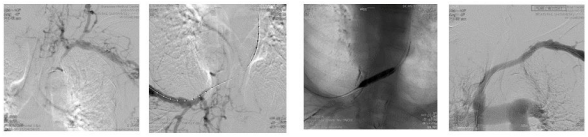


Treatment of central vein stenosis

- Access abandonment
  - Need new access
- Percutaneous transluminal angioplasty (PTA)
- PTA + Stent
- Surgical reconstruction

M/92. Total occlusion of left innominate vein

Angioplasty with stent insertion was done
(balloon dilatation (5mm, 7mm, 10mm), Stent insertion (14mmx8cm Zilver stent)



동정맥루 수술 후 문제점, 합병증

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- AV access Steal syndrome
- Neropathy
- Venous hypertension
- Noninfectious fluid collections

동정맥루 수술 후 문제점, 합병증

- Immaturation
- Stenosis/Thrombosis
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- Neropathy
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- *Noninfectious fluid collections*

Lymphocele

- **Persistant,often enlarging, sterile fluid collection confined within a nonsecretory fibrous pseudomembrane or well circumscribed gray spongy-like soft tissue mass (gelatinoma) or mixed type around a prosthetic graft.**





Perigraft seroma

- **A collection of clear and sterile ultrafiltrated serum, encased by a fibrous pseudocapsule, that develops around a patent prosthetic vascular graft**
- **caused by sweating graft**





Treatment

- Aspiration with or without removal of the pseudocapsule
- Reconstruction through a new route
- Replacement with homograft artery
- Plasmapheresis
- Autogenous vein interposition