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Cannulation of Vascular Access

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Objectives

- **To review AVF cannulation types**
- **To review the evidence comparing buttonhole versus step-ladder cannulation**
- **To review the evidence of infectious complications of buttonhole cannulation**

Access Cannulation

- **A well functioning vascular access for hemodialysis is critical to the success of the treatment**
- **2 options for cannulation**
 - Buttonhole (constant site, same site – not to be confused with same general area),
 - Step-Ladder (rope-ladder, rotating site)

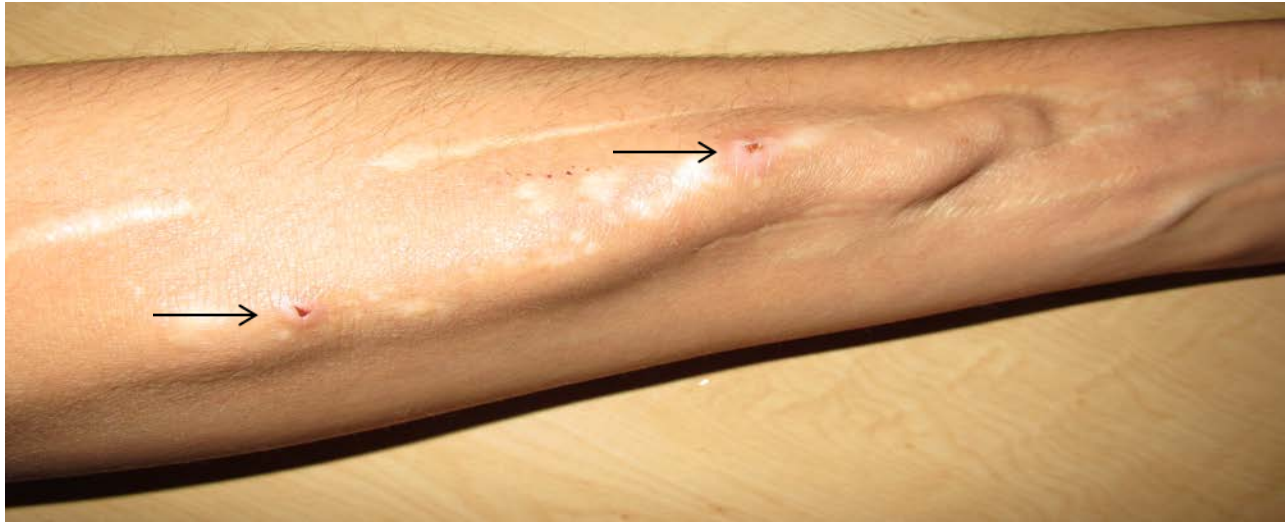
Buttonhole VS Stepladder

Buttonhole

- Cannulate the AVF in the exact same spot at the same angle and depth every time
- Scar tissue tunnel track develops that allows for blunt needle use

Stepladder

- Cannulate the AVF using the entire fistula
- Needles at least 1-1.5" apart
- New sites used each dialysis
- Sharp Needles



**Arrows point to
buttonholes**

What are the Issues?

- **Reported Benefits of Buttonhole Cannulation**
 - Less Pain on Cannulation
 - Less Aneurysm Formation
 - Less Radiologic/Surgical Procedures
- **Reported Risks of Buttonhole Cannulation**
 - Infection

Buttonhole – In Centre (Observational)

Diagnostic Tests and Interventions with the Different Cannulation Techniques During 9 Months

	Rope-Ladder (N=70)	Buttonhole (N=75)	P Value
Patient with Diagnostic Tests	28	15	
Diagnostic tests	73	24	0.004
Duplex	14	11	
Fistulogram	51	10	
MRA	8	3	
Patients with Interventions	21	6	
Interventions	41	10	0.001
Angioplasty	35	2	0.001
Thrombectomy	3	1	0.81
Surgical Revisions	3	3	0.55
Antibiotics because of access related infections	-	4	0.01

Prospective cohort study

Average followup – 9 months

Buttonhole

- More pain, fear
- More missed needle sticks
- More infections
- Less aneurysms
- Less hematomas
- Less interventions

van Loon et al, NDT 2010

Buttonhole – In Centre (RCT)

- Single centre
- N=140 patients
- Buttonhole
 - No better for pain
 - Less hematoma formation
 - Increased local (including abscess formation) and systemic (3 - S.aureus) infections

Buttonhole – In Centre (RCT)

Table 2. Pain scores at baseline and 8 weeks with standard and buttonhole needling

	Standard Needling (n=70)	Buttonhole Needling (n=70)	P Value (Between Group)
Baseline (week 1) median (25th to 75th percentile)	1.5 (0.4–3.2)	1.6 (0.5–3.2)	0.78
Study end (week 8) median (25th to 75th percentile)	1.2 (0.4–2.4)	1.5 (0.5–3.4)	0.57
P value (within group)	0.24	0.86	

The median value is based on the three pain scores per patient each week and expressed as median (25th to 75th percentile).

Table 3. Rates of secondary outcomes (per 1000 dialysis sessions) for standard and buttonhole needling

Outcomes	Standard Needling Rate per 1000 Dialysis Sessions	Buttonhole Needling Rate per 1000 Dialysis Sessions	P Value
Hematoma formation	436	295	0.003
Bleeding postdialysis			
No bleeding	23.6	28.3	
Any bleeding	97.6	97.2	0.40
Signs of localized infection	22.4	50.0	0.003

Signs of localized infection included erythema, pus, or swelling at the fistula site.

- **No difference in pain between buttonhole and standard needling**
- **Increased risk of bacteremia and infection in buttonhole needling patients**

More on Infection

- Quality improvement report from an in-centre hemodialysis program
- Evaluated all patients with an AVF from January 2010 to June 30, 2010
 - Program shifted to buttonhole Aug 2004 to Jan 2005
 - Educational workshops in 2008 after recognition of infection problem
N=177 patients, 193 AVFs – 186,481 AVF days
- Main Outcomes: Infectious events (unexplained bacteremia caused by skin bacteria and/or local AVF infection) and complicated infectious events (resulting in metastatic infection, death, or AVF surgery) were ascertained during 4 periods
 - (1) rope-ladder technique in all
 - (2) switch to buttonhole
 - (3) buttonhole in all before workshops
 - (4) buttonhole in all after workshops

Incidence of Infectious Events per Protocol

Infectious Events	Period 1 (rope-ladder technique)	Period 2 (progressive shift to BH)	Period 3 (BH before workshops)	Period 4 (BH after workshops)
Local Infection alone				
No	5	0	11	8
No of AVFs requiring surgery	0	0	3	0
Bacteremia alone				
No	3	1	12	2
No of AVFs requiring surgery	0	0	0	0
Combined local infection and bacteremia				
No	3	0	8	4
No of AVFs requiring surgery	0	0	2	0
Deaths				
No with endocarditis	0	0	2	1
No with septicemia	0	0	2	0
Total no of infectious events	11	1	31	14
Absolute incidence of infectious events	0.17 (0.086-0.31)	0.11 (0.0014-0.63)	0.43 (0.29-0.61)	0.34 (0.19-0.55)
Complicated infectious events	0	0	11	1
Absolute incidence of complicated infectious events	0	0	0.153 (0.076-0.273)	0.024 (0.001-0.118)

Tremendous increase in infections in period 3 including metastatic infections resulting in death (with buttonholes). Improves after intervention but infectious events remains 2-fold greater than baseline (compare period 4 and period 1)

Buttonhole - In Centre Randomized Controlled Trial

- Prospective randomized single center trial enrolling 140 maintenance hemodialysis patients
- Patients randomized to a 1-year intervention of buttonhole (constant site) or usual-practice (different site) cannulation
- Primary and secondary outcomes
 - Primary study outcome was AVF survival over 1 year, in which AVF failure was defined as an AVF no longer used for hemodialysis (also referred to as assisted patency).
 - Secondary outcomes included primary patency, number of access interventions, bleeding time, infection rate, cannulation time and pain, and aneurysm formation.

Buttonhole - In Centre RCT

- Demographic data were similar for both groups
- The primary outcome measure of AVF survival at 1 year was statistically significantly increased in the buttonhole group (100% vs 86% with usual practice; P 0.005, log-rank test)
- In the buttonhole group, there were fewer interventions (19% vs 39% in usual practice) and less existing aneurysm enlargement (23% vs 67% in usual practice).
- There were no bacteremia events in the buttonhole group and 2 in the usual-practice group (0.09/1,000 AVF days)
- There were no significant differences in bleeding times and lignocaine use between the 2 groups.
- Other Outcomes
 - Decreased aneurysm formation in buttonhole group
 - Decreased interventions in buttonhole gorup

Our Own Centres (Toronto and Ottawa, Canada)

	SD (n=46)	NHD (n=128)
Age (mean yrs)	46 (20-69)	42 (20-68)
Male sex	67%	61%
Caucasian	72%	78%
Etiology of ESRD: GN	50%	46%
Comorbidities: DM	6%	11%
Hypertension	89%	84%
CHF	17%	6%
CAD	6%	3%

Infectious Complications

- 39 buttonhole related bacteremic episodes
- Rate: 0.196/1000 access days
- 85% *S. aureus*
- 5 hospitalizations
- 3 metastatic infections
 - Endocarditis
 - Septic arthritis
 - Mycotic aneurysm with loss of the AVF

What about other important outcomes?

Table 4. Follow-up times and SAB episodes before and after the introduction of the mupirocin cream prophylaxis start date (January 1, 2004)

	By Treatment Period ^a	As-Treated ^b
Preintervention		
follow-up time for entire cohort (years)	93.4	98.1
mean ± SD follow-up time in years per subject (range)	2.7 ± 1.7 (0.2 to 5.7)	2.7 ± 1.7 (0.2 to 5.7)
infection episodes	8	10
infection rate (events/1000 AVF-days)	0.23	0.28
Postintervention		
follow-up time for entire cohort (years)	193.5	188.6
mean ± SD follow-up time in years per subject (range)	4.3 ± 1.9 (0.4 to 5.4)	4.3 ± 1.9 (0.4 to 5.4)
infection episodes	2	0
infection rate (events/1000 AVF-days)	0.03	0
OR (95% CI) ^c	6.4 (1.3, 32.3)	35.3 (2.0, 626.7)
CHD controls		
follow-up time for entire cohort (years)	–	565.9
infection episodes	–	1
infection rate (events/1000 AVF-days)	–	0.005

^aFollow-up time on treatment calculated from January 1, 2004; infections attributed to study period.

^bFollow-up time on treatment calculated from actual intervention start date for subjects initially not adherent to study intervention ($n = 2$); SAB episodes attributed to intervention status—"as-treated" analysis.

^cOR as calculated by univariate logistic regression.

Single center study that showed the risk of *S. aureus* bacteremia could be reduced with the application of mupirocin topical antibiotic post dialysis



More Buttonhole Tidbits

- **In the frequent hemodialysis network (FHN) trial, buttonhole use was associated with longer periods between successive arteriovenous access events (HR 0.44; 95% CI 0.20-0.97; p=0.041) - Suri et al, JASN 2013**

So what do we know?

- Pain is probably not better in buttonhole cannulation compared to stepladder cannulation
- Aneurysm formation and need for interventions may be reduced in buttonhole technique
- Infections are increased in buttonhole cannulation compared to stepladder cannulation
- Use of buttonholes should be limited to those patients with difficult cannulation or short segments unless strict infection control measures including topical antibiotics can be assured