Basic Hemodialysis – Vascular Access

Outcomes by Cannulation Method – Rope Ladder vs Buttonhole

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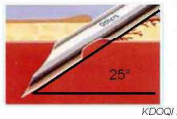
김 도 형

▶Vascular Access in Hemodialysis

- Lifeline and the Achilles' heel of hemodialysis therapy
- Complications associated with the vascular access
  - Common cause of patient hospitalization
- Vascular access management is important
  - choice of access type
  - monitoring of access function
  - aseptic techniques
  - prevention of complication
- Cannulation procedure
  - Successful cannulation : key component in maintaing an AVF

▶Cannulation Procedure

- Apply a tourniquet to the access arm
- Disinfecting the access site
- Advance the needle slowly using a 25° angle with the bevel up
  - not rotate axis
  - Arterial : antegrade or retrograde
  - Venous : antegrade
- Assess for adequate blood flow by alternately aspirating and flushing the needle with a syringe.
- Remove needle at same to angle of insertion



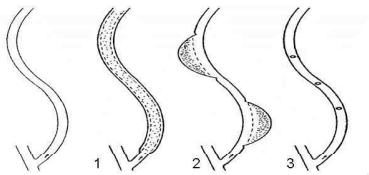
KDOQI 2006

▶Cannulation Procedure

- Recommendations for the cannulation procedure
  - needle size, angle of needle insertion
  - direction of needle bevel
  - rotation of needles after insertion
- Cannulation of fistula
  - Increased pain, stress
  - Increased vessel injury

▶ Method of Cannulation

- Area puncture : puncturing of the same general area
- Rope-ladder : changing the needle placement sites for each dialysis
- Buttonhole : needle insertion in the exact same spot and at the same angle and depth of penetration



1. Rope-ladder puncture
2. Area puncture
3. Buttonhole puncture

J Am Soc Nephrol 14: 1669–1680, 2003

▶Rope-ladder Puncture

- Site rotation with every cannulation
- Cannulators independently determine the angle of entry
- Three-point technique
- For fistula or grafts

▶Buttonhole Puncture

- First used in Europe (1979)
- For patients who had limited access cannulation sites

❖ Repeated sharp needle insertion
- The same site, single cannulator, same angle
- Over the course of six to nine hemodialysis sessions

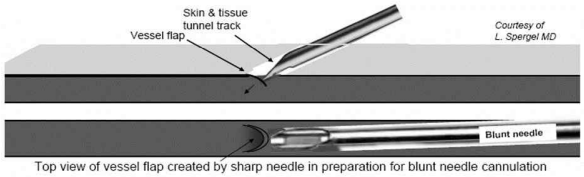
→ scar tissue tract from skin to the vein wall

→ after, cannulated with blunt needles

Sharp (left) and blunt dialysis needles (right)

▶Buttonhole Puncture

- Skin/Tissue tunnel track + Vessel flap
- Vessel flap is created by repeated punctures with sharp needle at the same site.



Top view of vessel flap created by sharp needle in preparation for blunt needle cannulation

▶Buttonhole Puncture

- Reuse same sites each treatment
- Same angle
- Uses blunt needles
- Scab removal required
- Side-to-side technique
- For AVF only
- Home hemodialysis

▶Outcomes

- Rope-ladder vs. buttonhole
- Infection
- Access Survival
  - Aneurysm formation
  - Access interventions
- Pain and Quality of Life

▶Infection

- Rope-ladder vs. buttonhole

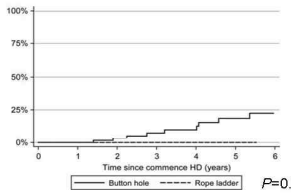
Study	N and population	Study duration	Infection
Toma et al. 2003	37 BH Patients and 43 RL patients	3 months	Local infection; **1 BH** vs. 0 RL
Struthers et al. 2010	56, in-center HD	6-Month follow-up	Local infection; **1 BH** vs. 0 RL
Chow et al. 2011	70, mixed home HD and in-center HD	6-Month follow-up	Local infection; **4 BH** vs. 1 RL ($P = 0.11$)
MacRae et al. 2012	140, in-center HD	8 Weeks for primary outcome; 1-year follow-up for other	**50.0 per 1000 (BH)** vs. 22.4 per 1000 (RL) ($P = 0.003$)
Vaux et al. 2013	140, in-center HD		Bacteremia 0 BH vs. **0.09 /1000 AVF days RL** Exit site/local **0.12/1000 AVF BH** vs. 0 RL

AVF, arteriovenous fistula; BH, buttonhole cannulation; HD, hemodialysis; RL, rope ladder cannulation; SAB, Staphyloccocus aureus bacteremia;

▶Infection

- Rope-ladder vs. buttonhole

Arterio-venous fistula buttonhole cannulation technique: a retrospective analysis of infectious complications



63 RL patients vs.
74 BH patients

MSSA, Staphylococcus epidermidis infection

P=0.023

Clin Kidney J (2012) 5: 526–529

▶Infection

Arteriovenous Fistula Survival and Needling Technique: Long-term Results From a Randomized Buttonhole Trial

- Rope-ladder (standard) N=69 vs. Buttonhole N=70
- F/U : 18 months

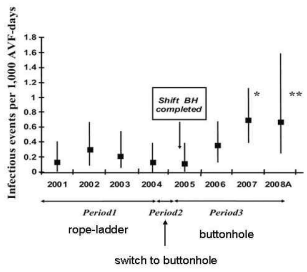
	Standard (n = 69)	Buttonhole (n = 70)	IRR (95% CI)	P value
Total infections	0	12	63.29 (22.2-180.0)	<0.001
Localized /exit site		3		
S. aureus bacteremia		9		

IRR, incidence rate ratio;

Am J Kidney Dis. 2014 63(4):636-642.

▶Infection

Infectious Complications Following Conversion to Buttonhole Cannulation of Native Arteriovenous Fistulas: A Quality Improvement Report



Am J Kidney Dis. 2011;57(3):442-448.

▶Infection

Infectious Complications Following Conversion to Buttonhole Cannulation of Native Arteriovenous Fistulas: A Quality Improvement Report

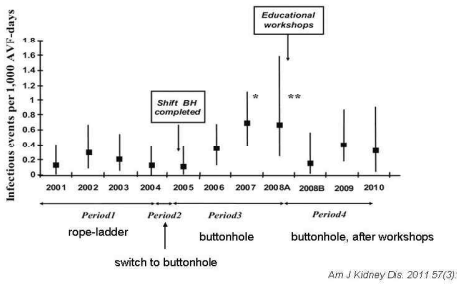
Educational Workshops

- ➢ Video showing the procedure
- ➢ Attention to skin disinfection (including contact time with disinfectant) and scab removal
- ➢ Standardized protocol
  - → 2 unsuccessful attempts → reference nurse using a sharp needle
- ➢ Hypertrophic and/or irregular or nodular (without local erythema, pain, or tenderness)
  - → new cannulation site

Am J Kidney Dis. 2011;57(3):442-448.

▶Infection

Infectious Complications Following Conversion to Buttonhole Cannulation of Native Arteriovenous Fistulas: A Quality Improvement Report



Am J Kidney Dis. 2011;57(3):442-448.

▶Infection

- Lack of the skin defense
- In buttonhole cannulation
  - Scab contained with bacteria → enter the blood → infection
- Rigorous disinfection + scab removal : important !!!
- Scab removal
  - Not using sharp instrument
    Avoid tissue injury during removal
- Cannulation
  - Not using sharp needle
    → damage the created track, formation of false tracks
    → larger scab formation, more tract injury

Am J Kidney Dis. 2011; 57(3):442-448.
Am J Kidney Dis. 2014; 63(4):636-642.

▶Aneurysm Formation

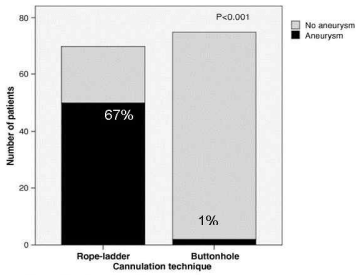
- Rope-ladder vs. buttonhole

Study	Rope-ladder	Buttonhole	P value
Hashmi et al. 2010	21%	8%	0.375
Magda et al. 2010	69%	1%	<0.001
Vaux et al. 2013	17%	4%	NS

Clin Nephrol 74:346–350, 2010
Nephrol. Dial. Transplant. 2010;25:225-230
Am J Kidney Dis. 2013;62(1):81-88

▶Aneurysm Formation

- Rope-ladder vs. buttonhole

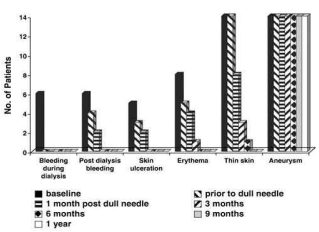


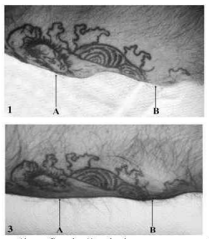
The number of patients who experienced an aneurysm

Nephrol. Dial. Transplant. 2010;25:225-230

▶Aneurysm Formation

- Buttonhole : solution for fistulae with aneurysmal dilatation
- 14 chronic hemodialysis (HD) patients, prospective study





26 months after buttonhole access creation

Hemodial Int. 2006 Apr;10(2):193-200.

▶Access Intervention

Diagnositic tests and interventions with the different cannulation techniques during 9 months

	Rope-ladder (n=70)	Buttonhole (n=75)	P value
Patients 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

Nephrol Dial Transplant (2010) 25: 225–230

▶Access Intervention

Diagnositic tests and interventions with the different cannulation techniques (Median follow-up : 18 months)

	Rope-ladder (n=69)	Buttonhole (n=70)	IRR (95% CI)	P value
Thrombosis rate	0.05 [0.03-0.11]	0.04 [0.02-0.09]	0.75 (0.25-2.24)	0.6
Fistulogram rate	0.75 [0.5-1.1]	0.99 [0.8-1.3]	1.36 (0.88-2.09)	0.2
PTA rate	0.72 [0.48-1.08]	0.90 [0.66-1.21]	1.28 (0.78-2.10)	0.3
Surgical intervention rate	0.11 [0.06-0.21]	0.09 [0.05-0.16]	0.79 (0.33-1.89)	0.6

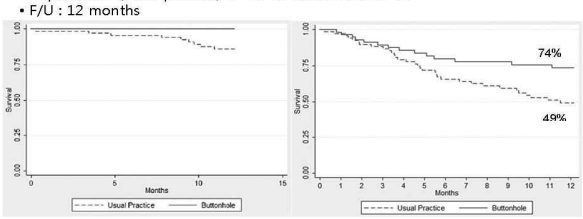
Rates are expressed as total number of events from study start until the end of the study or patient death (per patient-year at risk).
CI, confidence interval; IRR, incidence rate ratio; PTA, percutaneous transluminal angioplasty

Am J Kidney Dis. 2014; 63(4):636-642.

▶Access Survival

Effect of Buttonhole Cannulation With a Polycarbonate Peg on In-Center Hemodialysis Fistula Outcomes: A Randomized Controlled Trial

- Rope-ladder (usual practice) N=70 vs. Buttonhole N=70
- F/U : 12 months



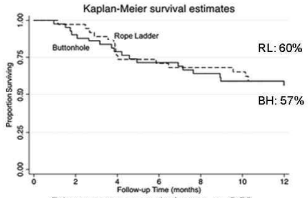
Arteriovenous fistula survival | One-year primary patency, (p=0.01)

Am J Kidney Dis. 2013;62(1):81-88

▶Access Survival

The Effect of Buttonhole Cannulation vs. Rope-ladder Technique on Hemodialysis Access Patency

- Rope-ladder (standard) N=38 vs. Buttonhole N=45
- F/U : 12 months



Primary patency survival curve, p=0.52

Semin Dial. 2014 Mar;27(2):210-6.

▶Access Survival

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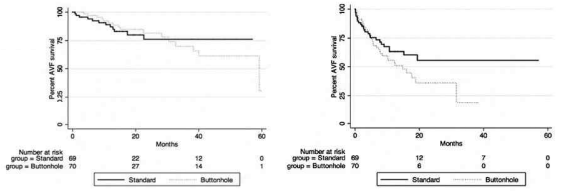

Survival curve for assisted patency, p=0.8

Survival curve for unassisted patency, p=0.1

Am J Kidney Dis. 2014;63(4):636-642.

▶Pain and Quality of Life

- Rope-ladder vs. buttonhole

Study	Design	Pain score	P value
van Loon et al. 2010	Prospective, n = 145	Mean pain score of 1.6 in BH vs. 1 in RL	<0.001
Pergolotti et al. 2011	Prospective, n = 45	Average pain measurement 47.8% less in BH	0.0049
MacRae et al. 2012	Randomized, n = 140	1.2 in RL vs. 1.5 in BH	0.57
Kim et al. 2013	Prospective, n = 32	Arterial 6.1 (RL) vs. 3.3 (BH); Venous 6.3 (RL) vs. 5.1 (BH)	0.001 0.001

BH, buttonhole cannulation; RL, rope ladder cannulation

Hemodial Int 14:451–463, 2010
Nephrol Nurs J 38:333–336, 2011
Clin J Am Soc Nephrol 7:1632–1638, 2012.
Hemodial Int 17:294–299, 2013

▶Pain and Quality of Life

The Effect of Buttonhole Cannulation vs. Rope-ladder Technique on Hemodialysis Access Patency

- 83 patients with BH or RL technique
- measured patient quality of life scores using the validated KDQOL-36

Variable	Rope-ladder (n=38)	Buttonhole (n=45)	P value
Physical component summary mean (SD)	37.83 (12.95)	35.96 (10.38)	0.59
Mental component summary	51.30 (8.63)	50.09 (10.81)	0.65
Burden of kidney disease	50.89 (24.84)	49.83 (28.43)	0.88
Symptoms/problem list	78.50 (13.44)	78.50 (13.44)	0.99
Effects of kidney disease	77.60 (23.23)	78.50 (13.44)	0.14

SD, standard deviation

Semin Dial. 2014 Mar;27(2):210-6.

▶In Korea

혈액투석 환자에게서 Biohole ™ 쐐기를 이용한 Buttonhole 천자법의 임상적 유용성

- 순천향대학교 부천병원
- 27 patients with BH, 13 patients with RL
- F/U : 12 weeks

Comparison of outcomes before and after the Biohole™ procedure

	Baseline	2 weeks	P value
Pain	5.6 ± 2.7	3.4 ± 3.1	**0.003**
Hs-CRP (mg/dL)	0.13 ± 0.13	0.23 ± 0.37	0.225
Access flow (mL/min)	1,536 ± 796	1,390 ± 827	0.159
Bleeding	1.8 ± 0.5	1.3 ± 0.5	**0.001**

Values are presented as mean ± SD.
Hs-CRP, high-sensitivity C-reactive protein.
Bleeding, bleeding at puncture sites after needle withdrawal.

Korean J Med 2012;82:307-312.

▶In Korea

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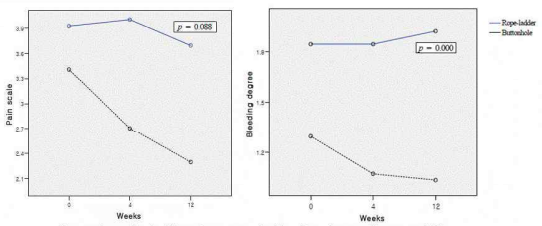

Comparison of pain (A) and puncture site bleeding after needle removal (B)

Korean J Med 2012;82:307-312.

▶In Korea

Clinical effects of buttonhole cannulation method on hemodialysis patients

- 가톨릭대학교 서울 성모병원
- 32 patients
- F/U : 8 weeks with RL → 16 weeks BH

Comparison of the rate of patients who stopped bleeding every 15 min after removing needles

Hemostasis time (min)	Rope-ladder (8wks)		Buttonhole (16wks)		P value
	1st, n (%)	2nd, n (%)	1st, n (%)	2nd, n (%)	
<15	7 (21.9)	7 (21.9)	15 (46.9)	19 (59.4)	**0.001**
16~30	16 (50.0)	17 (53.1)	17 (53.1)	13 (40.6)	**0.028**
>30	9 (28.1)	8 (25.0)	0 (00.0)	0 (00.0)	0.183

Hemodialysis International 2013; 17:294–299

▶In Korea

Clinical effects of buttonhole cannulation method on hemodialysis patients

Comparison of pain scores

Variables	Rope-ladder (8wks)	Buttonhole (16wks)	P value
	Mean ± SD	Mean ± SD	
Arterial site (score)	6.1 ± 1.2	3.3 ± 1.8	0.001
Venous site (score)	6.3 ± 1.3	5.1 ± 1.8	0.001

Comparison of the stress, the convenience, and the satisfaction level of nurses

Variables	Rope-ladder (8wks)	Buttonhole (16wks)	P value
	Mean ± SD	Mean ± SD	
Stress (score)	5.5 ± 2.0	3.7 ± 1.6	**0.001**
Convenience(score)	6.4 ± 1.3	6.7 ± 2.0	0.526
Satisfaction (score)	6.6 ± 1.2	6.8 ± 2.2	0.669

Hemodialysis International 2013; 17:294–299

▶Summery

	Rope-ladder	Buttonhole
	Standard	Limited access cannulation sites
Infection	Low	High
Aneurysm	High	Low
Intervention	No difference	
Access survival	No difference	
Pain	High	Low
Quality of life	No difference	

▶Conclusion

✓ The balance of risks and benefits with buttonhole cannulation remain uncertain.

✓ Buttonhole cannulation may be associated with greater risk of infection.

→ topical mupirocin

→ antiseptic procedure (facial mask, skin disinfection etc.)

→ careful removal of scab

✓ Optimal access cannulation type : individualized