

ULTRASOUND GUIDED VENOUS ACCESS: REVIEW OF THE LITERATURE

The AHRQ (Agency on Healthcare Research and Quality) in its 2001 report identified sono guided central venous access as #8 in a list of eleven “most highly rated in terms of strength of evidence supporting more widespread implementation”ⁱⁱⁱ.

Topic	Paper	Design	N	US vs LM	Other findings
Internal jugular (IJ)	Koski EMJ Crit Care Med 20/3, p424 – 6, 1992 ⁱⁱⁱ .	Prospective randomized convenience A single anesthesiologist	56	Avg sticks: 1.2 vs 3.3 Cann'n time 35 vs 198s	10% of previously accessed IJs are occluded
IJ	Troianos CA. Anaesth Analg: 72: 823-6, 1991 ^{iv} .	Prospective randomized 5-7.5 MHz Anaesthesiologists in O.R.	150	Success 100 v. 96% 1 st pass succ: 72 vs 54% Avg Advances: 1.4 vs 2.8 Time: 61 v 117s Carotid punct: 1.3% vs 7.8%	2/3 failed attempts by LM successful w sono
IJ	Docktor B: Can Assoc Rad J: 47 195-201, 1996	Prospective case series. Experienced radiologists Probe as close as possible to clavicle 5-7.5 MHz	150	Success 100% Avg sticks: 1.1 89% 1 st pass success 1.3% carotid puncture	20% of cannulations involve posterior wall puncture. Avoid puncture site where IJ is anterior to artery (seen in 25% of cases). L sided Ijs more difficult (? Practice issue)
IJ	Denys BG: Circ 87: 1557 – 62, 1993) ^v	Prosp random 7.5 MHz Needle guide. 29 cardiologists w/ experience of 1-288 procedures.	604, then prospective case series in 626	Success: 100 v 88% 1 st pass 78 v 38% Time 10 v 45s Carotid stick 1.7 vs 8.3% Hematoma 0.2 v 3.3% No PTX in 1230 cases	All levels of experience. More experienced operators slightly better stats. “Modified technique of ‘sideways’ puncture to avoid CCA”.
IJ and SC Meta-analysis	Randolph AG: Crit Care Med 24: 2053-8, 1996 ^{vi} .	Meta-analysis of 8 randomized controlled trials (RCT)	Cumulative N=533	Relative risk of failure w sono: 32% RR complication 22%. RR multiple passes 60%	
IJ, SC and Fem Meta-analysis	Calvert N, et al UK NHS Health Technology Assessment 2003 ^{vii} . Same Data published by Hind et al BMJ 2003 ^{viii} .	Meta-analysis of 14 RCTs investigating US-guided vs LM technique. (Meta-analysis also of Doppler technique... these excluded on current table).	Cumulative N=1021	RR of failure vs. LM: SC=IJ=0.14. FV=0.29 Time -70sec (only IJ vs. LM) # attempts IJ -1.5. FV -2.7 Complication rate IJ= 0.43; SC=0.1; FV=n/a Similar results in infants	“Very strong evidence that US-guided CVA is more effective [than LM technique]”
IJ, SC and Fem Meta-analysis	Rothschild JM, Chapter 21 of AHRQ 2001 report ⁱⁱ .	Meta-analysis of 5 studies using of IJ (3), SC(1) and FV (1) approaches (Meta-analysis also of Doppler technique... these excluded on current table).		RR Failure 71-100% Red'n mean insertion attempts: 44-54% RR complications 83 – 100%	

Topic	Paper	Design	N	US vs LM	Other findings
IJ: effect of inexperienced operators + and - sono	Geddes CC: Clin Nephrol: 50/5 329-5, 1998.	Prospective. Residents, fellows. "Experienced": > 25 IJ catheters, "inexperience" < 25 IJ catheters	107 procedures, 7 operators	No difference in success rate	
SC(85%); IJ(13%), Innominate (2%)	Fry WR. Arch Surg 134: 738-41, 1999.	Prospective case series. Complicated pts (coagulopathy, hypovolemia, unable to lay flat, stenosis, etc) 5 – 7 MHz, no guide Surgeons	52	Success 100% Complication: 1 PTX only	
Fem (75%), IJ (13%), SC (13%)	Miller AH: Acad EM 9: 800-5, 2002 ^{ix} .	Prosp random EM residents w attends Many inexperienced.	71	Sticks: 1.6 vs 3.5 (p<0.0001) Time 115 vs 512 s (p<0.0001)	
Fem vein in CPR	Hilty WM Annals EM 29:331-7, 1997.	Prosp random, subj controlled Emergency Physicians	20 7.5 MHz	Success: 90% vs 65% Advances: 2.3 vs 5 Time: 121 v. 124 s (NS)	LM Femoral v cath in other CPR studies similar (Jastremski 1984, Sessler 1987) Fem "pulse" w CPR is the vein (not femoral artery)
Peripheral PICC placement	Sofocleous CT. AJR 170 1613-6, 1998 ^x	Retrospective case series 5-7.5 MHz 70% of pts IVDA Radiologists	355	All sono Brachial 74%; Basilic 18%; Cephalic 8% 99% success Avg sticks 1.2	Keep angle between transducer and needle 85°-95°
Peripheral	LaRue GD. J Intraven Nursing 23/1 29 – 34, 2000 ^{xi} .	431 retrospect LM, 326 prospect sono. All by one nurse anesthetist	757 9 MHz	Avg sticks 1.2 vs 1.7 Avg advances 1.4 vs 2.4 Success 99% in both	Compression of ant wall causes penetration of post wall in many cases. Success w/ larger catheters w sono
Peripheral IV in difficult-access patients	Costantino TG et al: Ann Emerg Med, 2005 ^{xii}	PRCT 2- person technique. 20 operators. None > 6 lines. 4 'experienced' [>10 proced] and 16 'not experienced' operators	60	Success 97 vs. 33% Time: 13 vs. 30 min 1.7 vs 3.7 punctures.	Also greater pt satisfaction : 8.7 vs. 5.7 / 10
IJ	Leung J et al: Ann Emerg Med, 2006 ^{xiii}	PRCT in the ED Sonosite TRV real-time vs. landmark	130 Linear array 10-5 MHz	Success 94 vs 79% 1 st attempt success: 82 vs 71% Complications 5 vs. 17% No difference in time.	

Notes

For LM technique, typical overall success rates 90-95%; carotid stick rates 4-8%; 1st – 2nd pass rates 50 - 60%. (Daily 1970, Schwartz 1979, Golfarb 1982).

Cost: Modest savings \$3249 per 1000 procedures anticipated by analysis in Hind article, although this analysis assumes cost of purchase of dedicated equipment for US guided.

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- ⁱⁱ *Making Health Care Safer: A Critical Analysis of Patient Safety Practices*. Evidence Report/Technology Assessment: Number 43. AHRQ Publication No. 01-E058, July 2001. Agency for Healthcare Research and Quality, Rockville, MD. <http://www.ahrq.gov/clinic/ptsafety/>
- ⁱⁱⁱ Koski EM. Suhonen M. Mattila MA. Ultrasound-facilitated central venous cannulation. *Critical Care Medicine*. 20(3):424-6, 1992 Mar.
- ^{iv} Troianos CA. Jobes DR. Ellison N. Ultrasound-guided cannulation of the internal jugular vein. A prospective, randomized study. *Anesthesia & Analgesia*. 72(6):823-6, 1991 Jun.
- ^v Denys BG. Uretsky BF. Reddy PS. Ultrasound-assisted cannulation of the internal jugular vein. A prospective comparison to the external landmark-guided technique. *Circulation*. 87(5):1557-62, 1993.
- ^{vi} Randolph AG. Cook DJ. Gonzales CA. Pribble CG. Ultrasound guidance for placement of central venous catheters: a meta-analysis of the literature. *Critical Care Medicine*. 24(12):2053-8, 1996.
- ^{vii} The National Health Service Health Technology Assessment 2003; vol 7(12), The effectiveness and cost-effectiveness of ultrasound locating devices for central venous access: a systematic review and economic evaluation. Queen's Printer and Controller of HMSO 2003. www.cinahl.com/cexpress/hta/summ/summ712.pdf
- ^{viii} Hind D. Calvert N. McWilliams R. Davidson A. Paisley S. Beverley C. Thomas S. Ultrasonic locating devices for central venous cannulation: meta-analysis. *BMJ*. 327(7411):361, 2003 Aug 16.
- ^{ix} Miller AH. Roth BA. Mills TJ. Woody JR. Longmoor CE. Foster B. Ultrasound guidance versus the landmark technique for the placement of central venous catheters in the emergency department. *Academic Emergency Medicine*. 9(8):800-5, 2002.
- ^x Sofocleous CT. Schur I. Cooper SG. Quintas JC. Brody L. Shelin R. Sonographically guided placement of peripherally inserted central venous catheters: review of 355 procedures. *AJR. American Journal of Roentgenology*. 170(6):1613-6, 1998.
- ^{xi} LaRue GD. Efficacy of ultrasonography in peripheral venous cannulation. *Journal of Intravenous Nursing*. 23(1):29-34, 2000.
- ^{xii} Costantino TG. Bruno EC. Handly N. Dean AJ. Accuracy of emergency medicine ultrasound in the evaluation of abdominal aortic aneurysm. *Journal of Emergency Medicine*; 2005; 29(4):455-60.
- ^{xiii} Leung J. Duffy M. Finckh A. Real-time ultrasonographically-guided internal jugular vein catheterization in the emergency department increases success rates and reduces complications: a randomized, prospective study. *Annals of Emergency Medicine*, 2006; 48(5):540-7.