Systematic Review Snapshot

TAKE-HOME MESSAGE

Compared with the landmark technique, dynamic 2-dimensional (2D) (real-time) ultrasonographic guidance increases the success rate and reduces adverse events in subclavian vein catheterization.

CLINICAL QUESTION

Does ultrasonographic guidance reduce failure rates and adverse events for subclavian vein catheterization compared with the landmark technique?

DATA SOURCES

MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, and CINAHL were searched from inception through September 2014. Bibliographies of relevant articles were also hand searched and corresponding authors were contacted.

STUDY SELECTION

The study included all peer-reviewed randomized controlled trials comparing ultrasonographic guidance and landmark technique for subclavian vein catheterization in adult populations. The systematic review excluded more invasive procedures (eg, tunneled catheter placement) or other special device placement (eg, pacemaker placement). The outcomes of interest were failure of catheterization and frequency of adverse events (defined a priori to include pneumothorax, arterial bleeding or puncture, infection, thrombus, arrhythmia, malposition,

Does Ultrasonographic Guidance Reduce Failure Rates and Adverse Events for Subclavian Vein Catheterization Compared With the Landmark Technique?

EBEM Commentators
Jeremy L. Kim, MD
Department of Emergency Medicine
Icahn School of Medicine at Mount Sinai
New York, NY
Alex Koyfman, MD
Department of Emergency Medicine
UT Southwestern Medical Center/Parkland Memorial Hospital
Dallas, TX

Results

Table 1. Rate of failed catheterization.

	Ultrasonographically Guided (%)	Landmark Technique (%)	RR (95% CI)
Overall	118/1,031 (11.4)	147/1,048 (14.0)	0.67 (0.36–1.27)
Dynamic 2D only	9/310 (2.9)	58/324 (17.9)	0.24 (0.06–0.92)

RR, Risk ratio; *CI*, confidence interval.

Table 2. Rate of total adverse events.

	Ultrasonographically Guided (%)	Landmark Technique (%)	OR (95% CI)
Overall	101/1,031 (9.8)	176/1,048 (16.8)	0.53 (0.41–0.69)
Dynamic 2D only	33/310 (10.6)	97/324 (29.9)	0.30 (0.20–0.44)

OR, Odds ratio.

Ten of the 601 studies identified in the search met the inclusion criteria (interrater agreement κ=0.91). Dynamic (real-time) 2D ultrasonography was used in 6 studies (n=719), static 2D in 1 study (n=821), and Doppler in 3 studies (n=628). The studies were conducted in various countries (ie, the United States, European nations, India, and South Korea), in various clinical settings (eg, ICUs, emergency departments), and by clinicians with various levels of experience. The majority of studies had a low risk of bias for

hemothorax, cardiac tamponade, nerve injuries, and overall total complications).

DATA EXTRACTION AND SYNTHESIS

Failure of catheterization was dichotomously analyzed with inverse-variance random-effects modeling to calculate risk ratios. Adverse events were pooled with Peto's method to calculate odds ratios. Heterogeneity of the meta-analysis was evaluated with I^2 and χ^2 tests. Additional subgroup analysis was performed according to specific ultrasonographic technique.

random sequence generation and reporting of outcome data; however, most studies were unclear in regard to allocation concealment and blinding of outcome assessment. In addition, the funnel plot analysis did not show evidence of small-study effects.

The adverse events were further analyzed by individual event type. There were fewer cases of pneumothorax, arterial puncture, hematoma formation, and hemothorax among the ultrasonographically guided groups. There was no difference in catheter malposition. Data were insufficient for cardiac tamponade or nerve injuries and nonexistent for infection, thrombus, or arrhythmias.

Commentary

Central venous catheterization is often necessary during the care of critically ill patients because it allows administration of fluids, blood products, or vasoactive agents; hemodynamic monitoring; and other functions such as hemodialysis or transvenous pacing.[1] The procedure, however, is invasive and can lead to complications such as pneumothorax, bleeding, infection, and thrombosis.[1] To minimize these risks, ultrasonographic guidance is recommended by numerous specialty groups and presented as Class I evidence by the American College of Emergency Physicians.[2,3] The most commonly used technique is dynamic 2D ultrasonography, which incorporates real-time visualization of the vein during venipuncture. Alternative techniques include Doppler ultrasonography, which uses continuous Doppler signals during venipuncture, and static 2D ultrasonography, which can evaluate a vein's depth, caliber, and patency but does not incorporate continuous visualization during venipuncture.

Although most studies clearly demonstrate benefit for dynamic 2D ultrasonography for internal jugular catheterization, limited studies have also shown benefits in subclavian and femoral catheterizations.[4] One meta-analysis assessing internal jugular venous catheterization showed a 21.8% failure rate in the landmark technique compared with 1.7% with 2D ultrasonography.[4] One small study of 20 patients showed a 35% failure rate for the landmark technique in femoral venous catheterization compared with 10% with 2D ultrasonography.[4] Although access site is often influenced by clinician preference and patient factors, subclavian catheterization is particularly favored for reported reduction in infectious and thrombotic complications compared with the other sites.[2,5]

The meta-analysis had limitations: only a small number of studies met eligibility criteria and none reported on infections, thrombi, or arrhythmias, which may be due to a screening failure or underreporting. Also, adverse events were variably defined, so the clinical significance of reported adverse events remains uncertain. The dynamic 2D ultrasonography groups used both longitudinal (in-plane) and transverse (out-of-plane) techniques by the infraclavicular approach for ultrasonography probe placement. More recent studies suggest that compared with the infraclavicular approach, the supraclavicular approach provides superior views of the subclavian vein[6] but is comparable in clinical outcomes such as success rate and rate of complications.[7]

In summary, clinicians should strongly consider ultrasonographic guidance for subclavian catheterization.

Editor's Note: This is a clinical synopsis, a regular feature of the *Annals*' Systematic Review Snapshot (SRS) series. The source for this systematic review is: **Lalu MM, Fayad A, Ahmed O, et al. Ultrasound-guided subclavian vein catheterization: a systematic review and metaanalysis. *Crit Care Med.* 2015;43:1498-1507.**

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