

# How Safe Is the Ultrasonographically-Guided Peripheral Internal Jugular Line?

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**Editor's Note:** *Emergency physicians must often make decisions about patient management without clear-cut data of sufficient quality to support clinical guidelines or evidence-based reviews. Topics in the Best Available Evidence section must be relevant to emergency physicians, are formally peer reviewed, and must have a sufficient literature base to draw a reasonable conclusion but not such a large literature base that a traditional "evidence-based" review, meta-analysis, or systematic review can be performed.*

## INTRODUCTION

Vascular access is an essential procedure in the emergency department (ED). In patients with difficult intravenous access, alternatives to the traditional blind cannulation should be considered, including cannulation of an external jugular vein, a peripheral vein in the upper or lower extremity with real-time ultrasonographic guidance, or a central vein with ultrasonographic guidance.<sup>1,2</sup> Intraosseous lines and venous cutdowns may also be considered for unstable patients.<sup>3</sup> However, even with ultrasonographic guidance, peripheral venous cannulation may be unsuccessful and central venous cannulation is both time consuming and associated with potential complications, including infection, thrombosis, pneumothorax, and arterial injury.<sup>4-6</sup>

The peripheral internal jugular line is another option for vascular access that was originally described in 2009.<sup>7</sup> This procedure involves placement of a single-lumen peripheral catheter into the internal jugular vein, using real-time ultrasonographic guidance. The peripheral internal jugular may be safe, quickly placed, and obviate the need for central line placement in patients with difficult intravenous access. However, it is important to ensure that this technique is safe and reliable before routine clinical application. The objective of this article is to provide a summary of the current evidence about the efficacy and safety of placing ultrasonographically-guided peripheral internal jugular venous lines.

## SEARCH STRATEGY

A PubMed search from 1946 to June 19, 2017, was performed with the key words "peripheral" and "internal jugular," with no limitations. The search yielded 414 results. Bibliographic references found in all relevant articles were examined to identify additional pertinent literature. Citations were independently reviewed by both authors. Only original, published, primary research articles assessing the safety of ultrasonographically-guided peripheral internal jugular line placement in human beings were included. Isolated case reports without outcomes were excluded. We identified 5 original research articles that directly addressed our study question.

## ARTICLE SUMMARIES

### Zwank<sup>8</sup>

This study assessed the feasibility and safety of the peripheral internal jugular line in 9 patients with difficult intravenous access. The study was conducted at one academic center. Patients were identified by nurses and included in the study if they had difficult intravenous access and needed vascular access for a maximum of 72 hours. Exclusion criteria included patients who needed immediate (emergency) intravenous access or had a contraindication to using the right internal jugular vein for intravenous access. The ultrasonographically-guided procedures were performed by 1 of 4 investigators. Sonographers used a 10-MHz linear transducer to locate the right internal jugular vein in longitudinal or transverse orientation. Patients were placed in the Trendelenburg position, skin was prepped with chlorhexidine solution, a bio-occlusive dressing was placed over the ultrasonographic transducer, and sterile ultrasonographic gel was used. Local anesthesia was injected at the site of insertion before the procedure. An 18-gauge, 6.35-cm catheter (either Spring-Wire Guide Introducer Catheter Assembly [Arrow International, Redding, PA] or B Braun Angiocath [B Braun Medical, Bethlehem, PA]) was inserted until a flash of blood was achieved. At this point, the catheter was advanced over the

needle. Proper placement was confirmed by drawing blood and easily flushing saline solution.

Nine patients were enrolled by the authors, with a mean body mass index (BMI) of 34.4 kg/m<sup>2</sup>. All 9 patients (100%) had successful catheter insertion on the first attempt. It took an average of 5.5 minutes to insert the peripheral internal jugular line. Two catheters (22%) failed within the first 72 hours because of catheter kinking. Both catheter failures occurred with the Arrow Spring-Wire Guide catheters. Patients were followed for 1 year through chart review to assess for catheter-associated complications, defined as deep venous thrombosis, bacteremia, endocarditis, or pneumothorax. No patients had an adverse event at 1 year.

This study had several limitations, including the use of a small convenience sample of patients, unclear training and experience of the operators, and limited discussion of the failed lines with respect to associated line infiltration. Additionally, the follow-up was performed by chart review, with no discussion of how the review was performed. It is possible that some complications were missed with this methodology.

The author suggested that placing a catheter into the internal jugular vein is not significantly different from placing a catheter into any other vein, but that future studies should examine the safety of this procedure before routine application.

#### Teismann et al<sup>9</sup>

This study was a prospective case series assessing the feasibility of the peripheral internal jugular catheter in 9 patients with difficult intravenous access. The study was conducted at one academic center over a 1 year period. Patients were included in the study if they needed vascular access and had failed attempts at intravenous access by both nursing staff and a physician. Exclusion criteria included stable patients who were likely to require central line access for central venous pressure monitoring or medication administration. Ultrasonographically-guided peripheral internal jugular lines were placed by 1 of 6 investigators. Two were senior emergency medicine residents, 2 were ultrasonographic fellows, and 2 were attending physicians with expertise in ultrasonographically-guided procedures. Patients were placed in the Trendelenburg position with their heads turned away from the probe. Sonographers used a 10- to 13-MHz linear transducer to locate the internal jugular vein. Sonographers preferred an out-of-plane technique for catheter insertion and an in-plane technique for confirmation. Skin was prepped with chlorhexidine solution, a sterile cover was placed over the ultrasonographic transducer, sterile gel was applied to the

patient's skin, and sonographers used sterile gloves. In awake patients, subcutaneous lidocaine was injected before the procedure at the intended site of catheter insertion. In most patients, an 18-gauge, 6.35-cm Introcan Safety catheter (B Braun Medical, Melsungen, Germany) was inserted. In 2 of the patients who were unstable, a 14-gauge, 5.1-cm catheter was used instead of the 18-gauge catheter. Proper placement was confirmed by aspiration of venous blood and visualization of the catheter in the vein on ultrasonography.

Nine patients were enrolled, with all 9 (100%) having a successful catheter insertion. The peripheral internal jugular line was completed in 2.5 to 7 minutes. No initial complications were identified. Patients were then followed up at 1 week, either in person or by telephone, to assess for adverse events related to catheter insertion. Seven of 9 patients (78%) completed the follow-up and none of them had any complications at 1 week, defined as fever, chills, neck pain, neck stiffness, soft tissue swelling, or pain at the site of catheter entry.

This study was limited by the small convenience sample. Additionally, 8 of 9 peripheral internal jugular lines were removed in the ED, limiting the applicability to lines placed for more prolonged periods. The evaluation of complications was also limited because there was no definition for the initial complications and 1-week follow-up was available for only 7 patients and restricted to symptoms. It is possible that other complications (eg, occult pneumothorax or endocarditis) was missed.

The authors suggested that the peripheral internal jugular line is rapidly performed, well tolerated, and safe. They suggested that this procedure may benefit unstable patients who need immediate access, as well as stable ones with difficult intravenous access. However, they also emphasized that this line is a temporary solution and is not recommended as definitive access.

#### Butterfield et al<sup>10</sup>

This was a prospective, observational study of ICU or general medical floor patients with difficult or failed peripheral intravenous access who had a peripheral internal jugular line placed. Difficult access was defined as 2 or more failed attempts at peripheral intravenous line placement by experienced nursing staff. Patients were placed in the Trendelenburg position. Sonographers used a 10- to 13-MHz linear transducer to locate the internal jugular vein. Chlorhexidine solution was used to clean the neck. A sterile probe cover and sterile ultrasonographic gel were used for the ultrasonographic transducer. All patients underwent ultrasonographically-guided placement of an 18-gauge, 6.35-cm angiocatheter (Surflo catheters; Terumo, Somerset,

NJ) into either internal jugular vein. Placement was confirmed by direct visualization of the catheter in the vein on ultrasonography. The catheter was secured with a bio-occlusive dressing. Patients were monitored daily for any complications, defined as fever, neck pain, neck stiffness, or hematoma. The catheter was removed when the patient was discharged, a larger multiport catheter was needed, or at 7 days.

Twenty peripheral internal jugular lines were inserted in 19 patients. The mean age was 57 years and mean BMI was 26 kg/m<sup>2</sup>. Sixty percent of patients were men. The right internal jugular vein was cannulated in 85% of cases. The mean duration of cannulation was 3.6 days. The mean time to placement was 5.3 minutes (range 2 to 10 minutes). One patient with nephrotic syndrome developed a deep venous thrombosis of the right internal jugular on day 6 of catheter placement. However, this patient also had extensive deep venous thromboses in bilateral upper extremity veins, and the deep venous thrombosis was deemed more likely caused by her underlying illness. None of the remaining patients developed any complications.

Limitations to this study included a relatively small sample size, lack of extended follow-up, and an incomplete definition of complications, which may have missed other serious complications (eg, pneumothorax, endocarditis).

The authors concluded that the ultrasonographically-guided peripheral internal jugular line is feasible to achieve short-term intravenous access in patients who have failed traditional peripheral intravenous placement, but recommended larger trials to confirm safety and long-term complications.

### Kiefer et al<sup>11</sup>

This was a prospective, observational study on a convenience sample of patients with difficult intravenous access who had a peripheral internal jugular line placed. It was conducted in 2 EDs, one academic and one community. Patients were included if they were older than 18 years and had multiple failed attempts at peripheral intravenous access by nurses, absence of an easily identified external jugular vein, and no clinical indication for central venous cannulation. Peripheral internal jugular lines were placed by emergency medicine residents or attending physicians. Sonographers used either a 4- to 11-MHz linear transducer or a 5- to 14-MHz linear transducer to locate the internal jugular vein. The neck was cleansed with chlorhexidine solution. Sterile probe covers and sterile ultrasonographic gel were used. Either an 18-gauge, 6.35-cm, single-lumen, catheter-over-the-needle device (Arrow International) (75% of cases) or a 20-gauge, 5.7-cm, catheter-over-the-needle device with built-in echogenic

guidewire (Bard Access Systems, Salt Lake City, UT) (25% of cases) was used in the study. The catheter was secured with a bio-occlusive dressing. Outcomes were assessed by review of the chart up to 6 weeks after placement. The primary objective was to assess for complications (eg, local neck abnormality, bleeding, pneumothorax, pulmonary embolism, internal jugular deep venous thrombosis, positive blood culture result). Secondary objectives included number of needle insertion attempts and time to placement.

Thirty-three patients were enrolled in the study. The mean age was 56.4 years and the median BMI was 24.7 kg/m<sup>2</sup>. Forty-two percent of patients were men. Forty-eight percent had diabetes mellitus, 18% had end-stage renal disease, and 9% had a history of injection drug use. The right internal jugular vein was cannulated in 64% of cases. The median number of insertion attempts was one. The median time to placement was 4.0 minutes. There were no identified complications in any of the patients up to 6 weeks after placement.

Limitations with respect to this study included the use of a convenience sample of patients and the use of chart review for follow-up of possible complications. It is possible that some complications were missed by chart review or that patients presented to an external health care system and consequently were missed by the study.

The authors concluded that there were no immediate or short-term complications associated with the ultrasonographically-guided peripheral internal jugular line in their study. They suggest that it is a rapid and safe approach in patients with difficult vascular access.

### Moayedi et al<sup>12</sup>

This was a prospective, observational study conducted at 3 EDs in patients with difficult vascular access in whom a peripheral internal jugular line was placed. Patients were included if they had failed peripheral intravenous access and were able to dilate their internal jugular vein with the Valsalva maneuver. Exclusion criteria included hemodynamic instability, untreated pneumothorax, or the clinical need for a triple-lumen central venous catheter. Procedures were performed by physicians with previous experience in ultrasonographically-guided procedures. This included a minimum of 5 previous successful internal jugular vein catheterizations using the Seldinger technique and 5 previous successful peripheral intravenous line placements. Sonographers used a high-frequency linear transducer to locate the internal jugular vein. The neck was cleaned with chlorhexidine solution. A bio-occlusive adherent dressing was used to cover the ultrasonographic transducer and sterile ultrasonographic gel was used. An 18-gauge, 4.8-cm, catheter-over-the-needle device was used

**Table.** Summary of evidence assessing the safety and efficacy of the ultrasonographically-guided peripheral internal jugular line.

Study	Number of Participants	Catheter Size and Length	Complication Rate, %*	Average Time to Placement, Minutes
Zwank, 2012 <sup>8</sup>	9	18 gauge, 6.35 cm	0	5.5
Teismann, 2013 <sup>9</sup>	9	18 gauge, 6.35 cm	0	2.5–7 <sup>†</sup>
Butterfield, 2015 <sup>10</sup>	20	18 gauge, 6.35 cm	0 <sup>‡</sup>	5.3
Kiefer, 2016 <sup>11</sup>	33	18 gauge, 6.35 cm	0	4.0
		20 gauge, 5.7 cm		
Moayed, 2016 <sup>12</sup>	83	18 gauge, 4.8 cm	0	4.4

\*As defined by the individual study.

<sup>†</sup>Range of placement times (average time not reported).

<sup>‡</sup>One patient developed a deep venous thrombosis, but it was deemed unrelated to the peripheral internal jugular line placement.

for placement. The catheter was secured with a bio-occlusive dressing. Lines were kept in for no longer than 24 hours in accordance with institutional guidelines. Patients were enrolled during a 3-year period. Outcomes included time to placement, number of skin punctures, patient pain score during placement, success rates, subsequent loss of patency, pneumothorax, and arterial injury. Line infection was assessed by patient contact and chart review for up to 2 months after placement.

Eighty-three attempts were performed on 74 patients, resulting in an initial success rate of 88%. The median age was 44 years, with a median BMI of 27 kg/m<sup>2</sup>. Forty-four percent of patients were men. The mean time to placement was 4.4 minutes. The mean pain score was 3.9 out of 10. There were no cases of pneumothorax, line infection, or arterial puncture identified. Fourteen lines lost patency during the hospital stay.

This study was limited by the use of a convenience sample of patients and because the majority of placements were performed by experienced providers. Additionally, a shorter catheter length was used compared with that in other studies, which might explain the higher failure rate. There was no discussion of how many failed catheter placements resulted in soft tissue infiltration of medications or intravenous contrast. Finally, most peripheral internal jugular lines were removed within 24 hours, so it is unclear whether use beyond 24 hours would have led to an increased rate of catheter failure or complications.

The authors concluded that the ultrasonographically-guided peripheral internal jugular line can be used as a safe and rapid method of achieving short-term intravenous access in appropriately selected patients.

## THE BOTTOM LINE

According to the available evidence, ultrasonographically-guided peripheral internal jugular placement appears to be rapid and efficacious, with no evidence of significant complications (Table). The studies identified high success rates, with most placements occurring with a single needle

pass. There were very low rates of complications, with no identified cases of pneumothorax, arterial injury, or bloodstream infection related to the placement. Although no direct comparison was performed in the included studies, previous literature has demonstrated a 1.5% to 4.6% complication rate among traditional ultrasonographically-guided internal jugular central venous cannulations<sup>6,13</sup> and a 12% to 42% complication rate among ultrasonographically-guided peripheral intravenous lines placed in alternate locations.<sup>14,15</sup> The average time to placement ranged from 4.0 to 5.3 minutes. By comparison, central venous cannulation placement may take more than 20 minutes to perform.<sup>16</sup> In another study, the median delay for intravenous access in patients with difficult access was demonstrated to be 120 minutes.<sup>17</sup>

To our knowledge, this is the first review to summarize the current data on the ultrasonographically-guided peripheral internal jugular line. This review has several strengths, including performance at several different hospitals, inclusive of both academic and community sites, and assessment of patient-relevant outcomes (eg, infection, arterial injury, pneumothorax, procedural pain).

However, this review also has several limitations. Overall, a small number of total patients were included in the combined data (n=154 patients). Despite this fact, there was only one identified complication, which was a deep venous thrombosis in a patient with nephrotic syndrome and multiple other deep venous thromboses who had the line in for 6 days.<sup>10</sup> Although this suggests that the complication rate is less than 1%, more studies are needed to better quantify the exact complication rate. Nonetheless, the available data suggest that peripheral internal jugular lines are relatively safe for short-term use. Additionally, because most studies used chart review to assess for adverse events, it is possible that some events were missed.

Providers should be aware of the risk of pneumothorax, infection, and arterial injury associated with traditional internal jugular venous access as part of central venous cannulation placement.<sup>4</sup> Because the catheters used for



peripheral internal jugular line placement are thinner than traditional central venous cannulas, there is also a potential for kinking or dislodgement of the catheters.<sup>12</sup> Zwank<sup>8</sup> found that 2 of 9 catheters (22%) kinked within 72 hours of placement. Both occurred with the Arrow Spring-Wire Guide catheters. Moayedi et al<sup>12</sup> had 14 of 83 catheters (17%) fail within 24 hours of placement. The catheters used in this study were significantly shorter than those of the other studies, which may explain the high rate of catheter dislodgement.<sup>12</sup> It has been suggested that shorter catheter lengths may lead to higher rates of peripheral intravenous failure.<sup>18</sup> The authors recommended using a 6.35-cm catheter when possible for this procedure. Additionally, providers should be aware that placing a peripheral internal jugular line may limit the subsequent use of that location for central venous cannulation. Teismann et al<sup>9</sup> suggested that an alternate site be selected when possible, although the same vessel may be used if there is no evidence of infection or hematoma. The peripheral catheter should not be converted into a central venous line by advancing a guide wire through the catheter lumen because of the potential risk of infection.<sup>9</sup>

The studies had significant heterogeneity with respect to the size and length of the selected intravenous lines, as well as operator experience. There were also variations in the definitions of complications, with some trials relying on patient-described symptoms<sup>9,10</sup> and others relying on a defined list of complications.<sup>8,10-12</sup> Moreover, all studies were performed in adults, so there is unclear applicability to the pediatric population. It is also possible that publication bias was present, with positive-result studies having a greater likelihood of publication, although the limited number of studies makes this difficult to assess. Finally, there was variation in protocols between studies. Although most studies used a sterile ultrasonographic cover,<sup>9-11</sup> 2 used only a bio-occlusive dressing to cover the transducer and sterile ultrasonographic gel.<sup>8,12</sup> Current evidence is limited in regard to the efficacy of bio-occlusive dressings to reduce infection rates, and further data are needed to determine whether sterile ultrasonographic covers are necessary.<sup>19</sup>

Overall, ultrasonographically-guided peripheral internal jugular line placement appears fast and effective, with low rates of complications. According to the grading recommendations from the American College of Emergency Physicians, the overall evidence provides a level B recommendation supporting the use of this technique, based on class II and III studies.<sup>20</sup> Although further data are needed, this appears to be a reasonable option in patients with difficult venous access for whom rapid intravenous access is necessary.

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