

A Review of Various Techniques of Central Venous Catheter Insertion

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ABSTRACT

Central venous catheterization is a standard procedure used in the resuscitation of critically ill patients. There are different routes of CVP insertion which are:- subclavian vein, internal jugular vein, axillary vein and femoral vein. Each route has its own set of complications like artery puncture, pneumothorax, nerve injury, infections. Initially catheters were inserted by the landmark technique using guidewire through the needle commonly called Seldinger technique. The landmark technique is found to be associated with a higher range of mechanical complications. The use of USG however has proved to improve the success rate and decrease the complications.

Keywords: Central venous catheterization, resuscitation, internal jugular vein

INTRODUCTION

Central venous catheterization is a very important part of management of critically ill patients. They are inserted by anesthesiologists, intensivists, radiologists, attending physicians and surgeons. It is the standard clinical method for monitoring central venous pressure, therapeutic interventions like securing vascular access for administration of vasoactive drugs or to initiate rapid fluid resuscitation.

Various routes of central line insertion have been defined that is:- subclavian vein route, internal jugular route, axillary vein, femoral vein. However each route is associated with its own set of challenges and the overall incidence of

mechanical complications ranges from 5-19%¹. The choice of the access site depends on various factors including physician preference, ease of access, coagulation status, probable duration of catheter stay, infection rates and complication rates. Complications of central venous catheterization include arterial puncture, hematoma, pneumothorax, arterial venous fistula, air embolism, nerve injury, infections and thrombosis. The usefulness of ultrasound has demonstrated catheterization with low incidence of complications. Many studies have come up using ultrasonography guidance for central venous access showing higher success rates. Although there are studies and reports of use of USG guidance in all routes of central line access like subclavian, axillary and femoral routes, the highest evidence of usefulness has been demonstrated in internal jugular vein route.

REVIEW OF LITERATURE

Millions of central vein catheterizations are done annually by various clinicians for monitoring as well as therapeutic purposes. Central lines insertion was first described by Aubaniac² (1952) when he inserted a needle in subclavian vein under the clavicle. Various other routes of central venous access were described subsequently in the next decade including the infraclavicular axillary vein approach, internal jugular venous route and supraclavicular approach to subclavian vein.

Later Seldinger³ (1953) modified the technique of catheter insertion by passing a guide wire through the needle and threading the catheter over the guide wire. This technique became popular worldwide and now goes by the name 'Seldinger Technique'. Yoffa⁴ (1965) described supraclavicular subclavian vein catheterization where he described various landmarks and the technique⁵ of cannulation.

Hermosura et al⁶ (1966) first described the technique of percutaneous internal jugular vein cannulation. Nickalls⁷ (1985) described the infraclavicular approach to axillary vein cannulation. He described two surface landmarks for axillary vein cannulation, first one being three finger breadth below coracoid process and the second point at the junction of medial one third and lateral two third of clavicle.

Central venous catheterization is associated with many complications of which some can be serious and some life threatening. The incidence and associations of these complications with different approaches for central venous catheterization have been reported in literature. Tsotsolos et al⁸ (2015) shared the opinion on experience of the clinician in performing the procedure as a major risk factor for mechanical complications.

However, Schummer et al⁹ (2007) has studied central venous cannulation by landmark technique through various routes and reported a high incidence of mechanical complications even with experienced operators. He reported a significantly higher incidence of arterial puncture with IJV cannulation when compared with subclavian vein cannulation.

Anatomic considerations while inserting central line through various routes have been described in detail by Bannon et al¹⁰ (2011). In his article he described the anatomy of the central veins commonly used for catheterization, proper preparation, insertion techniques, various complications and use of ultrasound guidance.

Merrer et al¹¹ (2001) in his study comparing the complications of femoral venous access and subclavian approach in critically ill patients reported infection rates of 19.8% in femoral venous catheterization compared to 4.5% with subclavian route. The incidence of thrombosis was also higher with femoral route. The high incidence of thrombotic complications along with the high rates of infection has made femoral route the least preferred route for central venous access.

Eisen et al¹ (2006) in a retrospective study of mechanical complications in central venous catheters, observed a pneumothorax incidence of 2.3% with subclavian route whereas there was none in the jugular vein group. They concluded that the incidence of complications is higher with subclavian route and this is to be considered while choosing the approach.

There is a huge body of literature demonstrating the usefulness of ultrasound in vascular access. Ultrasound guidance was first used for vascular access by Legler et al¹² (1984). He compared the use of Doppler pre-location to classic landmark technique to guide the venous cannulation. He demonstrated the need of lesser needle passes and higher success rates with Doppler pre-location. Denys et al¹³ (1993) in one of the earlier studies comparing ultrasound guidance and external landmark technique for IJV cannulation reported success rate of 100% using ultrasound and 88.1% using the landmark-guided technique.

Fathi et al¹⁴ (2016) in a more recent study compared anatomical landmark and USG guided internal jugular vein catheterization in patients undergoing cardiac surgery. He reported high success rates of 99.4% with USG guidance. Slama et al¹⁵ (1997) in a prospective randomized study, compared use of anatomical landmarks with use of ultrasound guidance for IJV cannulation by junior house staff. They found that IJV cannulation was successful in 100% patients in the ultrasound group and 76% in the control

group. Ultrasound guidance has shown to decrease the venous access time, number of needle passes and the incidence of mechanical complications, improves overall and first attempt success rates. The evidence of the efficacy and usefulness of ultrasound in internal jugular vein cannulation is strong and this has prompted the adoption of ultrasound guidance in NICE¹⁶ guidelines for safe practices in 2002.

Vogel et al¹⁷ (2015) compared long axis and short axis views for internal jugular and subclavian vein cannulations in mannequins and found that posterior wall punctures were lesser with long axis views. Moore et al¹⁸ (2014) in his article described the importance of ultrasound in the present era, not just for central venous access but also for central or peripheral arterial access and peripheral venous access. He concluded that USG guidance can increase success and decrease complications in a wide variety of vascular access procedures.

Blaivas M et al¹⁹ (2003) did a randomized, observational study to compare short axis versus long axis approaches for teaching ultrasound guided vascular access on a new inanimate model. They concluded that novice USG users obtained vascular access faster using short axis approach than long axis approach on inanimate model.

Tammam TF et al²⁰ (2013) compared two different ultrasound guided techniques (short axis versus long axis approach) and landmark technique for internal jugular vein cannulation in 90 critical care and hemodialysis patients. They concluded that short axis and long axis approaches were comparable for IJV cannulation. Furthermore, both USG guided techniques were superior to the landmark technique for insertion of CVP.

Chaudhary MS et al²¹ (2016) compared Ultrasound guided internal jugular vein cannulation with short and long axis approach. They postulated that higher first attempt successful cannulation and overall less complications were seen in long axis approach but the difference was not statistically significant.

Shrestha GS et al²² (2016) did a comparison between short and long axis techniques for ultrasound guided cannulation of internal jugular vein and concluded that both techniques have similar outcomes when used for IJV cannulation.

CONCLUSION

There is a huge body of literature demonstrating the various techniques of central venous catheterization over the years. The use of ultrasound has converted a blind procedure into a procedure under vision reducing the complications markedly. Thus, USG guidance should be considered in all routes of central venous access. Training and experience with the use of USG improves the success rate and decreases complications.

Acknowledgement: None

Conflict of Interest: None

Source of Funding: None

Ethical Approval: Not required

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How to cite this article: Chaudhary S, Atwal MA. A review of various techniques of central venous catheter insertion. *International Journal of Science & Healthcare Research*. 2021; 6(3): 204-207. DOI: <https://doi.org/10.52403/ijshr.20210735>
