



ORIGINAL RESEARCH PAPER

Medicine

INTERNAL JUGULAR VEIN CATHETERIZATION FOR TEMPORARY HEMODIALYSIS ACCESS BY ULTRASOUND GUIDED APPROACH AND LANDMARK TECHNIQUE: A RANDOMISED COMPARATIVE STUDY

KEY WORDS: Internal jugular vein, Ultrasound guidance, Hemodialysis.

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ABSTRACT

Objective: To compare and contrast the ultrasound guided insertion of double lumen internal jugular catheterisation with landmark technique for establishing a temporary hemodialysis access.

Methods: This prospective, randomized study was conducted on patients attending or admitted in the department of medicine at Geetanjali Medical College and Hospital, Udaipur, from January 2017 to July 2018. The patients were randomly assigned to two groups, each having equalled number of patients. Randomization was done by a closed-envelope method.

Result and conclusion: Out of 100 diabetic patients we found that ultrasound guidance for access of the internal jugular vein for temporary hemodialysis minimizes procedure time, significantly reduces complications and provides a very high success rate in an elective setting. .

INTRODUCTION

Internal jugular vein (IJV) catheterization is commonly attempted to obtain central venous access for hemodynamic monitoring and hemodialysis. Many anatomical landmark (LM)-guided techniques for IJV puncture have been described.^{1,2} Complications are influenced by patient factors such as site of attempted access, and operator experience.³ It has been suggested that ultrasound (US) guidance could improve the success rate, reduce the number of needle passes, and decrease complications.^{4,5} Although the ultrasound method has been favorably compared to the landmark technique, its widespread use has been restricted by the impracticality of a specially designed ultrasound machine or sterile scanner manipulation, unavailability of equipment, and trained personnel.⁶ Cannulation of the IJV is usually preferred because of its anatomical position and large diameter in the Trendelenburg position.

Double lumen jugular catheters are widely used for hemodialysis. Hemodialysis patients are quite different from other patient groups who need central venous catheters. Blood clotting problems and volume overload are common in uremic patients. These factors increase the risk and complication rates of central venous catheterization in hemodialysis patients. Jugular venous access has become a mandatory part of clinical management in a variety of clinical circumstances. Nevertheless, one can expect a complication rate of 5-10% using this technique, depending on the experience of the operator. Complications include puncture of the carotid artery, neck or mediastinal hematoma, brachial plexus injury or irritation, pneumothorax, and injury to the stellate ganglion, phrenic, or recurrent laryngeal nerve.

The landmark-guided technique usually affords rapid and easy entry. In an occasional case, however, there are technical difficulties probably because external landmarks do not correlate exactly to the location of the vessel.⁽⁷⁾ Although the ultrasound method has compared favourably with the landmark technique in all studies, its widespread use has been hampered by the impracticality and expense of full-sized echo devices and by the absence of larger prospective study data.

Alternatively, ultrasound imaging can be applied for evaluation of anatomic structures before attempting venous puncture, which helps the clinicians locate the carotid artery and the IJV, and determine the direction and site of venepuncture. However, only few prospective studies exist comparing IJV cannulation by the ultrasound-guided prelocation and the anatomical landmark technique (central approach).⁸

Because sonography is still only rarely used clinically for the catheterization of central veins, and because sonography units are increasingly available in hospitals, this study sought to investigate the usefulness of a sonographically guided technique for the insertion of central venous catheters.

OBJECTIVE

To compare and contrast the ultrasound guided insertion of double lumen internal jugular catheterisation with landmark technique for establishing a temporary hemodialysis access.

PRIMARY OBJECTIVE:

1. To determine the success rate of internal jugular catheterization using ultrasound guided approach and landmark technique including access time, cannulation time and time taken for procedure and to compare both groups for their success rates.

SECONDARY OBJECTIVE:

1. To study the complications of USG guided approach and landmark technique with respect to number of attempts, vessel injury and hematoma and to compare both groups for their complications.

METHODS

A prospective, randomized study was conducted in the Department of Nephrology in Geetanjali Medical College and Hospital, Udaipur (Raj), India from January 2017 to July 2018. After Institutional ethics committee approval and written informed consent, one hundred patients were included in the study. The patients were randomly assigned to two groups:[US (ultrasound) and LM (landmark), each having equaled number of patients. Randomization was done by a closed-envelope method.

'INCLUSION CRITERIA

Age between 18 and 75 years
Negative Viral Markers

EXCLUSION CRITERIA

Coagulopathies/ patient on heparin or warfarin
Distorted chest anatomy
Superior Vena Cava Syndrome
Infection at the cannulation site
Pregnancy patients

One hundred patients of age 18 to 75 years, scheduled for hemodialysis that required internal jugular venous catheterization,

were taken up for the study. The patients were randomly allocated to one of the two groups (50 in each group). Patients of the first group had their catheter placement attempted in the internal jugular vein via the landmark technique (LM group). Patients in the second group, the catheterization was attempted using ultrasound guidance in the internal jugular vein (US group).

Demographic characteristics, such as age, gender, coagulation parameters (such as platelet numbers and international normalization number), and clinical parameters were recorded for all patients. The measured outcomes were the access time, guidewire time, cannulation time, procedure time, the number of attempts for successful placement, and catheter complications. Access time was defined as the time from the starting of insertion of the introducer needle to the return of dark colored venous blood into the attached syringe. Cannulation time was defined as the time from the starting of insertion of the central venous catheter to the end of catheter placement. Procedure time was defined as the time from the starting of insertion of the introducer needle to the end of catheter placement, not including the suturing and fixation time. Successful placement was defined as the observation of the catheters in the proper position by X-ray and functional determinants (i.e., no difficulty in the infusion or aspiration of venous blood).

RESULTS

Table 1: No. of Attempts and Success Rate

No. of Attempts	Ultrasound		LM		P value
	No.	%	No.	%	
1	39	78%	37	74%	>0.05 (NS)
2	10	20%	10	20%	
Rate of Success	49	98%	47	94%	TOTAL 96 (96%)

SUCCESS RATES

Successful catheterization (defined as success with ≤ 3 attempts) could be achieved in 96 (96%) patients. All the patients in US and LM group were catheterized within three attempts. In 1 patient (2%) in US group and 3 patients (6%) in the LM group catheterization through the designated approach was unsuccessful. However, on comparison, the differences in the overall success rates were not statistically significant ('p' value >0.05) among two groups.

Table 2: Venous Access/ Guidewire/Cannulation/Procedure Time

Time (secs)	US		LM		P value
	Mean	SD	Mean	SD	
Venous Access Time	49.04	19.38	53.54	21.94	0.280
Guidewire Time	59.64	20.52	63.36	18.16	0.339
Cannulation Time	149.28	43.54	158.56	33.31	0.234
Procedure Time	257.96	74.26	275.46	55.30	0.184

Mean procedure time was found to be 257.96 ± 74.26 sec in US group and 275.46 ± 55.30 secs in LM group. The mean venous access time was 49.04 ± 19.38 secs in US group and 53.54 ± 21.94 secs in LM group respectively. The mean guidewire time was found to be 59.64 ± 20.52 secs in US group and 63.36 ± 18.16 secs in LM group. The mean cannulation time was 149.28 ± 43.54 secs in US group and 158.56 ± 33.31 secs in LM group. The catheterization times were compared among the two groups using Kruskal-Wallis test and no statistical difference was found between the groups with respect to cannulation time (P > 0.05).

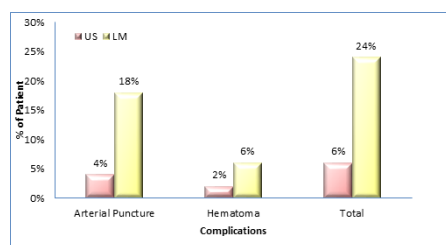
Table 3: Complications with Type of Procedures

Complications	US		LM		P value
	No.	%	No.	%	
Hematoma	1	2%	3	6%	0.30 (NS)

Arterial Puncture	2	4%	9	18%	0.02 (S)
Total Complications	3	6%	12	24%	0.01 (S)

There were 15 complications in the 100 patients, 4 being Hematoma and 11 Arterial Punctures being the complications. There were 15 complications in the 100 patients, total of 3 complications in US group (1 Hematoma and 2 Arterial punctures) and 12 in LM group (3 Hematomas and 9 Arterial Punctures). The comparison of both the techniques for hematoma was not statistically significant but it was statistically different for arterial punctures (p value 0.02) and total complications as a whole (p value 0.01). The patients who underwent these complications had the puncture site compressed using a gauze piece until coagulation was confirmed. In patients with Hematoma, after observation of the patient and after confirmation of accessibility from other sites using ultrasound (preferably right femoral vein), the catheter was placed for hemodialysis.

FIGURE 1



DISCUSSION SUCCESS RATES

Successful catheterization (defined as success with ≤ 3 attempts) could be achieved in 96 (96%) patients. All the patients in US and LM group were catheterized within three attempts. In 1 patient (2%) in US group and 3 patients (6%) in the LM group catheterization through the designated approach was unsuccessful. However, on comparison, the differences in the overall success rates were not statistically significant ('p' value >0.05) among two groups.

FIRST ATTEMPT SUCCESS RATES

In our study first attempt success rates were achieved in 78% (39 patients) of the US group, 74% (37 patients) of the LM group. On statistical analysis the difference in the first attempt success rates between the two groups were not statistically significant ('p' value >0.05).

Second attempt was successful in 20% of patients in US group and 20% of patients in the LM group. Catheterization by the designated approach failed in 4 patients and was achieved through right femoral vein approach.

In a series of 100 patients, Daily et al reported that arterial puncture occurred "occasionally" and that the mediastinum was infiltrated in one patient (1%).

In a series of 1,000 patients, Goldfarb and Lebrec (9) reported a success rate of 99.3%, but in 4.3% the left internal jugular vein had to be cannulated after unsuccessful attempts at right-sided access. This high success rate came at the cost of multiple attempts, as only 57.3% of patients were accessed in one or two attempts (one attempt: 43.3%; two attempts: 14.0%).

In another study by Denys and Reddy (10) of 302 patients in whom the landmark-guided technique was used compares favorably with this study, with 75% success rate with two attempts (one attempt: 38.4%; two attempts: 36.8%). Ultrasound guidance provides a significant improvement, with 93% success rate with two attempts (one attempt: 78%; two attempts: 14.7%). Other studies have shown a failure of cannulation rate of 7-19.4%, depending in part on the experience of the operator. Our failure

rate of 6% in the external landmark group is similar to the published data.

The complication rate of 2% in our US group is similar to that of Slama and Novara (11) and other published rates. The most common complication was arterial puncture, which was successfully treated by vessel compression without any further therapy.

The complication rate was lower with US than with the landmark method in the study by Denys and Reddy.(10) In our study, as in the Slama study, this complication rate was possibly due to the limited experience of young operator with the US technique.

Denys et al.[10] have reported 100% success using ultrasound and 88.1% success using the landmark-guided technique. They found a first attempt success of 78% with ultrasound-guided technique (USG) and 38% using the landmark technique. They reported carotid artery puncture in 1.7% of patients, brachial plexus irritation in 0.4%, and hematoma in 0.2% when using the ultrasound-guided approach.

COMPLICATIONS

There were 15 complications in the 100 patients, total of 3 complications in US group (1 Hematoma and 2 Arterial punctures) and 12 in LM group (3 Hematomas and 9 Arterial Punctures). The comparison of both the techniques for hematoma was not statistically significant but it was statistically significant for arterial punctures (p value 0.02) and total complications as a whole (p value 0.01). The patients who underwent these complications had the puncture site compressed using a gauze piece until coagulation was confirmed. In patients with Hematoma, after observation of the patient and after confirmation of accessibility from other sites using ultrasound (preferably right femoral vein), the catheter was placed for hemodialysis

Goldfarb and Lebrec (9) reported carotid puncture rate of 7.4%, hematoma was 1%, hemothorax and Horner syndrome were 0.2% each, and dysphagia was 0.1%.

CONCLUSION

One hundred patients were enrolled in this randomized study. Patients were randomly allocated into two groups, 50 in each group. In the first group of patients, catheterization as a temporary access for hemodialysis was done in internal jugular vein (IJV) via landmark technique (LM Group); in the second group, catheterization was in IJV using Ultrasound guided technique (US Group).

- In our study successful catheterization was achieved in 96 (96%) patients. All the patients in US and LM group were catheterized within three attempts. In 1 patient (2%) in US group and 3 patients (6%) in the LM group catheterization through the designated approach was unsuccessful.
- First attempt success rates were achieved in 78% (39 patients) of the US group, 74% (37 patients) of the LM group.
- Second attempt was successful in 22% of patients in US group and 20% of patients in the LM group. Catheterization by the designated approach failed in 4 patients and was achieved through right femoral vein approach.
- Mean procedure time was found to be 257.96 ± 74.26 sec in US group and 275.46 ± 55.30 secs in LM group. The mean venous access time was 49.04 ± 19.38 secs in US group and 53.54 ± 21.94 secs in LM group respectively. The mean guidewire time was found to be 59.64 ± 20.52 secs in US group and 63.36 ± 18.16 secs in LM group.
- The mean cannulation time was 149.28 ± 43.54 secs in US group and 158.56 ± 33.31 secs in LM group (p<0.001). On post hoc analysis using Dunn's multiple comparison tests, the difference in catheterization times between the US group and LM group were found to be statistically significant.

- There were 15 complications in the 100 patients, Hematoma (4) and Arterial punctures (11) being the complications.
- 2% patients in US group and 6% in LM group had hematoma as the complication. Hematoma was managed immediately by compressing the puncture site using a gauze piece until coagulation was confirmed. After observation of the patient and after confirmation of accessibility from other sites using ultrasound (preferably right femoral vein), the catheter was placed for hemodialysis.
- Arterial Puncture occurred 4% in US group and 18% in LM group which was statistically significant (p value 0.02). This was managed by compressing the puncture site with a gauze piece.
- Total complications when compared between the two groups were found to be statistically significant with 6% complications in US group and 24% in LM group (p value 0.01).
- We conclude that ultrasound guidance for access of the internal jugular vein minimizes procedure time, significantly reduces complications and provides a very high success rate in an elective setting. Further studies will determine definitely whether ultrasound guidance should be used routinely in obtaining jugular venous access.

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