

## Evaluation of success rate in internal jugular vein access between anatomical landmark method and ultrasound guided method in Shahid mohammadi

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**KEY WORDS:** Central venous catheterization; Ultrasounds, Anatomic landmark, Jugular veins.

**ABSTRACT:** Introduction: Central vein catheterization is a common method in patients who need monitoring of central vein pressure, long-term venous treatment, total parenteral nutrition, and hemodialysis. Internal jugular vein is the most commonly chosen route. Ultrasound guided jugular vein access is a more technically successful method with lower complications. However, based on the report from The Society of Cardiovascular Anesthesiologists, only 15% of those in practice are interested in the use of ultrasound guided catheterization of central veins as a routine method. Higher frequency of needle insertion for cannulation can increase the risk of bacterial infection, pneumothorax, hemothorax, hematoma, and brachial plexus injury. Methods: The study was performed as a clinical trial. 324 cases were randomized into two groups by means of the randomization table. Group A included 162 patients with anatomic access to internal jugular vein and group B included 162 patients with ultrasound guided jugular vein access. Sampling and CVC (Central Vein Catheterization) was done by a surgical resident. Having been entered into SPSS software (version 19), the data was analyzed using descriptive statistics (number, percent) and chi-square test. Results: From the 162 patients in group A, 97 (59.9%) were successfully catheterized. In group B 132 out of 162 patients (81.5%) were successfully catheterized through the internal jugular vein (P-value<0.001). Carotid artery injury occurred in 19 patients in group A (11.7%) and 7 patients in group B (4.3%) which was the ultrasound guided group (P-value=0.14). Hematoma formed in 14 patients (8.6%) and 8 patients (4.9%) in group A and B respectively (P-value=0.185). Infection of the site of catheterization occurred in 13 patients in group A (8%) and 7 patients in group B (4.3%) (P-value=1.91). Discussion and Conclusion: According to the results of this study and based on its detailed comparison with other studies, with a small margin of error, we can conclude that the ultrasound guided catheterization of the internal jugular vein is preferred over the traditional anatomic method. In addition, due to its lower complications regarding patient safety compared to the traditional technique, the ultrasound guided catheterization is recommended as an acceptable method.

### Introduction

One of the reliable venous access sites for blood sampling and hemodynamic monitoring of patients is central catheters (1-3). Jugular veins are the most popular central venous access sites due to their availability and generally lower complications, and are the preferred route for temporary hemodialysis because of their large diameter, anatomical availability, low possibility of catheter obstruction or its movement(4).

Among the different methods, the blind catheterization is associated with more needle insertions and higher need for altering the insertion site to achieve a proper access site, which in turn leads to more complications(5). Ultrasound guided jugular vein access is a more technically successful method with lower complications because it gives us direct vision of the site of the insertion and thus, decreases the number of needle insertions(5). However, based on the report from The Society of Cardiovascular Anesthesiologists, only 15% of those in practice are interested in the use of ultrasound guided central vein catheterization as a routine method(4). There are also some difficulties associated with this method including the need to complete the ultrasound learning curve, requirement of theoretical knowledge of ultrasound, instructions on how to use the device, knowledge of anatomical landmarks the ability to match it with what you see through the ultrasound device and knowledge of the color Doppler to be able to distinguish between veins and arteries(5).

In a study by Oguzkurt et al in 2004, they showed that the use of ultrasound to access deep veins, is safe and enjoys high success rate and low complications but the number of studied cases were not adequate (172 cases)(6). Cajazzo et al reached similar results in 2003 but the number of cases weren't more than 200(7). Karimi et al also reported similar results in 2014 but the number of cases studied were also low (100 cases)(8).

The aim of this study was to compare the success rate of the anatomical landmark method with the ultrasound guided method of internal jugular catheterization. In the design of this study we increased the size of the sample in order to lower the statistical error. In addition, the two aforementioned methods including the ultrasound guided technique and the traditional anatomical landmark technique were done by a surgeon specifically experienced in the field of catheterization in our study.

**Results**

A total number of 324 patients were included in the study from which 177 were male and 147 were female. Group A (Anatomical landmark method) was made up of 162 patients, 89 of which were male (54.9%) and 73 were female (45.1%). Group B (ultrasound guided method) was made up of 162 patients, 88 of which were male (54.3%) and 74 were female (45.7%). P value=0.911 was not significant for gender which means the population of both groups was homogenous regarding gender.

According to Kolmogorov-Smirnov test (K-S), the gender variable was normally distributed in both groups but BMI (Body Mass Index) was not normally distributed. Therefore, we used independent t-test for age and Mann-Whitney test for BMI in both groups.

The mean age of the patients was 51.13 years. The mean age of group A and group B were 88.18±13.51 and 70.54±16.18 years respectively. The difference was not significant according to the independent t-test; thus, the two groups were homogenous regarding age (P=0.84).

According to the Mann-Whitney test, BMI was 87.4±4.27 and 30.4±68.26 in group A and group B respectively. Test statistics was -1.35 and P value=0.256 which were not statistically significant and the two groups were homogenous.

Topographic characteristics of the study population is shown in table 1. Chi square test results of the age of the study population is demonstrated in table 2. Results of the independent t-test regarding age is shown in table 3. Maximum and minimum of age is shown in table 4. The comparison of BMI between the two groups is depicted in table 5.

Table 1. Topographic characteristics of the study population

		gender		
		Female	Male	Total number
Number		73	89	162
Group A	Group percentage	45.1%	54.9%	100.0%
	Gender percentage	49.7%	50.3%	50.0%
	Total percentage	22.5%	27.5%	50.0%
	Number	74	88	162
Group B	Group Percentage	45.7%	54.3%	100.0%
	Gender percentage	50.3%	49.7%	50.0%
	Total percentage	22.8%	27.2%	50.0%
	Total number of patients	147	177	324
Both groups	Group percentage	45.4%	54.6%	100.0%
	Gender percentage	100.0%	100.0%	100.0%
	Total percentage	45.4%	54.6%	100.0%

Table 2. Chi square test results of the age of the study population

	Value	df	Asymp. Sig. (1-sided)	Sig. (2-Exact sided)	Sig. (2-Exact sided)	Sig. (1-sided)
Pearson Chi-Square	.012 <sup>a</sup>	1	.911			
Continuity Correction <sup>b</sup>	.000	1	1.000			
Likelihood Ratio	.012	1	.911			
Fisher's Exact Test				1.000	.500	
Linear-by-Linear Association	.012	1	.911			
N of Valid Cases	324					

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 73,50.

Table 3. Results of the independent t-test regarding age

Group	Number	Mean age	Degree of freedom	T-test statistics	Standard deviation
A	162	51.1358	322	-1.733	18.88063
B	162	54.7037			18.16518

Table 4. Maximum and minimum of age

Group	Age Average	Minimum	Maximum	Standard Deviation
A	51.14	18.00	84.00	84.00
B		18.00	18.17	

Table 5. The comparison of BMI between the two groups

Group		BMI			
		Minimum	Maximum	Average	Standard Deviation
A		20.00	38.00	27.42	4.87
B		19.00	37.00	26.68	4.30

The study of the success rate of internal jugular catheterization in the two groups showed that 97 out of 162 patients in group A (59.9%), and 132 out of 162 patients in group B (81.5%) were catheterized successfully.

According to Chi square test, test statistics was 18.244, the degree of freedom was 1, and P value<0.001; therefore, there was a significant difference between the two groups.

14 patients in group A (8.4%) and 8 patients in group B (4.9%) developed hematoma (P=0.0185) and the difference between the two groups was not significant.

**Materials and Methods**

The study was a clinical trial and 324 consecutive patients in need of internal jugular catheterization for any reason, in a hospital in Iran, entered the study. The exclusion criteria were patients with short necks (sternocleidomastoid muscle length of less than 15 cm), patients who had undergone any kind of surgery in the same anatomical region, deformity in the neck and upper thorax, restlessness of the patient, children under 14 who were not cooperative, coagulopathy and platelet count<50000/mm<sup>3</sup> even in the absence of bleeding. Patients gave their informed consent to have their data collected in a database and to have them anonymously used for scientific purposes. Patients were divided into groups A and B by means of the randomization table (through Random Allocation Software). Group A included 162 patients who had internal jugular vein access via the anatomical landmark method and group B included another 162 patients who had internal jugular vein access via the ultrasound guided method. CVC (Central Vein Catheterization) and sampling was done by a surgical resident (a colleague in the study) for all the patients.

In this study failure was defined as more than 3 times needle insertion or having to change the access site for more than 3 times in both methods. Hematoma was defined as swelling and discoloration of the needle insertion site in the first 24 hours after the primary surgery.

The ultrasound device used in the ultrasound guided method was a MEDISON-SONOACE X8 model which was made in Korea. Data were analyzed using SPSS software (version 19) by means of descriptive statistics and Chi square test was also performed.

**Discussion**

In a study by Filho et al in 2013, which included 40 patients, the duration of the anatomical landmark method and the ultrasound guided method did not differ significantly. The need for alteration of the site of catheterization (which was defined as failure in our study) was 0 in the ultrasound guided method and 4 in the anatomical landmark method (23%) and the difference was statistically significant (P=0.03). In this study, there was no statement about the definition of failure regarding the number of needle insertions. Failure was defined as the duration of catheterization for venous access(5).

In the study done by Oguzhurt et al in 2005, 172 seriously ill patients were catheterized in their internal jugular vein assisted by the guide of ultrasound. Final success rate of the catheterization was reported as 100% and the number of needle insertions was 1.24. One of the patients developed hematoma (0.004). According to this study and its statistical results, despite absence of a control group, the ultrasound guided method was introduced as a safe and reliable method for jugular vein catheterization in seriously ill patients(6).

In the study by Calin et al in 2010 in which catheterization of the external jugular vein was designed in the same way as our study, 60 patients were divided into two groups each comprising of 30 patients. Success rate in the anatomic group in comparison with the ultrasound guided group was 80% versus 73% ( $P=N.S$ ). Hematoma developed in 11 patients in the anatomic group and 3 patients in the ultrasound guided group, there was a considerable difference but the difference was not significant statistically. This study suggests further studies, a bigger sample size and taking ultrasound learning curve into consideration(9).

In the study done by Turker et al in 2009 on 380 patients who underwent catheterization either by the anatomic landmark method or the ultrasound guided method. The success rates of the two methods were similar (97% versus 99%) but the duration of needle insertion was significantly higher in the ultrasound group ( $P<0.05$ ). This study differs from ours regarding success rate, but regarding complications and the definition of failure, duration of needle insertion was similar to our study(10).

In a retrospective study done by Teichgraber et al in 2010 on 3160 patients via reconsideration of the patients' files, the success rate was reported as 99.8% in the catheterization of the internal jugular vein by the ultrasound guided method and in this method the complications were low and within an acceptable range(11).

In another retrospective study performed by Garziera et al, published in 2014, patients who needed port catheterization by different methods of cutdown, anatomical landmark and ultrasound guided were studied. There were 796 patients in the study from which 104 underwent cutdown, 48 patients anatomic and 646 patients the ultrasound guided method. In the cutdown method there was no need for changing the site of needle insertion. 10% of cases (5 patients) in the anatomic method and only 2% of cases (13 out of 646) in the ultrasound guided method reported failure and had to change the needle insertion site ( $P<0.05$ ).

In addition, regarding the development of hematoma the results were similar to our study. Due to its being retrospective plus the considerable difference of the number of patients in the three groups, they faced a lot of difficulty synchronizing the groups(12).

In the study done by Cajazzo et al in 2004(7), 196 patients were included. The duration of catheterization of jugular vein was significantly more successful and shorter in the ultrasound guided method in comparison with the anatomic method (4 minutes versus 7 minutes) and the overall success rate of the ultrasound method was higher than the anatomic method (98% versus 91%,  $P<0.025$ ). Complications in the ultrasound method was 0.0% versus 8% in the anatomic method ( $P<0.001$ ). Regarding the statistics and results, this study was the most similar one to the study done in our center.

In the study done by Leung et al in 2006, 130 patients in the emergency condition who were seriously ill were catheterized. Success rate was 93.9% in the ultrasound method and 78.5% in the anatomic method ( $P=0.009$ )(13). The results of this study regarding complications were similar to ours. Leung et al suggested that in the emergency department, deep catheterization is better done by the guide of ultrasound(13).

In the study by Karimi et al in 2014 the results were similar to ours regarding success rate and lower complications. However, in their opinion the number of patients (100) was not enough to reach a general conclusion(8).

## **Conclusions**

According to the results of this study and the detailed comparison of it with other studies, we can with a slight margin of error declare that the ultrasound guided method in internal jugular catheterization is preferred over the conventional anatomic method. In addition, due to lower complications of the ultrasound guided technique versus the conventional technique, the ultrasound technique is a reliable method considering patient safety and therefore this technique is recommended.

An important point which was not considered in this study, was the comparison of the cost of the aforementioned methods and also the investigation of the learning curve in the ultrasound method.

Considering the cost of the two different methods, study of the cost regarding the economics of treatment, cost-effectiveness and acceptance by the insurance system can be of help.

Besides, study of the learning curve and teaching radiology and surgical residents to simultaneously coordinate the two-dimensional image with the three-dimensional method can be helpful in the field of medical studies and the acceptance of this method among surgeons and radiologists.

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