A comparison of real-time ultrasound-guided method and anatomical landmark technique for subclavian vein catheterization

Fki M., Khoudi R., Charrada H., Mili S., Fareh K., Benali M.

Background and goal of study:

Several meta-analysis and recent clinical practice guidelines strongly support ultrasound guidance (USG) when inserting through the internal jugular vein (IJV) [1]. However, there are few data on the potential advantages of the use of USG for subclavian vein (SCV) catheterization. The aim of this study was to determine whether USG of SCV catheterization reduces catheterization failures and adverse events compared to the traditional “blind” landmark method (LM).

Material and methods:

After approval from the local Ethics Committee. We conducted a prospective randomized study from January to June 2015. Patients requiring a central venous catheter placement (CVC) in non emergent conditions were randomly allocated into 2 groups: real-time USG SCV catheterization according to the longitudinal approach (Group US) and anatomical LM method (Group LM). The non inclusion criteria were the presence of a coagulopathy or the vein thrombosis. All procedures were performed by the same novice operator. The primary outcome parameter was the catheterization success rate (SR). The number of attempts, the number of redirections (N-RE), the access time, and catheterization-related mechanical complications were recorded. Chest X-ray scans were used to evaluate the position of the catheter tip and pneumothorax, ultrasonography to evaluate hematoma. Statistical analysis was performed using IBM SPSS 20. Normal distributions continuous variables were compared using Student t-test .Mann-Whitney U test was used for continuous variables without normal distribution.

Results:

70 patients were included, 35 in Group US and 35 in Group LM .There were no significant differences between groups in age, gender, body mass index (BMI) and side of catheterization.

Table 1 : Patients’ characteristics and Clinical Features

	Group LM	Group US	P
Age (years) ^a	44 ± 18	48 ± 20	NS ^b
Sex (M/F)	26/9	26/9	NS ^c
BMI			
>30	4 (11,4%)	7 (20%)	NS ^c
< 30	31 (88,6%)	28 (80%)	NS ^c
Side (Right/Left)	15/20	16/19	NS ^c

^a Mean±SD ; NS : not significant ; ^b Student t-test ; ^c Fisher’s exact test

Success rate of SCV catheterization was 100% in Group US versus 85.7% in Group LM (p=0.54). Success rate was significantly higher in the obesity subgroup US (100%) than obesity subgroup LM (25%) with p=0.024. the success rate in the first attempt was significantly lower in Group LM (40% versus 82.9% in Group US; p=0.000). Other results were expressed in Table 2. The evolution of the access time in terms of the patients’ rank showed a significant learning curve in the US group (r²=0.5854; p=0.00022), however, in the LM group this relation was weak (r²=0.24; p=0.2).

References:

[1] Intensive Care Med 2012;38(7):1105–17 [2] Crit Care Med 2011;39(7):1607–12 [3] N Engl J Med 1994;331(26):1735–8 [4] Crit Care 2006;10(6):R162 [5] Br J Anaesth 1999;82(6):822–6 [6] Crit Care Med 2015;43(7):1498–507 (7) Am J Emerg Med 2013;31(3):478–81 [8] Am J Emerg Med 2010;28(3):343–7 [9] Crit Care Med 2015;43(4):832

Table 2. Outcome measures in the ultrasound group vs. the landmark group of patients

	Group US	Group LM	p
SR	100%	85,7%	0,054 ^b
SR in Subgroup Obesity	100%	25%	0,024 ^b
SR in the first Attempt	82,9%	40%	<10-3 ^b
Number of Attempts ^a	1[1-1]	2[1-4]	<10-3 ^c
Incidence of redirection of the needle	14,3%	68,6%	<10-3 ^b
N-RE ^a	0[0-0]	2[0-5]	<10-3 ^c
Access time(s) ^a	19[14-40]	48[15,75-70,25]	0,028 ^c
Complications rate	5,7%	37,1%	0,001 ^b
Arterial Puncture	0	14,3%	0,54 ^b
Hematoma	0	25,7%	0,002 ^b
Pneumothorax	0	5,7%	0,493 ^b
Malposition	5,7%	2,9%	1,00 ^b

^aMedian(25th percentile-75th percentile);^bfisher’s exact test;^cMann-Whitney U test.

Discussion:

Our results are comparable to those of previous studies (2). In fact, USG is associated with higher success rate with less manipulations and lower complication rate.

We should take in consideration the parameters evaluating manipulation because Mansfield (3) concluded that failure rate increases with the number of attempts (1.6% after one attempt, 10.2% after two attempts and 43.2% after three attempts). Also, Karakitsos (4) established a significant relation between the number of attempts and related-line sepsis.

Our observations showed that ultrasound-guidance in case of difficult catheterization (obesity is the mean example in our study) would be of particular benefit from its value in more general populations of patients. These findings are supported by the study of Hatefield (5) in which he assesses the usefulness of ultrasound-guidance in 33 patients presenting various risk factors of difficult catheterization.

A recent meta-analysis (6) concluded that these benefits are provided by real time 2D ultrasound-guidance (the method that we used) in comparison with other forms (static ultrasound-guidance or Doppler) especially in terms of success rate.

From a technical point of view we adopted the longitudinal approach to UG SCV catheterization. We should notice the great contribution of this approach to have such results. Compared with the transverse one, this technic enables the operator to visualize the needle, including its tip, in its entirety from entry into the skin until vessel puncture. So, the long-axis approach would be associated with greater first-attempt success, fewer needle redirections (7), and lower complication rate (8) notably less arterial puncture and posterior wall penetration (which could cause pneumothorax) (9).

According to the experience conducted, the learning curve depends of the ability to identify the sonoanatomic structures but mostly the ability to keep both the curved vessel and the entire length of the needle in plane of the ultrasound.

This study exhibits several limitations. The lack of the operator’s experience may influence results but it allowed us to assess the learning curve for each method. Also, late complications (infection, thrombosis) were not evaluated as it wasn’t the aim of this study.

Conclusion:

Real-time USG infraclavicular SCV catheterization is more effective than the traditional LM technique with best success rate and less rate of complications. This technic is easy to learn so it allows the non-experimented operator to be quickly efficient.

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