J Surg Med. 2019;3(8):553-556.
DOI: 10.28982/josam.596891

Research article
Araştırma makalesi

Journal of Surgery and Medicine
e-ISSN: 2602-2079

Ultrasonographically marked catheterization of internal jugular vein in intensive care patients: Retrospective cohort study

Yoğun bakım hastalarında ultrasonografi kılavuzluğunda internal juguler venin kateterizasyonu: Retrospektif kohort çalışma

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Ethics Committee Approval: Ethics committee approval was received from the ethics committee of Kecioren Research and Training Hospital Clinical Research Ethical Committee, 13.04.2016, 2012-KAEK-15/1111.
Etik Kurul Onayı: Etik kurul onayı Keçiören Eğitim ve Araştırma Hastanesi Klinik Araştırma Etik Kurulundan alındı, 13.04.2016, 2012-KAEK-15/1111.

Conflict of Interest: No conflict of interest was declared by the authors.
Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Financial Disclosure: The authors declared that this study has received no financial support.
Finansal Destek: Yazarlar bu çalışma için finansal destek almadıklarını beyan etmişlerdir.

Published: 8/9/2019
Yayın Tarihi: 09.08.2019

Abstract

Aim: This study was designed to compare the method of internal jugular vein (IJV) catheterization with prior ultrasonographic (USG) skin marking with the conventional method regarding the performance of a less experienced practitioner in learning ultrasonographic manipulation and safely performing the cannulation.

Methods: The records of patients admitted to the Intensive Care Unit of Ataturk Chest Diseases and Chest Surgery Research and Training Hospital between April and September 2018 were retrospectively examined. 14 female and 26 male patients (n=40) whose IJV cannulations had been performed with the two above-mentioned methods were included in the study. The practitioner was theoretically trained by an experienced radiologist before the cannulation.

Results: The success rate was 65% in the conventional group and 95% in the USG skin-marked group; the difference was statistically significant (P=0.019). The mean time from the first entry of the needle to the skin to the placement of the catheter in successful cannulations in conventional and USG-marked methods were 110.6 (25.6) and 121.6 (28.3) seconds, respectively. There was no statistically significant difference (P=0.22).

Conclusion: This study shows that educating the inexperienced practitioner about the use of USG in IJV cannulation and successful application of skin marking method is important.

Keywords: Ultrasound, Internal jugular vein cannulation, Intensive care

Öz

Amaç: Bu çalışma, ultrason (USG) manipülasyonu öğrenen ve güvenli bir şekilde internal juguler ven (IJV) kanülasyonu yapan daha az deneyimli bir uygulayıcının performansı bakımından IJV'in işlem öncesi USG ile işaretlenmesi ile konvansiyonel yöntemin karşılaştırılması amacıyla düzenlendi.

Yöntemler: Çalışma, retrospektif olarak Atatürk Göğüs Hastalıkları ve Göğüs Cerrahisi Eğitim ve Araştırma Hastanesi Yoğun Bakım Ünitesinde Nisan ve Eylül 2018 tarihleri arasındaki kayıtların çalışılması ile yapıldı. Uygulayıcıya deneyimli bir radyolog tarafından teorik eğitim verildi. Toplamda 40 hastanın (14 kadın ve 26 erkek) IJV kanülasyonu iki farklı yöntemle gerçekleştirildi.

Bulgular: Konvansiyonel grupta başarı oranı %65 ve USG cilt-işaretli grupta %95 olup, fark istatistiksel olarak anlamlıydı (P=0.019). İğnenin cilde ilk giriş anından kateterin yerleştirilmesine kadar geçen ortalam süre sırasıyla 110.6 (25.6) ve 121.6 (28.3) saniye idi. İki grup arasında istatistiksel olarak anlamlı bir fark yoktu (P=0.22).

Sonuç: Bu çalışma, deneyimsiz bir uygulayıcıya IJV kanülasyonunda USG ve cilt işaretleme metodunun kullanımı konusunda eğitim vermenin önemli olduğunu göstermiştir.

Anahtar kelimeler: Ultrason, İnternal juguler ven kanülasyonu, Yoğun bakım

How to cite / Atıf için: Menteş O, Cırık MÖ, Ünver M, Avcı S, Doğanay G, Alagöz A. Ultrasonographically marked catheterization of internal jugular vein in intensive care patients: Retrospective cohort study. J Surg Med. 2019;3(8):553-556.

Introduction

Internal Jugular Vein (IJV) cannulation, a central venous catheterization (CVC) method, is frequently preferred for hemodynamic monitoring, long-term fluid and antibiotic therapy, total parenteral nutrition and hemodialysis in intensive care unit (ICU) patients [1]. The puncture of IJV using anatomical landmarks has been described in many articles since 1966 [2-5]. Recently, IJV cannulation with ultrasonographic (USG) guidance has become a widely used method in ICUs and studies have reported that it is significantly superior to traditional anatomical marking techniques [1].

The steps of the conventional method in internal jugular vein catheterization are as follows: 1) Extend the patient's neck 2) Palpate the carotid artery and mark a triangle with clavicle and sternal leg of the sternocleoidomastoid muscle 3) Puncture the skin with the needle at a 30-40^o angle to the apex of this triangle while palpating the carotid artery with the free hand 4) Insert the needle in this direction. Nowadays, we use USG in ICUs for real time demonstration of CVC, but this method may cause a waste of time during emergencies. The risk of complications related to practitioner experience is an important concern.

In this study, we compared the method of internal jugular vein (IJV) catheterization with prior USG skin marking with the conventional method regarding the performance of a less experienced practitioner in learning USG manipulation and safely performing the cannulation.

Materials and methods

Ethics Committee and Study Protocol Approval (05/12/2018, App. No: 612) were obtained from Ankara Ataturk Chest Diseases and Chest Surgery Research and Training Hospital Ethics Committee and Medical Specialization Training Board. In this case-control study, the records of patients admitted to the Intensive Care Unit of Anesthesiology and Reanimation Clinic in Ataturk Chest Diseases and Chest Surgery Research and Training Hospital between April and September 2018 were retrospectively examined. The practitioner, a single physician lacking enough experience, who had previously performed IJV cannulation, was a pulmonology specialist within his first year in the ICU minor certification program as an intensive care resident with no previous experience of USG. The practitioner was given theoretical training on CVC and USG before the procedure. In addition, at least 8 hours of USG training practice of the vascular anatomy of the neck was held by an experienced radiologist. A total of 40 patients whose IJV cannulations had been performed with two different methods were randomly selected, divided into two groups of 20 patients and retrospectively studied. Only one method was used for each patient. Catheterization procedures were all carried out under the supervision of an experienced practitioner. In case of failure of IJV catheterization after three attempts or complication occurrence during catheterization, the supervising practitioner carried on with the procedure. Patients who were evaluated by the same practitioner were included in the study and randomized. Informed consent forms signed by the patients or their relatives if they were unable to give consent were obtained. Patients' necks were rotated 30^o to the contralateral side of the cannulation in Trendelenburg position before the procedure and this position was held throughout the catheterization process.

The conventional method involved IJV cannulation by using anatomical landmarks, without the help of USG marking. Sedation and analgesia were used while adhering to proper sterilization conditions. The common carotid artery pulse was palpated and skin above the common carotid artery was slightly retracted medially to make lateral puncturing possible.

In the USG-assisted method, the anatomical relationship between IJV and common carotid artery was evaluated; the distance to skin and variations were recorded with the USG device (SL1543 model 13-4 MHz linear probe Esaote® MyLab ™ Six). Using the edges of a linear probe, the puncture points and direction in the short (Figure 1) and long axes (Figure 2) of IJV were determined and marked with a wipe-resistant surgical marker pen (Figure 3). Then, IJV was cannulated in accordance with proper sterilization conditions considering this pen-mark only. Sedation and analgesic agents were used. Following both blind and USG-marked catheterizations, the cannula locations of patients were evaluated with USG (Figure 4).

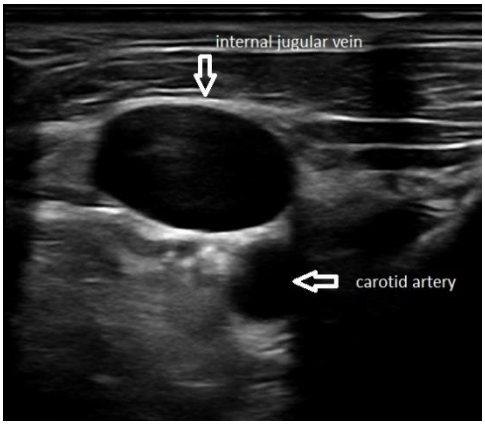

Figure 1: The puncture point in the short axis image of the IJV with USG

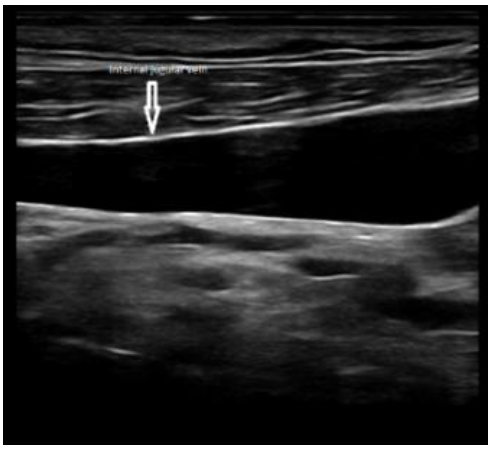

Figure 2: The long axis image of the IJV with USG

Figure 3: The puncture direction was marked with a surgical pen

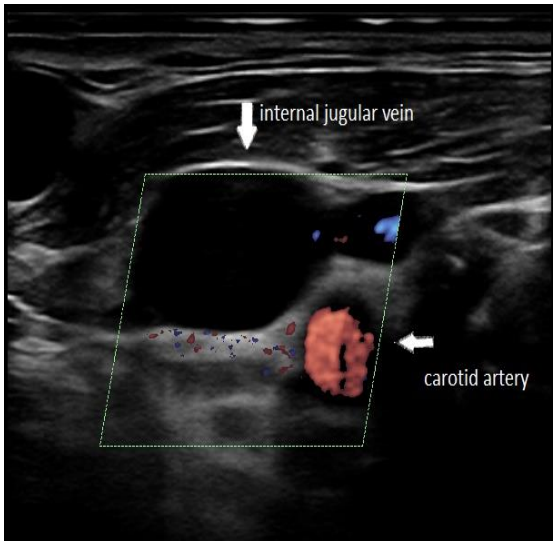

Figure 4: The cannula location of patient was evaluated with USG

TUORen® Central Venous Catheter Set and 18 G Y type introducer needle were used for puncturing. Also found within the set were a 0.035-inch in diameter and 60 cm long Nickel Titanium guide and a 7F 3-lumen catheter, which were used during catheterization. Age, gender, body mass index, international normalized ratio (INR) and platelet counts of the patients, the success and complications of the procedures, anatomical localization of IJV, the distance of the IJV to the skin, the time from insertion of the needle into the skin to the catheter placement and the number of punctures were recorded. Patients with INR >1.5 and/or platelet count <50.000/mm³, patients who did not accept the procedure or refused to sign the CVC consent form, those with skin diseases, anatomical defects, abscesses or active infections in the neck were excluded from the study.

Statistical analysis

Power analysis was based on the success rate differences of the groups in similar studies in the literature and a minimum sample size of 20 patients per group was calculated for 80% power and 0.05 type-I error. The confidence interval of this analysis was 34%. The data regarding the success rates between the two groups in this study were compared with Student T-test using SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.) for Windows. Regression analysis was performed to determine whether body mass index and IJV depth were correlated. A *P*-value less than 0.05 was considered statistically significant.

Results

A total of 40 patients, 14 females and 26 males, were included in this study. Gender distribution was equal among groups. The mean ages of the group who underwent USG-assisted skin marking and the conventional group were 71.8 (9.4) and 71.3 (8.2) years, respectively. 39 of the patients' right IJVs were cannulated while 1 patient, who underwent left pneumonectomy had their left IJV catheterized.

IJVs of 80% of the patients in this study were located anterolateral to the common carotid artery, in accordance with the literature. 20% of the patients' IJVs lied anterior to the common carotid artery.

The average distance of IJV to skin in male and female patients in the USG-marked group were 7.3 (2.7) mm and 7 (3.2) mm, respectively. This difference was not statistically significant (P=0.48). The successful IJV catheterization rate of the USG-marked group was significantly higher (95%) than the conventional group (65%) (P=0.019).

The mean time from the first entry of the needle to the skin to the placement of the catheter in successful cannulations in conventional and USG-marked groups were 110.6 (25.6) and 121.6 (28.3) seconds, respectively. There was no statistically significant difference (P=0.22).

Simple linear regression analysis showed that increased BMI was significantly correlated with deeper-probed IJV (P=0.034). In both methods, minimal hematoma was seen with complication rates close to 15%. No further complications occurred.

Discussion

In this study, we compared the success rates of USG-assisted skin marked IJV catheterization method with the conventional technique as performed by an inexperienced practitioner. In a similar study involving newborns, USG-assisted skin-marking method had similar success and complication rates, which suggested that this method was applicable in the adult patient group [6]. IJVs of 80% of the patients in this study were located anterolateral to the common carotid artery, in accordance with an anatomic variance study. [7]. In addition, the distances from the IJV to the skin were similar in females and males.

Conventional IJV cannulation is known to be more difficult due to the narrowness of the area, more difficult palpation of carotid pulse and vagueness of anatomic landmarks in the neck in patients with increased BMI. Although a study has detected no significant difference between obese and non-obese patients in terms of IJV cannulation success, the puncture rates of common carotid artery were reported higher in obese patients and USG use for IJV cannulation was recommended [8]. In our study, we found that the distance of IJV to the skin increased with BMI. Therefore, when IJV cannulation is planned in obese patients, we recommend using prior or concurrent USG for the procedure.

In our study, the success of IJV cannulation was significantly higher in the USG-marked group as compared to the conventional one. There was no significant difference between the two groups in terms of procedure times. However, since the duration of the procedure includes the time between the needle contact with the skin and the placement of the cannula, we can foresee that the procedure will take longer in the USG-marked group if the pre-procedural USG imaging and marking time is added. Therefore, we believe that USG marking method is not suitable for patients requiring urgent central vascular access. In a study performed by Hideaki and Amano [9], IJV was localized prior to catheterization using the USG-skin marking method in one group and jugular venodilation method in the other. They reported that USG imaging had no contribution to cannulation success, but it was helpful when IJV could not be localized by venous jugular venodilation. Regardless of the level of experience, considering the anatomical variations of the IJV, USG use may become mandatory in IJV catheterization of some patients.

Limitations

This study was designed retrospectively, and all data of the patients could not be obtained. The cannulation was performed by a single practitioner; who eliminated factors depending on the practitioner. Comparing the success rate of one practitioner with different methods may prohibit comparison of different experiences. In our opinion, further research comparing cannulation methods among different practitioners with similar experiences would be beneficial.

Conclusion

In the literature, many studies can be found on IJV cannulation. However, we believe that this study regarding the use of USG in IJV cannulation and the successful application of the skin marking method by an inexperienced user is different and educational. Along with other studies, we believe that the comparison of concurrent USG cannulation of IJV with the conventional and USG-skin-marking methods by intensive care residents with limited experience will contribute to shaping central venous cannulation training.

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This paper has been checked for language accuracy by JOSAM editors.
The National Library of Medicine (NLM) citation style guide has been used in this paper.

Suggested citation: Patrias K. Citing medicine: the NLM style guide for authors, editors, and publishers [Internet]. 2nd ed. Wendling DL, technical editor. Bethesda (MD): National Library of Medicine (US); 2007-[updated 2015 Oct 2; cited Year Month Day]. Available from: http://www.nlm.nih.gov/citingmedicine