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Modification of the technique for subclavian-vein catheterization

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ABSTRACT

Introduction. In invasive monitoring, subclavian-vein puncture is a routine procedure indicated for central vein cathe-terization. It is indicated in patients according to hospital stay, including the administration of drugs and the treatment of chronic and cardiac disease. The techniques described to date include infraclavicular percutaneous puncture; others place catheters using angiographic methods, and the use of magnetic resonance imaging and ultrasound has also been reported. Studies have been done in cadavers to get a better understanding of the procedure since the relationship between vascular elements and surrounding tissues are obtained. The usual technique is with the patient in Trendelenburg position, with the arm in adduction, the placement of an interscapular roll, and the head turned away from the puncture site. **Objective.** The aim of this study was to demonstrate less frequent technical failures and complications using a modification of the usual technique. We propose catheterization of the right subclavian vein with the patient in decubitus, without an interescapular roll, with the arm in abduction and using the distal third of the clavicle and the suprasternal notch as anatomical references. **Results.** Two technical puncture failures and three complications occurred in a total of 42 patients with a statistically significant difference (p = 0.0410) in frequency (11.9%) from that reported with the traditional technique (21.8%). **Conclusions.** Greater efficacy with the technique modified by the authors was confirmed. Anatomical cadaver dissections showed a greater space between the right subclavian vein and the clavicle.

Key words. Catheterization. Veins. Right subclavian vein.

Modificación de la técnica para la cateterización de la vena subclavia

RESUMEN

Introducción. *En la monitorización invasiva la punción de la vena subclavia constituye un procedimiento de rutina ante el requerimiento de una cateterización venosa central. Está indicada en los pacientes de acuerdo al tiempo de permanencia hospitalaria, incluyendo la administración de medicamentos y tratamiento en padecimientos crónicos y cardiacos. Las técnicas descritas hasta ahora refieren una punción infraclavicular percutánea, otras colocan el catéter con apoyo de medios angiográficos y también reportan el uso de imagen por resonancia magnética y de ultrasonido. Se han realizado estudios en cadáver para una mejor comprensión del procedimiento al obtener las relaciones de los elementos vasculares con los tejidos que los rodean. La técnica habitual es con el paciente en posición de Trendelemburg, el brazo en aducción, un cojín ínter escapular y la cabeza en rotación contra lateral al sitio de la punción.* ***Objetivo.*** *El presente estudio tuvo como objetivo demostrar una menor frecuencia de fallas técnicas y de complicaciones, mediante una modificación a la técnica habitual. Se propone la cateterización de la vena subclavia derecha con el paciente en decúbito dorsal, sin cojín ínter escapular, el brazo en abducción y tomando como referencias anatómicas el tercio distal de la clavícula y al hueco supraesternal.* ***Resultados.*** *Se encontraron dos fallas técnicas de punción y tres complicaciones en un total de 42 pacientes diferenciándose esta frecuencia (11.9%) en forma estadísticamente significante (p = 0.0410) de la reportada con la utilización de la técnica tradicional (21.8%).* ***Conclusiones.*** *Se comprobó una mayor eficacia con la técnica modificada por los autores. Las disecciones anatómicas en cadáver, demostraron un mayor espacio entre la vena subclavia derecha y la clavícula.*

Palabras clave. *Cateterización. Venas. Vena subclavia derecha.*

INTRODUCTION

Catheterization of the subclavian vein is a clinical procedure that was introduced by Aubaniac in 1952 using an infraclavicular approach.[1] It is a common method practiced on inpatients, when necessary, according to their clinical status. Some other authors describe the axillary vein approach through the pectoral muscles as a catheterization method.[2-8] The use of ultrasound to identify the path of the subclavian vein and mark the puncture site on the skin surface as well as Doppler ultrasound placing the patient in different positions has been reported.[9,10] Others have developed an ultrasonographic study of the axillary vein placing electrodes to obtain cross-sectional images of the blood vessel. Also, with the support of cadaveric anatomical dissections, the subclavian vein puncture procedure has been optimized by identifying the elements related with blood vessels.[11,12] In the usual technique, the Trendelenburg position with the arms on the side of the body and placement of a roll between the scapulas is recommended to facilitate needle insertion.

Mansfield et al (1994)[13] refer a complication and failure rate of 21.8%. Based on anatomical findings we propose a modification of the usual technique to decrease this frequency.[11]

Reyes (2007)[11] asked residents to practice punctures on cadavers to improve precision and decrease complications and failures.

By evidencing the anatomical relationships in a dissection, we can demonstrate that modifying the technique by placing the arm in abduction, the vessels move 1.5 cm caudally from the clavicle. This exposure of the blood vessels will decrease the failures and complications that occur. This anatomical finding was corroborated by the authors in ten dissections with the described displacement of the blood vessels. The dissection procedure is described in the material and methods section.

Objective

Our objective was to compare the efficacy of a modification of the usual technique to decrease technical failures and complications. We defined the placement of the catheter through the subclavian vein in any place other than its final position in the right atrium as a technical failure. A complication was the morbidity caused by the result of performing a puncture and damaging any adjacent tissue.

Hypothesis

There is a statistically significant difference in the relative frequency (percentage) of technical failures and complications between the usual technique for subclavian vein access described in the literature and our proposed technique.

Null hypothesis

There is no statistically significant difference in the relative frequency (percentage) of technical failures and complications between the usual technique for subclavian vein access described in the literature and our proposed technique.

MATERIAL AND METHODS

This study was reviewed and authorized by the Ethics Committee of the School of Medicine and the Dr. Jose E. Gonzalez University Hospital of the Autonomous University of Nuevo Leon, code number AN08-001. An n of 42 patients of both sexes was calculated, 20 men and 22 women were recruited from the Dr. Jose E. Gonzalez University Hospital after previous informed consent.[14-17] The age range

Table 1. Patient data

Sex (%)	Age (yrs)	Weight (kg)
Women (52)	18 – 83	46 – 90
Men (48)	18 – 84	50 – 105

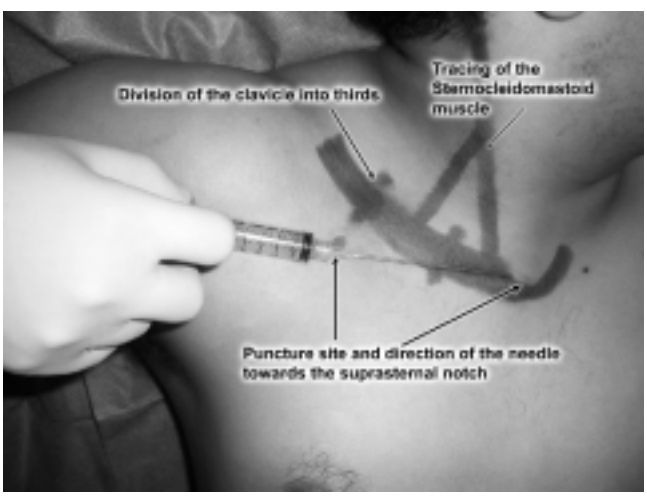

Figure 1. *Division of the right clavicle into three thirds, the subclavian vein is punctured with the needle directed at the jugular notch of the sternal manubrium at the site where the middle third joins the lateral third.*

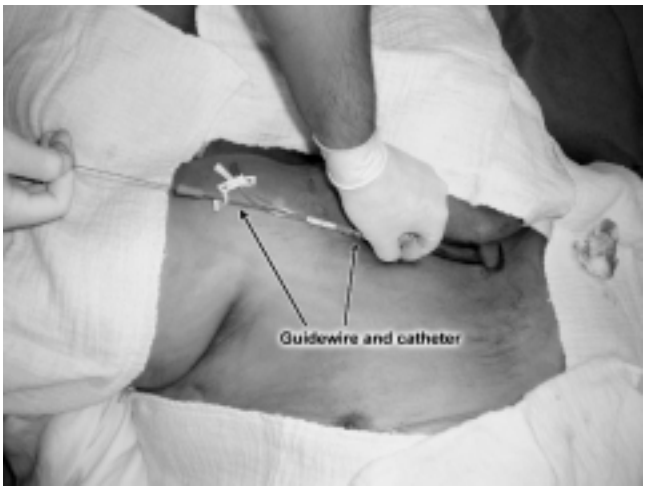

Figure 2. *The guidewire is slightly withdrawn and the catheter placed in the right subclavian vein.*

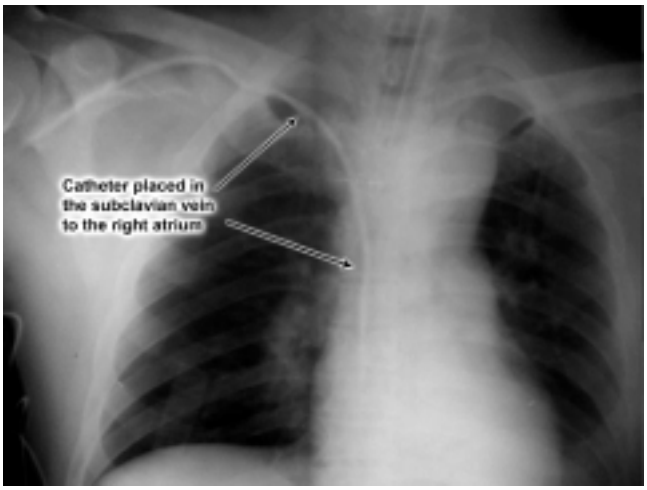

Figure 3. *Confirmation by radiographic imaging of the placement of the catheter in the right subclavian vein down to the right atrium of the heart.*

was 18 to 84 years with a median of 48.5 years (Table 1). Inclusion criteria included patients of both sexes that entered the operating room of the University Hospital who, because of their clinical status, required placement of a central venous catheter. Previous neck, upper thorax, shoulder or clavicle surgeries were considered exclusion criteria. The technique consisted of placing the patient in the dorsal decubitus position with abduction of the right arm at a 90º angle with relation to the body axis with the purpose of increasing the distance between the right subclavian vein and the clavicle. After asepsis of the region with iodopovidone (Figure 1), the borders and the three portions of the clavicle were drawn on the skin pointing out the point where the middle third joins the lateral third, marking a point one centimeter caudally where the puncture is made with a 16-gauge trocar towards the suprasternal notch (Figure 2). Intravenous placement was confirmed by slightly aspirating the syringe, followed by placement of a guidewire using the Seldinger technique (1953),[18] empirically confirming placement of the guidewire in the heart by observing rhythm changes on the EKG. Radiographic control of the position of the guidewire was performed and afterwards a #14 radio-opaque catheter placed. Definite position was confirmed with a chest X-ray (Figure 3). Procedure success was considered if an effective puncture was carried out on the first pass, if the catheter was located in the right atrium, its function of measuring the central venous pressure was achieved, and if there were no complications. A technical failure was defined as having performed two and up to three effective punctures, the catheter was not in place, the catheter was not in the subclavian vein or the right atrium, and it did not measure central venous pressure. Arterial puncture, pneumothorax, hemothorax, mediastinal hemothorax, and others were considered complications.

Anatomical dissection in the cadaver

Anatomical dissections were carried out on 10 cadavers fixed with a formol, alcohol and glycerine solution. These were placed in a supine position and dissection of the upper thorax was carried out by planes. The right subclavian vein, lateral and anterior to the scalenus anterior muscle over the first rib and beneath the clavicle was identified, as well as the second and third portion; their relationship with the brachial plexus and the artery were described. The clavicle was divided into three portions, medial, middle and lateral; measures were taken from the lower border of the clavicle at the point where the middle third joins the lateral third to the subclavian vein. Dissection by planes was done separating the skin from the subcutaneous tissue, identifying and removing the pectoralis major muscle from its clavicular insertion. When separating the pectoralis major muscle, the tissue surrounding the subclavian vessels was dissected until the vein and artery as well as the nerves of the brachial plexus were identified. The relationship between the subclavian vein, the homonymous artery and nerves of the region with the arm in abduction as well as adduction were analyzed (Figures 4 and 5). Modification of the blood vessels with movement of the arm in abduction as the best option

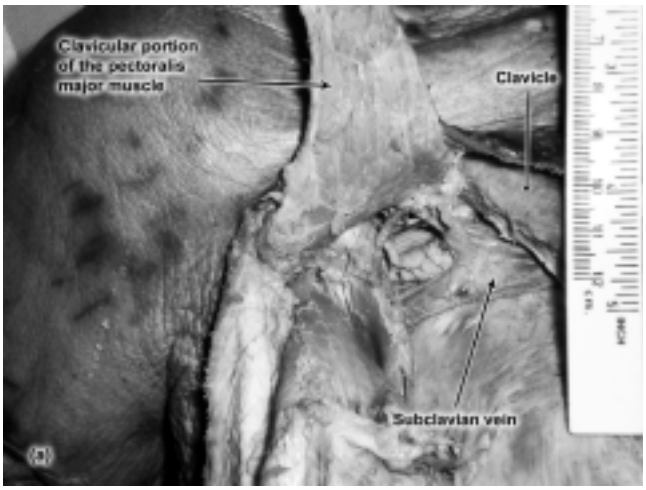

Figure 4. *Measures of the distance between the lower border of the right clavicle and the midline of the wall of the subclavian vein, which was 0.5 cm with the arm in adduction.*

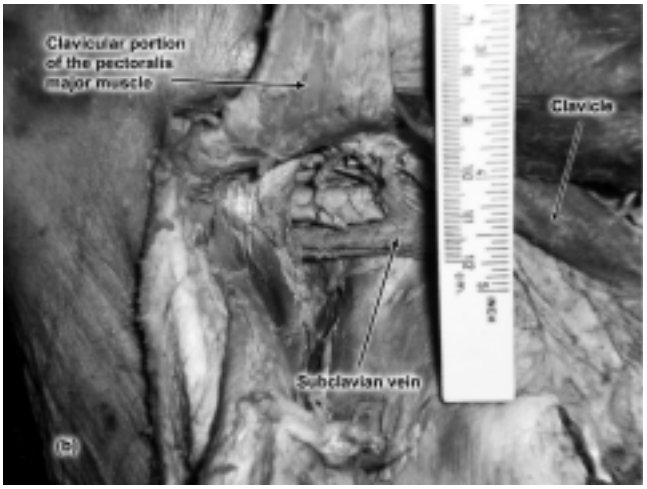

Figure 5. *Measures of the distance between the lower border of the right clavicle and the midline of the wall of the subclavian vein, which was 1.5 cm with the arm in abduction.*

for exposing the subclavian vein for puncture was observed (Figure 6).

RESULTS

Of the 42 patients included, we attempted 50 right subclavian vein punctures with three complications and in two cases we were not able to enter the vessel (Table 2). The complications that occurred were hemopneumothorax in one case of subclavian artery puncture. We observed that the arm in abduction was below the level of the body axis and that after correcting the arm position, the catheter entered the right subclavian vein.

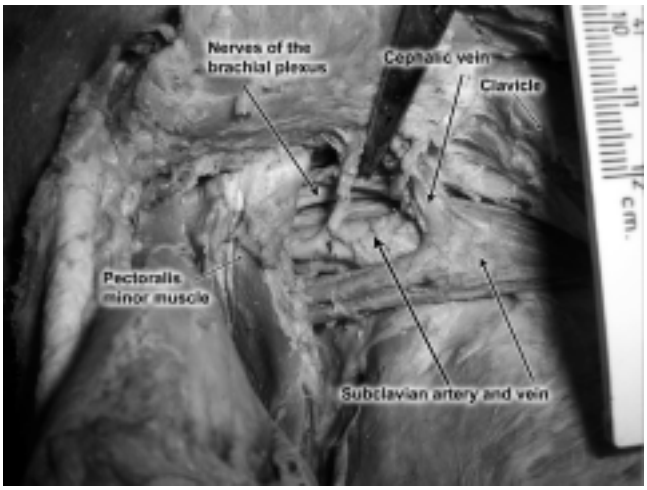

Figure 6. *Dissection of the right side with greater amplification to show the relationship of the subclavian vein with the distance it maintains with the clavicle with abduction of the arm.*

Table 2. Absolute and relative frequencies of complications and technical failures.

Complications	3 of 42	0.071
Technical failures	2 of 42	0.047
Total	5 of 42	0.118

The patient was managed with thoracic drainage after thoracotomy with only subclavian artery laceration being observed. The patient evolved satisfactorily. In the other two cases, the subclavian artery was punctured without complications and we carried out a right internal jugular vein approach. In two other patients, the vessel was not located after three attempts, so a right internal jugular vein approach was done.

There were five technical failures and complications in 42 patients (11.9%). When we compared the results in our study with the total amount of complications and technical failures reported by Mansfield et al (21.8%), we found that there was a statistically significant difference ($p = 0.000019$). These data are of complications and technical failures that occurred without ultrasound guidance. This same author states that using ultrasound complications and technical failures are 22.1%, which differs statistically from our results ($p = 0.000011$) Mansfield states that out of 821patients, they had 47 complications and 105 that were not catheterized or out of place for a total of 152, which is 18.5%; this differs significantly from the 11.9% found in our study ($p = 0.000066$).

DISCUSSION

Puncture of the subclavian vein is a routine procedure performed when central vein catheterization is indicated.[13,19,20] Some studies recommend the Trendelenburg position with placement of an interscapular roll with the shoulder in adduction in a neutral position during venous puncture.[1,16,19,21] Other authors describe puncture of the subclavian vein with the shoulder in adduction, but 5 cm caudal to the neutral position.[22] There are descriptions that point out that anatomical knowledge is essential to facilitate the approach of the subclavian vein to avoid complications.[23-25] One study of the consistency of the anatomical position and caliber of the subclavian vein in anatomic dissections in cadavers demonstrates the valid indication of cutaneous venous puncture instead of venous cutdown for placement of a central venous catheter.[15]

Our study showed a statistically significant lower frequency of technical failures and complications using a modification of the usual technique, without the Trendelenburg position or the interscapular roll, with the arm in abduction to enter the right subclavian vein with ease during central catheter placement in 40 patients, which represents an efficacy of 95%, considering the relationship between the subclavian vein and the clavicle and the other vascular-nerve elements of the area.[14,16]

Anatomical study in cadavers demonstrated the change of position of the right subclavian vein with the arm in abduction, with regard to its direction as well as its relation to the clavicle and the homonymous artery and the nerves of the brachial plexus. We observed that the clavicle moves in a cephalic direction with the arm in abduction, separating itself 1.5 cm from the subclavian vein, creating a space without bony obstacles; also the subclavian vein moves away from the artery and the nerves of the brachial plexus when it moves anteriorly towards the anterior scalenus muscle.

This facilitates subclavian vein puncture. Practice in cadavers is recommended to obtain better regional, and above all, three-dimensional location of structures that can not be obtained with imaging studies used for this technique. The possibility that the unequal position of the arm with regard to the body axis as the cause of the complications mentioned was corroborated in dissections performed on cadavers when position changes were carried out.

The difficulty we encountered when comparing our results with the literature was the definition of complications and technical failures, which differ from other authors. This motivated us to compare the total of complications and technical failures found in our study with the total reported by other authors. When the studies reported in the literature did not mention this total, we carried it out to compare them with our results. Other procedures include puncture with ultrasound guidance; we compared the technical failures with this procedure with our study and found a statistically significant difference. With regard to learning the technique, each and every puncture was carried out by a third year anesthesiology resident. Even though we did not analyze this point, the small amount of complications and technical failures of the proposed technique lead us to recommend the procedure with the hope that better results will be obtained with more experience.

CONCLUSIONS

The hypothesis is accepted since a minor difference in the relative frequency of technical failures and complications when modifying the usual technique was found.

The study of cadavers proved the results by showing the anatomical relationships of the right subclavian vein with the arm in adduction and abduction.

The authors propose the use of the modified technique for punctures of the right subclavian vein, as well as the practice of anatomical dissection to obtain a three-dimensional image of the area.

ANNOTATION

This study was approved by the Ethics Committee of the University Hospital, code number AN08-001.

The authors report that they have no conflict of interest in the present study.

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