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Original Contribution

Finger width as a measure of femoral block puncture site: an ultrasonographic anatomical-anthropometric study☆

Vedran Frković MD, DESA, EDRA[a,1], Sebastian K.T.S. Wärmländer PhD[b,c], Anja Petaros MD[d], Iva Španjol-Pandelo MD[e,2], Josip Ažman MD, PhD, DESA, EDRA[a,*]

[a]*Department of Anaesthesiology and ICU, University Hospital Rijeka, Rijeka, Croatia*
[b]*Division of Biophysics, Arrhenius Laboratories, Stockholm University, 106 91 Stockholm, Sweden*
[c]*Division of Commercial and Business Law, IEI, Linköping University, 581 83 Linköping, Sweden*
[d]*Department of Forensic Medicine and Criminalistics, Rijeka University, School of Medicine, Rijeka, Croatia*
[e]*Department of Surgical Pediatrics, Rijeka University Hospital, Rijeka, Croatia*

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Abstract

Study objective: Femoral nerve blockade is a regional anesthetic procedure that may be used in prehospital and emergency settings in cases of femoral trauma. Its speed and performance depend on how well the puncture site can be accurately located, something that usually is achieved via visible landmarks and/or by combining various universal preestablished measurements. Most of these methods have been derived from cadaver studies, which often suffer limitations in clinical settings. To facilitate a quick and easy determination of the puncture site, we here attempt to find an in vivo anthropometric measure that closely corresponds to the distance between the femoral artery and femoral nerve.

Design: This is a prospective observational study.

Patients: The study includes 67 patients presenting for elective surgery.

Measurements: The distance from the femoral nerve to the femoral artery, projected to the skin, was measured by a 13-MHz ultrasonographic linear probe. Anthropometric measurements of the width of the hand fingers were carried out at the distal interphalangeal joints.

Results: The distance from the femoral artery to the femoral nerve projected to the skin was found to closely correspond to the width of the fifth finger of the dominant hand measured at the distal interphalangeal joint.

Conclusion: Because it relies on individual anthropometric information, this finding offers an individualized approach to determining the puncture site in a given patient. We believe that such an approach can improve and simplify femoral nerve blockade procedures in prehospital and emergency settings.

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* Corresponding author at: Department of Anaesthesiology and ICU, Rijeka University Hospital, Tome Strižića 3, 51000 Rijeka-HR, Croatia. Tel.: +385 98 878 372.

E-mail addresses: vfrkovic@yahoo.com (V. Frković), seb@dbb.su.se (S.K.T.S. Wärmländer), anja.petaros@yahoo.com (A. Petaros), iva_spanjol_pandelo@yahoo.com (I. Španjol-Pandelo), josip_azman@yahoo.com (J. Ažman).

[1] Present address: Department of Anesthesia and Intensive Care, University Hospital Linköping, 581 85 Linköping, Sweden.

[2] Present address: Department of Surgery, University Hospital Linköping, 581 85 Linköping, Sweden.

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1. Introduction

Femoral injuries and fractures produce significant pain, anxiety, and distress in traumatized patients. This may, among other things, compromise subsequent hospital management. Pain in femoral trauma can be produced by various conditions, such as femoral neck and/or shaft fracture, hip dislocation, patellar tendon rupture, knee trauma, and others [1,2]. Pain and anxiety scores measured after femoral trauma are high and usually score greater than 70 mm on the 100-mm visual analog scale for pain assessment [3]. These patients therefore require a prompt and effective initial pain management, which can be obtained by either systemic or regional analgesia. Femoral nerve blockade has showed to be a reliable alternative to oral/parental analgesia, as it produces less adverse effects and complications and significantly decreases pain and anxiety in traumatized patients [4–6]. Despite being both a reliable and a cost-effective technique, it is still not widely used in prehospital/emergency settings [7–9].

Non-anesthesia practitioners often find regional analgesic techniques to be technically complex and to require vast practice and skill in locating the exact puncture sites [9]. To facilitate provision of quality regional analgesia in prehospital/emergency settings, fast and easily applicable methods for puncture sites prediction are desirable, especially for use when ultrasonography (US) or nerve stimulators are not present. Because femoral nerve blockade is most commonly performed by inserting the needle laterally to the palpable pulse of the femoral artery [10,11], an accurate prediction of the distance between the femoral nerve and the femoral artery (FN-FA distance) could substantially improve the method. Because the femoral nerve and the femoral artery usually do not lie in the same plane, the FN-FA distance projected to the skin (nerve to artery projection [NAp]) may offer better possibilities for locating the puncture site than the actual FN-FA distance measured in 3 dimensions.

The aim of this study is to determine the distance from femoral artery to the femoral nerve, evaluated in relation to some anthropometric measurement that easily can be recorded by any health provider in a prehospital and/or emergency setting. In this study, we investigate the usefulness of the widths of the hand fingers at the level of the distal interphalangeal joints (a body part easily accessible in every setting) in predicting the location of the femoral nerve in relation to the femoral artery.

2. Material and methods

The study has been approved by the University Hospital Ethical Committee of the Rijeka University Hospital, Croatia. The study population included 67 patient (43 men, 24 women), aged between 18 and 98 years (median = 48 years), presenting for elective surgery (Table 1). The height of the subjects ranged from 154 to 197 cm (median, 176 cm), whereas the weight ranged between 48 and 115 kg (median, 78 kg). Body mass index (BMI) ranged from 17 to 32.9 (median, 25), with 2 patients (3%) underweight (BMI <18.5), 31 patients (46%) overweight (BMI 25-29.9), and 6 patients (9%) obese (BMI >30). The research included patients with American Society of Anesthesiologists score between 1 (healthy patients) and 3 (patients with severe systemic disease).

The distance between the femoral nerve and the femoral artery projected to the skin (NAp distance) was measured with a 13-MHz US linear probe (Aloka Prosound-SSD-3500; Aloka Holding Europe AG, Zug, Switzerland) (Fig. 1). The probe was set at the inguinal crease level at a right angle to the patient's vertical axis, with the leg abducted to 5°. No pressure was exerted during the US imaging to reduce the possibility of anatomical alterations due to probe manipulation. For each patient, the widths of the fingers of the dominant hand at the level of the distal interphalangeal joints (distal interphalangeal distance) were recorded with a sliding caliper (Fig. 2). Both the anthropometric and the US measurements were recorded 3 times by a single observer (VF), and the average values were used for the statistical correlation and regression analysis.

3. Results

Nerve-artery distances in the range 8.2 to 20.1 mm (median, 13.3 mm) were observed for the 67 patients (Supplementary Table 1). Correlation coefficients between nerve-artery distance and finger width were calculated for all 5 fingers and were found to range from 0.43 for finger 3 to 0.66 for finger 5 (Table 2).

As the strongest correlation was observed for finger 5, this data set was selected for further statistical analysis. In Fig. 3, the NAp distance vs width of finger 5 (F5w) is plotted for all 67 patients. Regression analysis provides the relation NAp = $0.3 + 0.99 \cdot$ F5w (shown as the solid black line). Many of the outlying data points under the regression line correspond to the 10 patients with lowest BMI (green triangles), and most of the outliers above the regression line correspond to the 10 highest-BMI patients (red squares). Thus, BMI appears to affect the nerve distance/finger width relation, which helps explain the less-than-perfect correlation between the two parameters. Nevertheless, the regression equation is of interest, as the slope of 0.99 is very close to unity. Approximating the slope as unity yields the relation NAp = F5w + 0.3 mm. Here, a distance of 0.3 mm is very difficult to measure in practice, and 0.3 mm is furthermore a small amount compared with the average width of the nerve in

Table 1 Descriptive statistics for the sample consisting of 67 patients (24 women, 43 men).

	Median	Range
Age (y)	48	18-98
Height (cm)	176	154-197
Weight (kg)	78	48-115
BMI	25.0	17.0-32.9