Hypertension Research (2010) 33, 1186–1191

www.nature.com/hr

ORIGINAL ARTICLE

Accuracy of a single rigid conical cuff with standard-size bladder coupled to an automatic oscillometric device over a wide range of arm circumferences

Elisa Bonso, Francesca Saladini, Ada Zanier, Elisabetta Benetti, Francesca Dorigatti and Paolo Palatini

Although the upper arm has the shape of a truncated cone, cylindrical cuffs and bladders are currently used for blood pressure (BP) measurement. The aims of this study were to describe upper arm characteristics and to test the accuracy of a standard adult-size conical cuff coupled to an oscillometric device over a wide range of arm circumferences. Arm characteristics were studied in 142 subjects with arm circumferences ranging from 22 to 45 cm (study 1). In a subset of 33 subjects with the same range of arm circumferences, a rigid conical cuff with standard-size bladder (12.6×24.0 cm) and a rigid cylindrical cuff (13.3×24.0 cm), both coupled to a Microlife BP A100 device, were tested according to the requirements of the protocol of the European Society of Hypertension (ESH; study 2). Study 1. In all subjects, upper-arm shape was tronco-conical with slant angles ranging from 89.5° to 82.2°. In a multiple linear regression analysis, only arm circumference was an independent predictor of conicity ($P<0.001$). Study 2. The rigid conical cuff passed all three phases of the ESH protocol for systolic and diastolic BPs. Mean device-observer BP differences obtained with the conical cuff were unrelated to arm circumference. When the rigid cylindrical cuff was used, ESH criteria were not satisfied, and the cuff overestimated systolic BPs in subjects with large arms. BP can be measured accurately with the use of a standard-size rigid conical cuff coupled to a BP A100 device for a wide range of arm circumferences.
Hypertension Research (2010) **33,** 1186–1191; doi:10.1038/hr.2010.146; published online 5 August 2010

Keywords: blood pressure; conical; cuff; device; measurement

INTRODUCTION

Although the upper arm has the shape of a truncated cone, cylindrical (rectangular) cuffs and bladders are currently used for brachial blood pressure (BP) measurement. However, when the arm circumference near the shoulder is much greater than the arm circumference near the elbow, a cylindrical cuff may challenge the ability of a health care provider to measure BP. In such arms, the elbow end of the cuff remains loose and may extend past the elbow in subjects with short humerus bones. When a large-size cylindrical cuff is inflated, it will expand irregularly over the lower part of a conical arm, making it impossible for a doctor to perform a reliable measurement. This problem is even greater for cuffs made of rigid material, which can barely fit the distal part of a conical arm. In a previous study performed with obese patients, a conical cuff was shown to reflect arterial BP more accurately than standard cylindrical cuffs.[1] However, this problem has been overlooked in the literature, and it is not known what shape and size an optimal cuff should have in order to fit the arms of most subjects. Thus, the aims of the present study were to study the shape of the upper arm in a large sample of subjects with a wide range of arm circumferences and to test a conical cuff potentially suitable for the majority of the subjects. We also evaluated the accuracy of a rigid conical cuff in comparison with a rigid cylindrical cuff, both coupled to a validated oscillometric automatic device (BP A100 model, Bonso *et al.*[2]) in a subsample of the main group.

METHODS

Subjects

Arm characteristics were studied in 142 subjects (of whom 74 were men) aged 58 ± 18 years, with mid-arm circumference ranging from 22 to 45 cm (study 1). This study was designed with the aim of assessing the shape of the arm in a large sample. A validation study was performed in 33 out of these 142 subjects with BPs within the range required by European Society of Hypertension (ESH) rules (study 2). In all, 28 subjects were excluded from the validation study because the BP ranges were complete (n=18), Korotkoff sounds were of poor quality (n=4), the BP was out of range (n=4) or there was atrial fibrillation (n=2). All subjects agreed to participate in the protocol and gave informed consent.

Department of Clinical and Experimental Medicine, University of Padova, Padua, Italy
Correspondence: Professor P Palatini, Dipartimento di Medicina Clinica e Sperimentale, Università di Padova, via Giustiniani, Padova 2-35128, Italy.
E-mail: palatini@unipd.it
Received 18 February 2010; revised 11 May 2010; accepted 17 June 2010; published online 5 August 2010