

BRIEF NOTE

An Improved Indirect Measuring Method for Arterial Blood Pressure in Unanesthetized Rats

Shigeru SUGANO, Hisashi HIROSE and Hiroshi SAWAZAKI

Laboratory of Animal Environmental Physiology, Faculty of Agriculture, University of Tokyo, Bunkyo-ku, Tokyo 113

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Arterial blood pressure is a very important parameter for the cardiovascular function, and it should be easily measured by non-invasive and accurate methods. Many attempts have been so far made to measure the arterial blood pressure of the unanesthetized rats [4–10]. Some employed a direct measuring method using the rat with a chronically indwelling arterial catheter [5, 7, 8]. The direct method has the advantage for successive and accurate measuring, but is more invasive than the indirect method. Moreover, it is not always practical to get measurements from many individuals at a time by the direct method.

As a method for measuring the arterial blood pressure of unanesthetized rats, the indirect method using the caudal artery has been often adopted [4]. In this indirect method, so-called indirect tail-cuff method, it is unavoidable that a rat is warmed up beforehand to get vasodilatation enough to detect the tail pulse wave [6, 9]. The exposure of unanesthetized rats to a heat lamp, however, is reported to cause an elevation in their rectal temperature and systemic blood pressure [1, 3, 6]. This paper describes an improved tail-cuff method for measuring arterial blood pressure in unanesthetized rats without warming up procedure.

The measuring apparatus weighing about 6 kg is composed of the following parts; a compressor, a tail pulse detector, an amplifier, a signal processor and an indicator. As shown in Fig. 1, the tail-cuff consists of the parallelly installed thin-walled (0.5 mm) translucent rubber tubes with outer diameter of 2 cm and length of 5 cm. The tail is placed at the root between the two tubes, by which the caudal artery is compressed simultaneously from the upper and lower sides with an automatic air compressor. The tail pulse wave is detected by a photo-electric pickup composed of a lens lamp and a silicon diode. The frequency of the electric signals picked up from the tail pulse waves is converted to the corresponding voltage (F-V conversion). The cuff pressure at the time when the signal voltage has become identical with the basal voltage in the course of inflation of the cuff represents the systolic arterial pressure. The present apparatus has an error detective circuit which can exclude electrically as the artifacts the influences of tail movements or respiratory ones.

Fig. 2 shows an example of the application of our apparatus. Simultaneous recording by the polygraph of tail pulse wave, cuff pressure, carotid arterial pressure, signal
Fig. 1. Schematic diagram of a tail cuff and a photoelectric pickup.
A: Tail-cuff, B: Photoelectric pickup,
1: Rubber tubes, 2: Lens lamp, 3: Silicon diode,
4: Tail of a rat, 5: to an amplifier and a signal processor, 6: to an automatic air compressor.

Fig. 2. Original record showing the principle of the present instrument in an unanesthetized rat previously cannulated into the carotid artery.
PW: Tail pulse wave of the caudal artery, CP: Tail-cuff pressure, AP: Carotid arterial pressure, F-V (1): Signal voltage, V_ref: Basal voltage, Sig: Trigger signal. AP was measured directly by means of a pressure transducer.

Arterial pressure was set to release when the tail pulse waves disappeared. In the tail-cuff methods reported hitherto, the detection of systolic arterial pressure is performed during deflation of the cuff, so that the principle of theirs seems different from that of the present method. Buñag [2], however, found that reading of blood pressure during inflation of the cuff was almost identical with that during deflation. Based on his observation, it may be more preferable to detect the systolic arterial pressure during inflation of the cuff, because shortening of the measuring time is desired to have unaffected blood pressure values.

Fig. 3 shows the correlation between the direct and indirect measurements in the unanesthetized Sprague-Dawley rats, which have previously been cannulated into the carotid artery. Significant linear relationship was obtained between the values by both methods. Moreover, similar experiments using Wistar rats and spontaneously hypertensive rats (SHR) gave the following
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equations respectively; \( Y = 0.807X + 26.312 \) 
\( (r = +0.823, \ P < 0.01, \ N = 120) \), 
\( Y = 0.989X + 3.563 \) 
\( (r = +0.949, \ P < 0.01, \ N = 30) \).

The above-mentioned experiments were performed at room temperature (20 to 29°C), and each measuring finished within 5 minutes. The rats were not warmed up before measuring, but their tails may possibly be heated by the lens lamp locally. From these results, the present method may be applied usefully to measuring of arterial blood pressure in unanesthetized rats.

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References