A Comparative Study of Measurement of Arterial Blood Pressure Using HEM-802F and Arterial Cannulation

Kenji SHIGEMI, Hakuo TAKAHASHI, Satoru HASHIMOTO*, Shinhachirou NOMI, Eiichi CHIHARA*, Takashi KINOSHITA*, Yoshifumi TANAKA* and Masao MIYAZAKI*

Finger arterial blood pressures determined by a newly developed sphygmomanometer, HEM-802F, were compared with arterial pressure obtained from direct measurement of the radial artery. An excellent correlation was found between the two methods (systolic: r = 0.93, diastolic: r = 0.91), although there was a large variability among individual subjects. The range of differences between them are from +32 to −13 mmHg for systolic and +15 to −25 mmHg for diastolic blood pressure measurement. HEM-802F underestimated systolic pressure (−4.0 mmHg) and overestimated diastolic pressure (+6.7 mmHg), compared with intra-arterial readings.

The HEM-802F was useful for the non-invasive arterial pressure monitoring during general anesthesia. (Key words: finger arterial blood pressure, direct arterial blood pressure, Omron HEM-802F)

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Being non-invasive, automatic blood pressure monitors based on arm oscillometry, are relatively safe and have gained in popularity. However, they have long tubes connecting a cuff with a huge box-like main device, and the cuff sometimes interrupts the intravenous administration of fluid.

The "finger sphygmomanometer" (HEM-802F, Omron Tateishi Electric Co. Ltd., Kyoto) is small (66 × 138 × 45 mm, 220 g including batteries), and works by two SUM-4 batteries applied around a left index finger. We compared the device with direct blood pressure monitoring at different levels of blood pressure from 57 to 183 mmHg in systolic pressure.

The finger blood pressure was measured indirectly from the second finger of the left hand with the newly developed manometer (HEM-802F). The circumference of the rubber bladder cuff is 2.2 cm, and the width 2.4 cm. The cuff is made of synthetic rubber. Two light emitting diode and one phototransistors are attached in the inner surface of the center of the cuff to detect the blood flow. The systolic and diastolic pressure is automatically calculated by measuring the interval between the initial point of the signals and the peak point.

Eleven patients (three males, eight females), of ASA physical status class 1 and 2 were scheduled for surgery under general anesthesia. None was obese, hypertensive or

Kyoto Prefectural Yosanoumi Hospital, Kyoto, Japan

**Department of Anesthesiology, Kyoto Prefectural University of Medicine, Kyoto, Japan*

Address reprint requests to Dr. Shigemi: Kyoto Prefectural Yosanoumi Hospital, Yosa-gun, Kyoto, 629-22 Japan

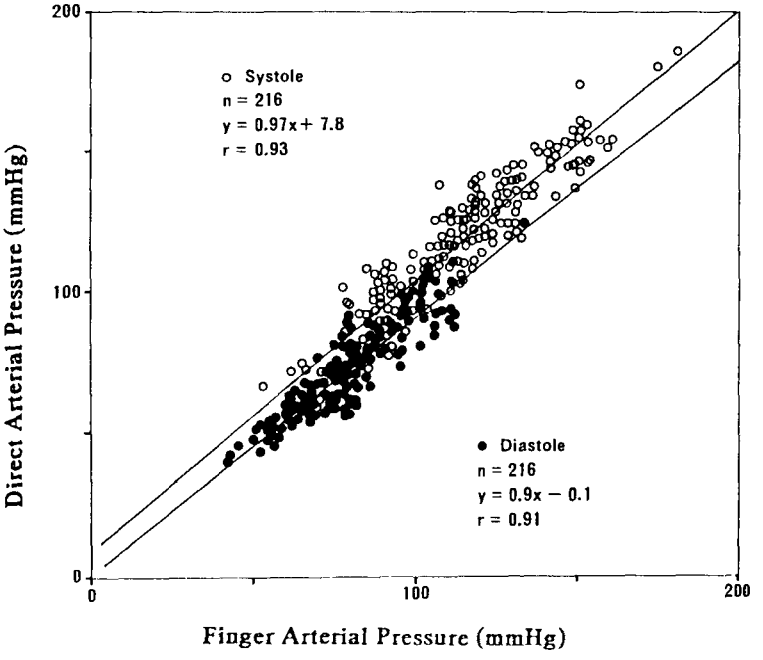

Fig. 1. Comparison is systolic and diastolic blood pressure as determined by HEM-802F (horizontal axis) and intra-arterial method (vertical axis) for all patients (216 points). The equation of the regression line in systolic pressures is showed in the upper area and that of diastolic pressures is shown in the lower area. Open circles show systolic and closed circles show diastolic blood pressures.

suffering from cardiac disease or cardiac arrhythmia. The average age of the patients was 64.4 years. All patients had premedication (atropine: 0.5 mg, buprenorphine: 0.2 mg, droperidol: 2.5 mg) intramuscularly one hour before the induction (thiopental: 150 mg, succinylcholine chloride: 50–60 mg). Anesthesia was maintained with oxygen (2 $l \cdot min^{-1}$), nitrous oxide (4 $l \cdot min^{-1}$), enflurane (1–2%) and pancuronium (initial dose: 4 mg, maintenance dose: 1 $mg \cdot h^{-1}$). Some patients were administered vasoactive agents: prostaglandine E_1 (two patients, 21 points), glyceryl trinitrate (two patients, 49 points), ephedrine (one patient, 76 points), phenylephrine (one patient, 27 points), and one patient (14 points) was generally anesthetized with a epidural anesthesia (with 1% lidocaine).

After induction of anesthesia, the left radial artery was cannulated with a Teflon catheter (20 G, 5 cm), which was irrigated with a continuous flush device (Safti-flo, PVB, West Germany), and which was connected to a pressure transducer (P50, Spectramed, U.S.A.). The system was used and verified for correct calibration using a mercury column at the beginning, middle and end of each study. The zero point was set at the midaxillary line. The mean natural frequency response of the system was 15–20 Hertz with a damping coefficient of 0.2–0.3, values which are acceptable for dynamic response. Systolic and diastolic pressure are determined directly from the arterial blood pressure curve.

Regression analysis was done for systolic and diastolic pressure using all values (216 points) in order to establish the best fit lines (method of least square). The difference between the two technique was also plotted against the values directly.

Linear regression was found to produce the best fitting curve for all data (analysis

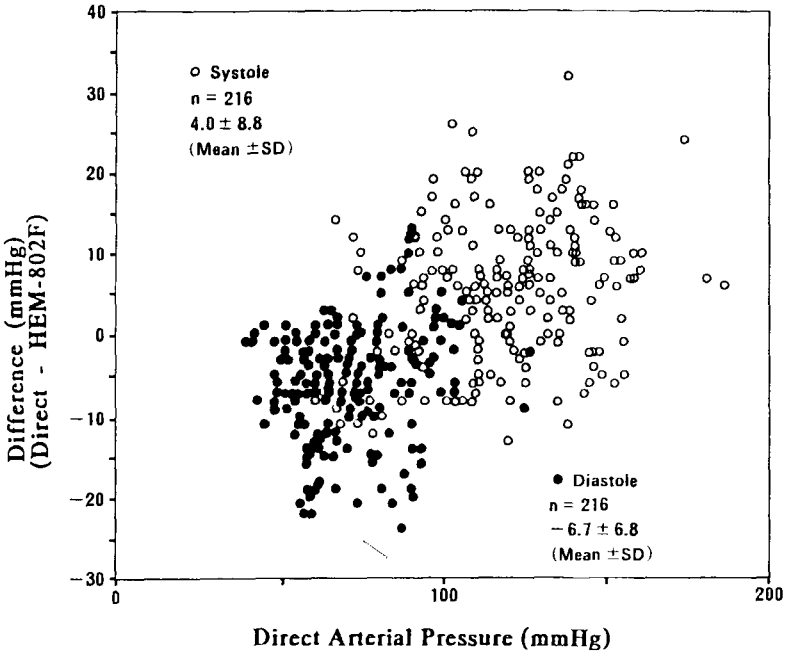

Fig. 2. The differences between two methods. The horizontal axis shows the values for the intra-arterial method, and the vertical axis shows the difference value (the value determined by HEM-802F is subtracted from the value determined by intra-arterial method). Open circles are systolic and closed circles are diastolic pressures.

of variance). Figure 1 shows the correlation coefficients obtained and the slope of the regression equation for systolic and diastolic blood pressure. The results show that for each pressure, the correlation between indirect and direct method is excellent (systolic: $r = 0.93$, diastolic: $r = 0.91$).

The differences between the two techniques are plotted against the value of the direct method in figure 2. The results show that the HEM-802F underestimated systolic pressure, compared with direct pressure of 4.0 mmHg with a standard deviation of 8.8 mmHg, and overestimated diastolic pressure of 6.7 mmHg with a standard deviation of 6.8 mmHg.

The results presented here clearly indicate that the instrument (HEM-802F) permits the accurate tracing of arterial blood pressure during general anesthesia and performs acceptably over a range of arterial systolic pressure from 57 to 183 mmHg.

There are many factors (for example changes in natural frequency and the damping coefficient) which determine whether accurate recordings of systolic and diastolic pressure are made with invasive monitoring. The values with the direct method have overshoot and undershoot, so underestimation and overestimation might be detected with HEM-802F.

The speed of deflation of the cuff also is one of the factor which effects the difference of the values between two methods.

It is advisable to use this device during anesthesia for it has many advantages, namely it is simple, time and cost saving, compact and dose not interrupt infusion.

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