ACCURATE MEASUREMENT OF INTRAARTERIAL PRESSURE THROUGH RADIAL ARTERY CATHETERS IN NEONATES

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ABSTRACT. A technique is described for accurate measurement of intraarterial pressure through radial artery catheters in neonates. The technique, which can be used for short-term monitoring, uses cannulation of the radial artery with a 24-gauge Teflon catheter, connected by a Luer-Lok fitting to a three-way stopcock and a high-fidelity tip transducer. In vitro studies showed that the system is linear and the frequency response is flat (+3 dB) up to 50 Hz. The technique permits gathering of high-quality pressure data and can be used in the area of neonatal clinical research for short-term monitoring. It needs to be developed further before routine application in clinical practice can be recommended.


To obtain intraarterial pressure measurement in neonatal intensive care and neonatal clinical research, liquid-filled umbilical artery catheter transducer systems are commonly used. Although these systems are adequate for most clinical needs, they do not permit highly accurate measurement of pressure wave shapes [1,2]. This is because of the poor dynamic response of the systems, mainly caused by the long umbilical catheter with a small diameter.

In recent years, however, radial artery cannulation has become an alternative method for arterial access in neonates. The accuracy of blood pressure measurement is likely to benefit from this technique of cannulation since radial artery catheters are much shorter and stiffer than umbilical artery catheters. Although blood pressure measurement through radial artery catheters has been reported in previous studies [3,4], a catheter/transducer system enabling accurate measurement of pressure waveforms using these catheters has not yet been reported.

The present report describes a system using a high-fidelity tip transducer that enables accurate blood pressure measurement in neonates through radial artery catheters. This high-fidelity system is compared with a standard radial artery blood pressure system commonly used in neonatal intensive care.

MATERIALS AND METHODS

The high-fidelity system (Fig 1) comprises cannulation of the radial artery with a 24-gauge Teflon catheter (Quik-Cath, Baxter Deutschland GmbH; length, 16 mm), which is connected to one horizontal portal end of a three-way stopcock (Spectra-Med, Albuquerque,
Fig 1. High-fidelity radial artery blood pressure system. Transducer is connected to stopcock by Luer-Lok fitting.

NM). A high-fidelity tip transducer (MTC [MicroTransducerCatheter], Honeywell, Pleasantville, NY) is attached to the other horizontal portal end. The proximal end of the transducer is fitted with the stopcock by Luer-Lok fitting, sealed to the transducer. This high-fidelity system is compared with a standard system constructed as follows: a 24-gauge Teflon catheter (Quickcath) connected to a T connector (Venisystems, Abbott, Salt Lake City, UT), which in turn is attached to a three-way stopcock. To this stopcock, a 100-cm extension tube (Lectro-Cath, Vygon, Ecouen, France) and a disposable pressure transducer with flush device (Gould, Cleveland, OH) are connected. This standard system is a slight modification of the radial artery pressure systems reported by Todres et al [5] and Randel et al [3].

The static accuracy of the high-fidelity radial artery system is tested with a blood pressure simulator, (Model 610A blood pressure system calibrator, Bio-Tek Instruments, Winooski, VA) as static input signal. The applied pressures range from 0 to 110 mm Hg with 10-mm Hg steps.

The dynamic response of both systems is tested by application of sinusoidal pressure variations [6,7], using the blood pressure simulator externally connected to a sine wave generator (Hewlett-Packard, Model 3310B). A reference tip transducer and the radial artery catheter/transducer system to be tested are connected to the blood pressure generator. The sinusoidal outputs are recorded on an oscilloscope (Tektronix storage scoop, Tektronix, Beaverton, OR); the amplitudes are measured simultaneously with a digital voltmeter. The phase responses of the standard system and the high-fidelity system are determined by measuring on the oscilloscope the phase lag between the reference tip transducer and the system under test. The catheter/transducer system to be tested and the blood pressure simulator are carefully filled with degassed 0.9% saline. Introduction of air bubbles is avoided.

Cannulation of the radial artery is performed percutaneously by direct technique with the 24-gauge Teflon catheter, using a fiberoptic light source. After the catheter is inserted, it is connected to the three-way stopcock with high-fidelity tip transducer. To ensure that no air bubbles are present in the system after connection, blood is drawn from the catheter through the stopcock into a plastic syringe without disconnecting the system. Then the system is carefully flushed with 0.2 to 0.3 ml of the infusion solution by gently pushing the plunger of the plastic syringe.

In 2 neonates, admitted for neonatal intensive care and requiring arterial cannulation, radial artery blood pressure curves were obtained. Infant A was born after a full-term pregnancy. Birth weight was 3,440 g. He had duodenal atresia. Prior to surgery, on the third day of life, the radial artery of the right hand was cannulated. Infant B was born after 36 weeks of gestation. Birth weight was 3,275 g. He had transposition of the great arteries. On the second day of life, prior to surgery, the radial artery of the right hand was cannulated.

In both infants blood pressure waves were obtained over a 30-minute period. The pressure signal was amplified (Bridge Amplifier, Model 11-4113-01, Gould Instruments) and stored on an analog tape recorder (SE-7000, SE Labs [EMI], Wells, Somerset, UK).

Pressure waveform recordings from both infants

![Graph showing linearity between 0 and 110 mm Hg](attachment:image.png)