Aortic Pressure versus Doppler-measured Peripheral Arterial Pressure

ALDEN H. HARKEN, M.D.,* and ROBERT M. SMITH, M.D.†

Measurement of blood pressure during operation has been greatly facilitated by the recent application of the Doppler principle. The concept, the apparatus, its construction, and its application have been adequately described.1-4 Since the values obtained by this noninvasive method have been almost identical to those obtained by intra-arterial cannulation at the same sites,5 and acceptance of the technique has been so enthusiastic, it is easy to be led into the belief that this gives the best possible evaluation of a patient’s arterial blood pressure.

One must bear in mind, however, that peripheral arterial flow is affected by vasoconstrictive forces, and peripheral pressure is not always identical to central aortic pressure, especially during periods of great stress.

The present study was undertaken to demonstrate the difference between central aortic pressure and peripheral arterial pressure (Doppler) during gradual exsanguination.

METHOD

Five mongrel dogs which served as controls were anesthetized with pentobarbital, the tra-

* Chief Resident, Cardiovascular Surgery.
† Director of Anesthesia.
Received from the Children’s Hospital Medical Center, Boston, Massachusetts. Accepted for publication July 26, 1972.

![Graph](https://example.com/graph.png)

**Fig. 1.** Differences between central aortic and radial arterial pressure in five untreated dogs.
Fig. 2. Differences (or lack of difference) between aortic and radial arterial pressures in two dogs pretreated with phentolamine.

Fig. 3. Differences (or lack of difference) between aortic and radial arterial pressures in two dogs pretreated with dibenzylx. 
CHEAS intubated, and respirations controlled on
an inspired gas mixture containing 0.5 per cent
halothane and 21 per cent oxygen. A period
of stabilization of at least half an hour fol-
lowed. During this period a polyethylene
catheter (16-gauge) was threaded up the
femoral artery into a central aortic position.
This catheter was attached to a pressure trans-
ducer. A femoral-vein catheter was also
placed. The Doppler transducer was then
taped into position over the paw artery. A
standard pneumatic cuff was placed on the
dog's leg proximal to the Doppler transducer.

Following the period of stabilization, the
dogs were bled 2.5 per cent of their estimated
blood volumes, (EBV) every 5 minutes. Blood
volume was calculated as 8 per cent of body
weight. Doppler and aortic pressures were
monitored continuously.

Four additional animals were similarly pre-
pared except that 15 minutes prior to bleeding
they were premedicated with a large dose of
an alpha-blocking agent. Two were pretreated
with dibenzylene, 0.33 mg/kg, and the other
with phentolamine, 0.8 mg/kg.

RESULTS

Aortic pressure and peripheral blood pressure
\( BP_{dop} \) were measured as the control
animals were slowly bled until they had lost
79 per cent of their estimated blood volumes.

There was no change in either \( BP_{dop} \) or
aortic pressure until 15 per cent, or more, of
EBV had been removed.

With further bleeding peripheral and cen-
tral aortic blood pressures decreased in a
parallel fashion until 25 per cent of blood
volumes had been lost.

With loss of more than 25 per cent of EBV,
\( BP_{dop} \) decreased rapidly to unobtai-
nable levels. The aortic pressure remained
measurable following removal of 60 per cent of EBV. The
differences between the two values are shown
in figure 1.

Aortic pressures and \( BP_{dop} \)'s in dogs pre-
treated by adrenergic blockade were measured
as the animals were slowly bled until they had
lost 50 per cent of their EBV's. The discrep-
ancies between the two pressures are presented

---

1 Transcutaneous Doppler Model 101-A, Parks
Electronics Laboratory, Beaverton, Oregon.

There was no change in either aortic pres-
sure or \( BP_{dop} \) until the dogs had lost 5 per cent
of their EBV's. With further bleeding, Dop-
pler and aortic pressures decreased in parallel
fashion until 30 per cent loss had been
achieved. The difference between the aortic
and Doppler measurements was less than 3
mm Hg. With more than 30 per cent of the
EBV discrepancies between \( BP_{dop} \) and aortic
pressure were frequently greater, sometimes
reaching 5-10 mm Hg. In all instances, blood
pressures fell in a parallel fashion and became
unobtainable when the dogs had lost 50 per
cent of their EBV's.

CONCLUSION

We feel that the accuracy of the Doppler
method of obtaining peripheral blood pressure
is beyond question. As increasingly ill patients
are treated, however, clinicians must remember
that the peripheral blood pressure is frequently
lower than aortic pressure in the maximally
stressed individual. This physiologic pressure
differential has prompted us to place central
arterial lines (via the radial or femoral artery)
in children and adults with refractory hypoten-
sion and/or hypoperfusion states.

REFERENCES

1. Ware RW: New Approaches to The Indirect
Measurement of Human Blood Pressure.
Third National Biomedical Instrumentation
Symposium (ISA BM-65), 1965
2. Kirby RR, Kemmerer WT, Morgan JL: Trans-
cutaneous Doppler measurement of blood
pressure. ANESTHESIOLOGY 31:88-89, 1969
3. Hernandez A, Coldring D, Hartman AF Jr:
Measurement of blood pressure in infants and
children by the Doppler ultrasonic technique.
Pediatrics 48:788-794, 1971
4. Waltemath CL, Preisus DD: Determination of
blood pressure in low-flow states by the Dop-
pler technique. ANESTHESIOLOGY 34:77-79,
1971
5. Janis KM, Kemmerer WT, Kirby RR: Intra-
operative Doppler blood pressure measure-
ments in infants. ANESTHESIOLOGY 33:361-
363, 1970
6. Poppers PJ, Epstein RM, Donham RT: Auto-
matic ultrasound monitoring of blood pressure
during induced hypotension. ANESTHESIO-