*From the DES Archives*

- Legacy of D.E. Strandness Jr MD -

# Arterial Testing Before Duplex Scanning

No disclosures

## The Noninvasive Testing Legacy of Dr. Strandness

- Development of physiologic noninvasive testing at U of Wash prior to Duplex testing

- A collaboration between vascular surgery and bioengineering that led to applications for Doppler ultrasound for indirect and direct physiologic testing.

- Clinical duplex testing developed in Dr. Strandness research lab because of the need for artery imaging

Gen'l Surgery Resident

## "Gene" Strandness Jr MD

A Vascular Surgeon of Persistent Curiosity"

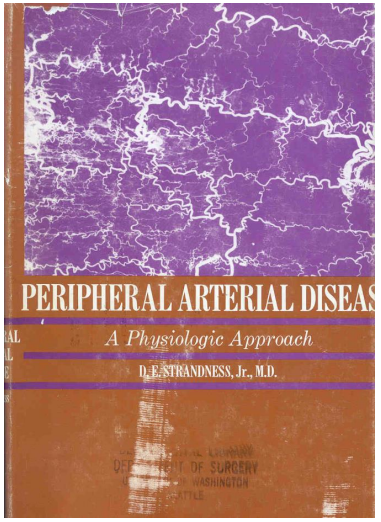
- U of W School of Medicine 1950-54
- U of W General Surgery 1955-62
- NIH Fellowship 1962-64
- **U of W Faculty 1964-1972**

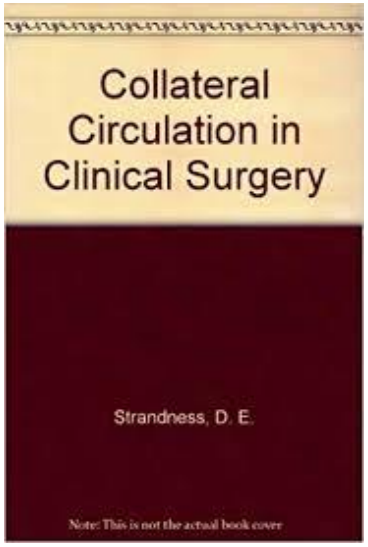
- Died of pulmonary failure at the age of 73

Headed a multidisciplinary team of bioengineers, physicists, researchers, and surgeons to develop duplex ultrasound scanning and its clinical applications – ***Revolution in Vascular Diagnosis****

**DE Strandness Jr MD and the Revolution in Noninvasive Vascular Diagnosis, Beach KW,, J Ultrasound Med 2005.*

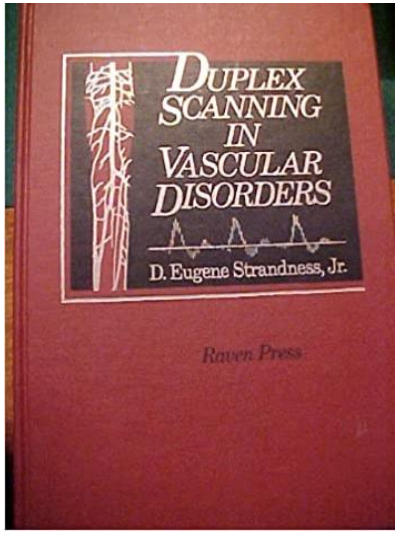
Strandness Published >400 articles and contributed to 32 books

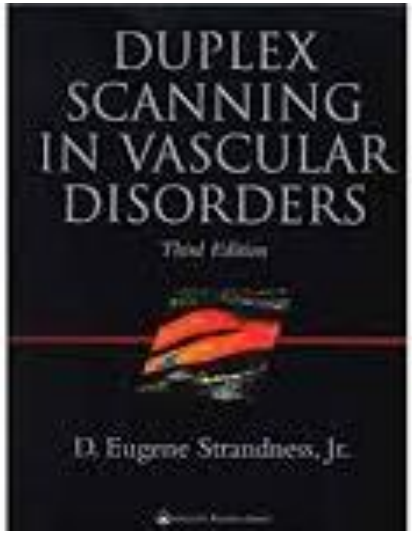




Written in 1 mo
entirely by
Dr. Strandness
Published 1990




3rd Edition
published in 2002
Immediately after
his death

## A favorite quote of Dr. **Strandness** from Lord Kelvin

Library of Congress

**William Thomson, 1st Baron Kelvin**
**1824-1907**
**Physicist & Engineer**

"When you can measure what you are speaking about, and express it in numbers, you know something about it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts advanced to the stage of science."

# The Collaboration of Dr Strandness with UW Bioengineering

- Founded the Center for Bioengineering in 1968
- Recruited engineers to build electronic devices to monitor heart rate, blood pressure, blood velocity, & flow rate in living animals
- Developed ultrasonic transit time flowmeter to remotely monitor vital signs of dogs

**Robert F. Rushmer, MD**

**Donald Baker** – an engineer with military background in Doppler radar

- Built an ultrasonic Doppler blood velocimeter using a Hallicrafters shortwave radio receiver on the amateur 60-m band: λ = C/F, C (radio waves) = 300 Mm/s = 300 m/μs; 5 MHz = 5 cycles/μs; 60 m/cycle = (300 m/μs)/(5 cycles/μs)

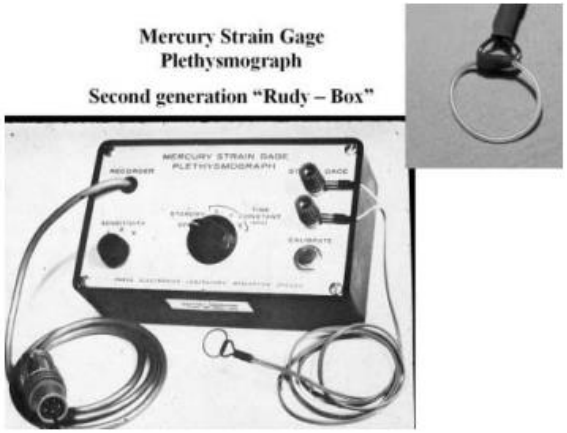
**Prototype CW Doppler**
***circa 1961***

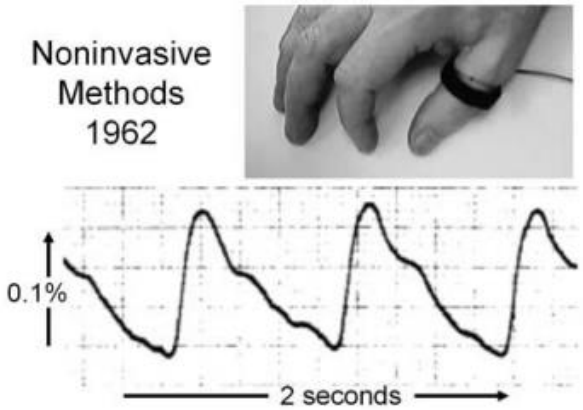

- choice of 5 MHz produces the optimal 300-μm ultrasonic wavelength, which results in the strongest echo by Rayleigh scattering from erythrocytes under 2 cm of overlying tissue

As new UW faculty, Dr Strandness was assigned by Chairman Dr Henry Harkins to research vascular disease at the Seattle VAMC

- Became convinced that physiology of arterial occlusive disease was more important to clinical outcome than the anatomy shown by arteriography (primary diagnostic technique of patient evaluation)

- Used strain-gauge plethysmography to measure limb/digit blood pressure; at rest and following exercise




Radke HM, Bell JW, Strandness DE Jr, Jesseph JE. Monitor of digit volume changes in angioplastic surgery: use of strain gauge plethysmography. Ann Surg 1961; 154:818–825. 2. Strandness DE Jr, Gibbons GE

*Diabetes* 1964;13(4):366–372

# Combined Clinical and Pathologic Study of Diabetic and Nondiabetic Peripheral Arterial Disease

*D. E. Strandness, Jr., M.D., R. E. Priest, M.D., and G. E. Gibbons, M.D., Seattle*


## SUMMARY

**The results of a combined clinical and pathologic study of large and small arteries in the diabetic and nondiabetic patient show that the diabetic has the same incidence of occlusion in the femoral-popliteal system but a higher incidence below the knee. A specific lesion of small arteries and arterioles which distinguishes the diabetic from the nondiabetic was not observed in this study. The results of this investigation provide no support for the concept that a specific disease of small arteries and arterioles in diabetic patients contributes to the ischemic process. We believe the ischemic lesions found in the diabetic patient can adequately be explained on the basis of arteriosclerotic obstruction of the major arteries, and those ulcers occurring in the absence of major artery disease are attributable to peripheral neuropathy.**


Strain gauge plethysmography

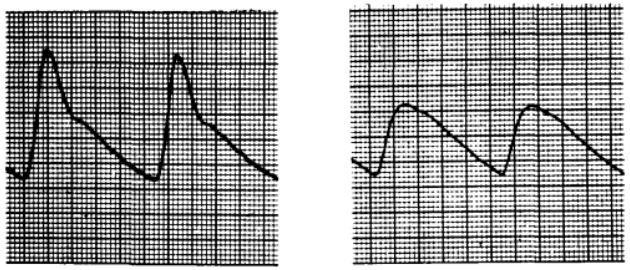
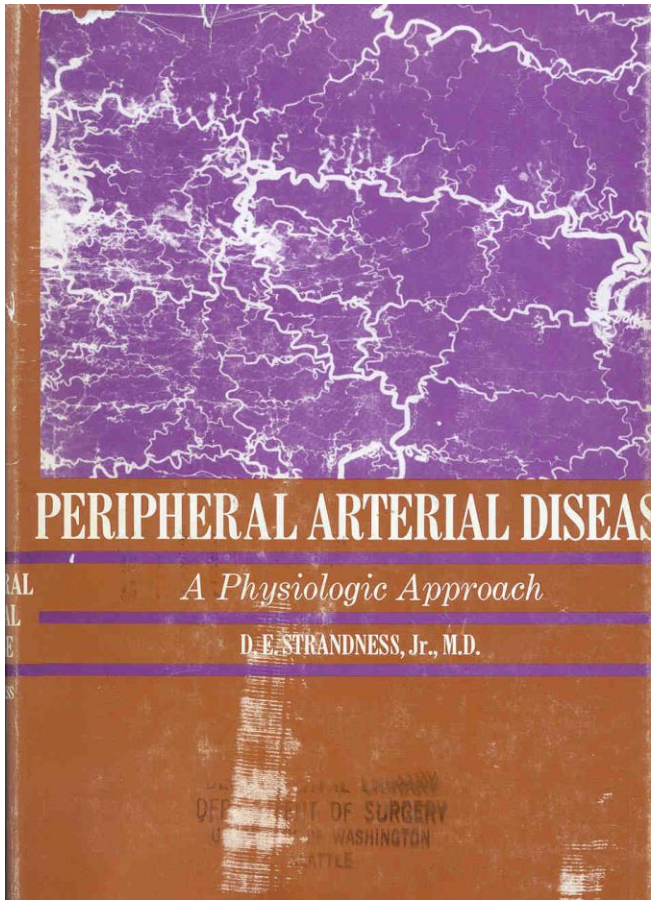
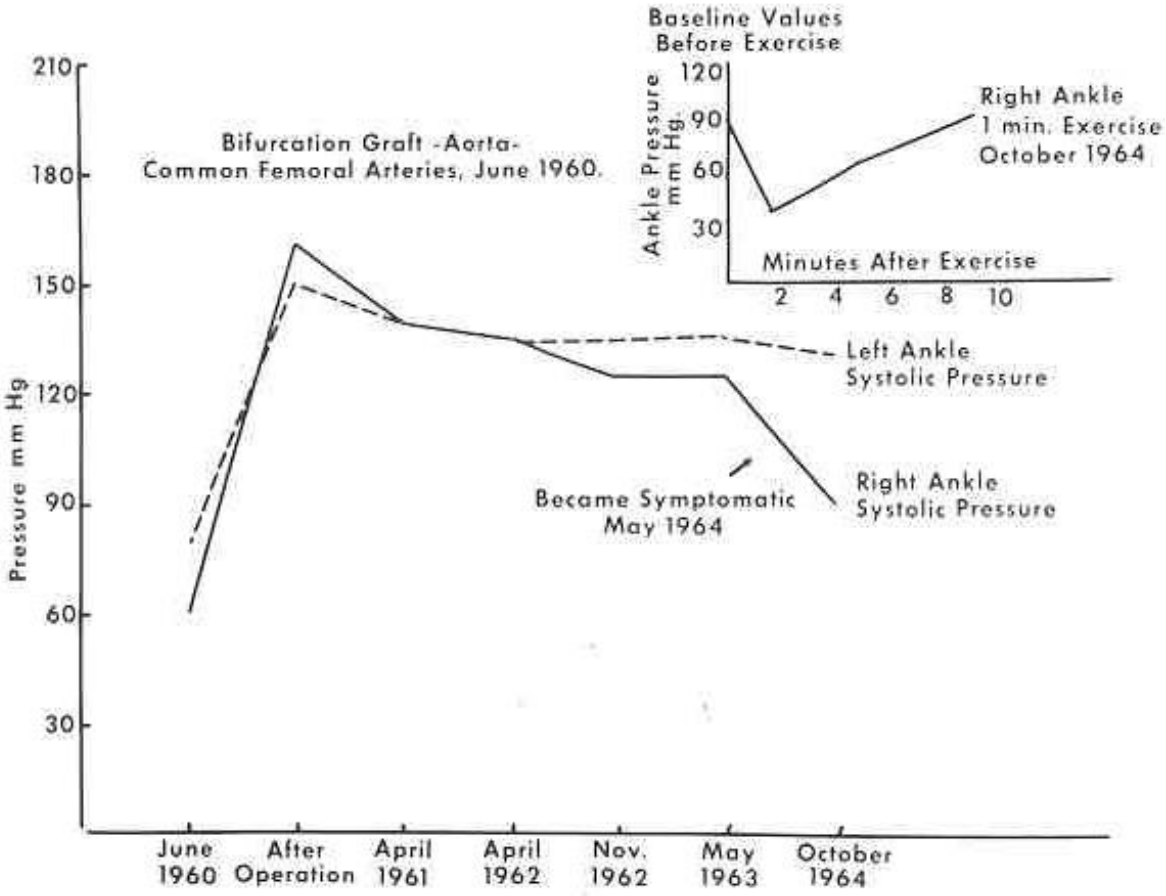



FIG. 1. (A) illustrates a normal digit pulse with a sharp systolic peak and a dicrotic wave on the downslope. In the presence of arterial obstruction (B), the curve loses its sharp systolic peak and the dicrotic wave disappears.

Performed segmental pressures

Published in 1969



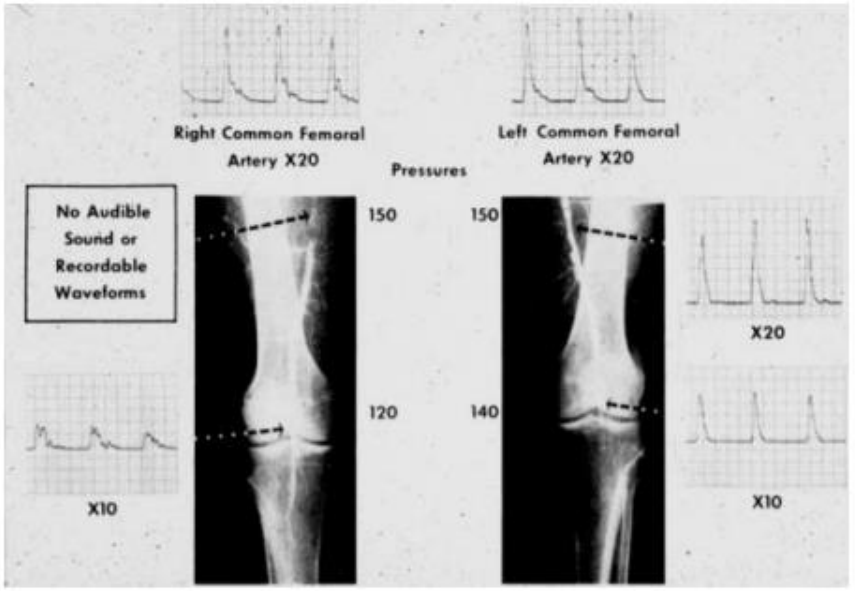




"when distal anastomosis narrowed, the ankle pressure began to decrease and the exercise test was abnormal. after the anastomosis was revised, the ankle pressure increased to 130 mm Hg and claudication disappeared"

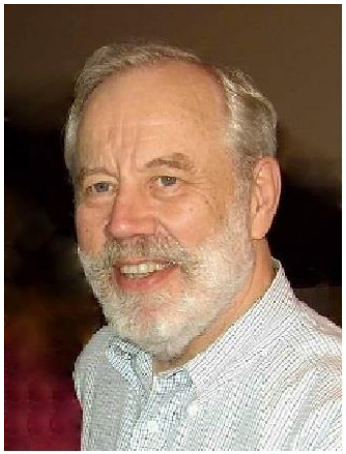
By 1962 – Dr Strandness was routinely using CW Doppler to evaluate patients with arterial and venous disease

- Developed directional Doppler to display flow velocity waveform
- “triphasic” normal peripheral artery waveform
- damped monophasic flow distal to occlusive lesions

Arterial Plethysmograph Waveform and Doppler Waveform

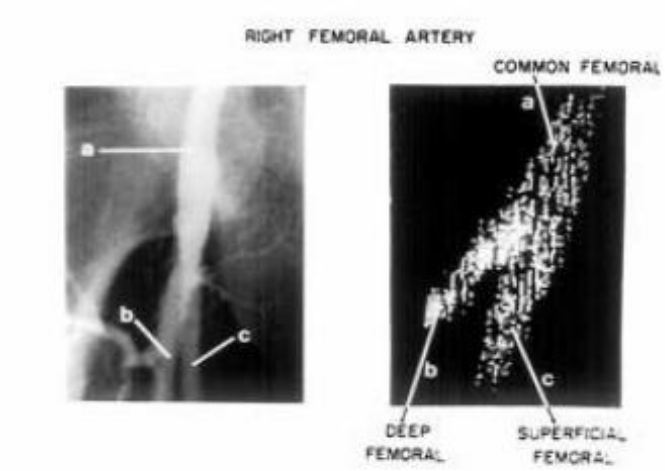


# Ultrasonic Arteriograph – the beginning of Doppler imaging



DE “Gene” Hokanson


Hokanson
Pulsed Doppler
Arteriograph



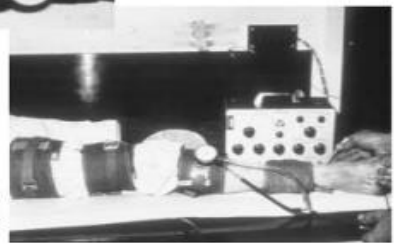

Peak systolic velocity >150 cm/s =
>50% stenosis

# State of UW Noninvasive Vascular Testing in the 1970s

- Vascular Lab staffed by clinical vascular technologist (Dick Krugmire)
  - took call/consults 24/7
- Testing performed exams with a pocket Doppler device & blood pressure cuff.
  - measured ABI
  - segmental pressures with 4-level blood pressure cuffs

Systolic Blood Pressure Measurement with Doppler

Medsonics "Pocket Rocket



Parks Doppler

- exercise treadmill testing (claudicants): 2 mph @ 12% grade for 5 min followed by ankle pressure measurements

- Venous exams for DVT performed by listening for respiratory phasicity in conjunction with manual compressions

# Timeline and researchers involved in the development of Doppler ultrasound applications at U of Washington

1960s Dr Standness measurement of limb blood flow with CW Doppler
Donald Baker – bioengineer – develop pulsed Doppler technology

1970s Gene Hokanson Phd & Dr Strandness developed a pulsed Doppler imaging system (Seattle VA).

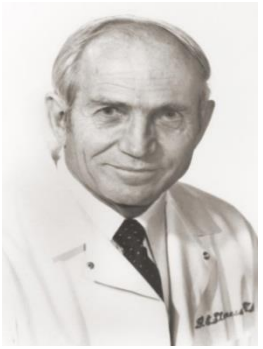
UW Bioengieering & Vascular Surgery build a protype duplex scanner in Strandness research lab (3rd floor – University Hospital)

FFT Spectrum analysis of pulsed Doppler ICA signals (David Phillips)

UW technology transfer agreement to Advanced Technology Laboratories (ATL – now Phillips Ultrasound ) to manufacture the 1st commercial duplex scanner (ATL Mark V)

1980s Validation of carotid duplex criteria (Kirk Beach, Gene Zierler),

# What I Learned from Dr. Strandness



The importance of noninvasive vascular testing
– more accurate than physical exam alone

The need for vascular surgeons to have “hands-on” expertise with both the CW Doppler and duplex ultrasound scanning.

The clinical application of duplex testing in operating room and for post-op surveillance

Intervention can be based on clinical evaluation and duplex ultrasound – NOT every patient needs an arteriogram.

# UW Vascular Lab - 1978