

ROLE OF DOPPLER ULTRASOUND IN EVALUATION
OF CAROTID DISEASE

THESIS

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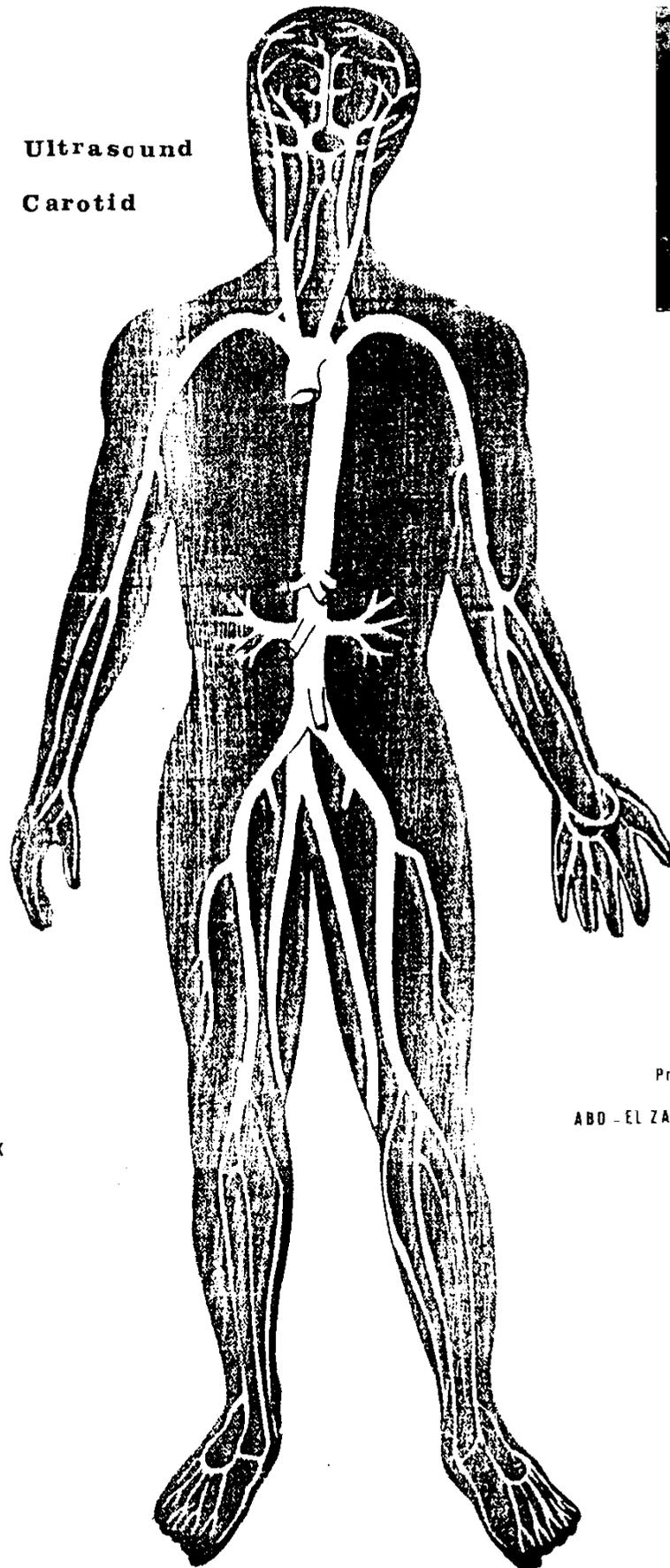
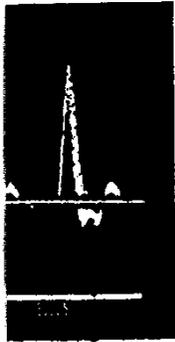
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Use of Doppler Ultrasound
in the Evaluation of Carotid
Artery Disease



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ABBREVIATIONS.

(FFT) = fast fourier transform

(CW) = Continuous wave Doppler.

(PD) = Pulsed Doppler.

(PRF) = Pulsed repetition frequency.

(R.B.CS.) = Red blood cells.

(ICA) = Internal carotid artery.

(ECA) = External carotid artery.

(CCA) = Common carotid Artery.

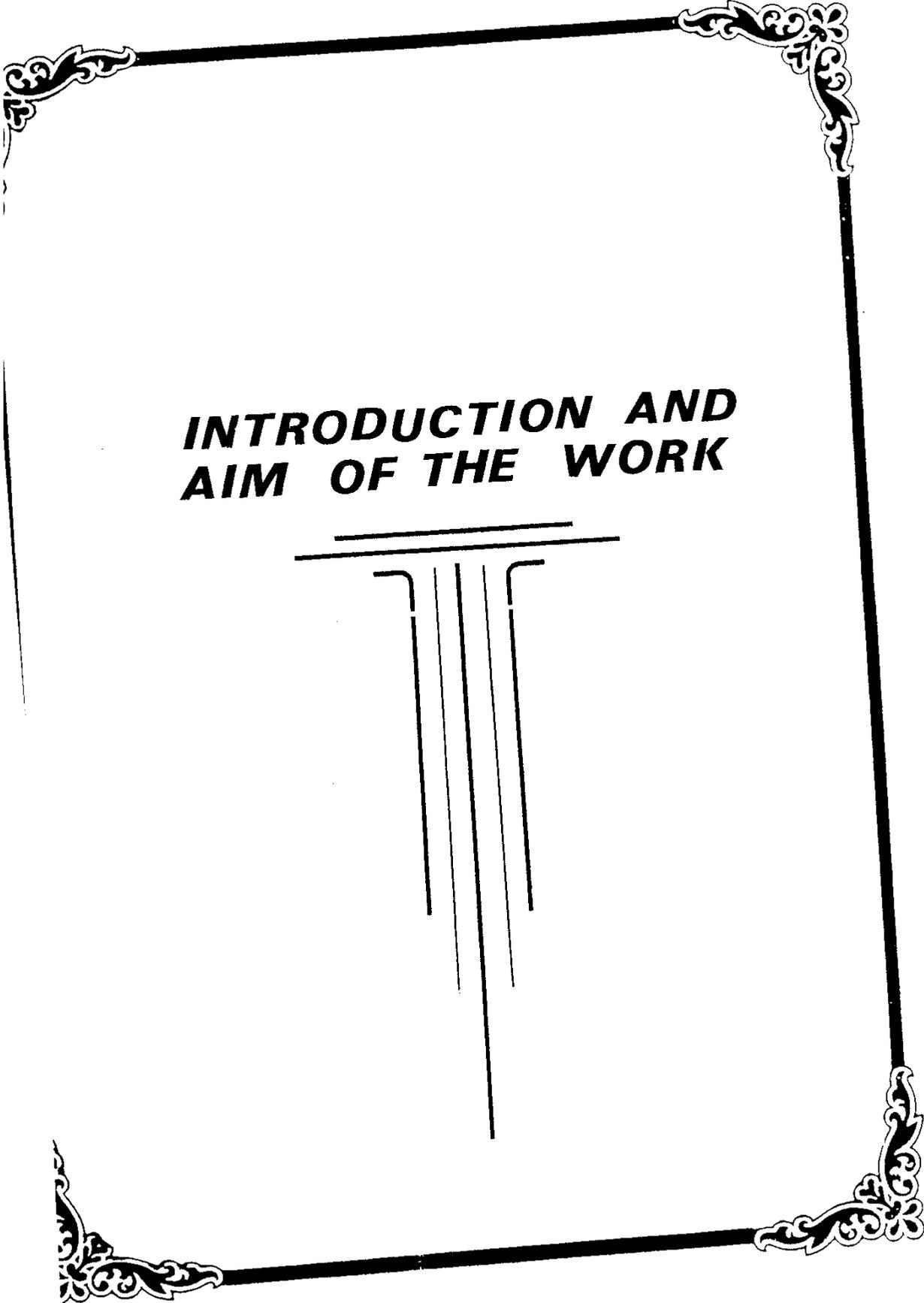
(HRS) = High resolution system.

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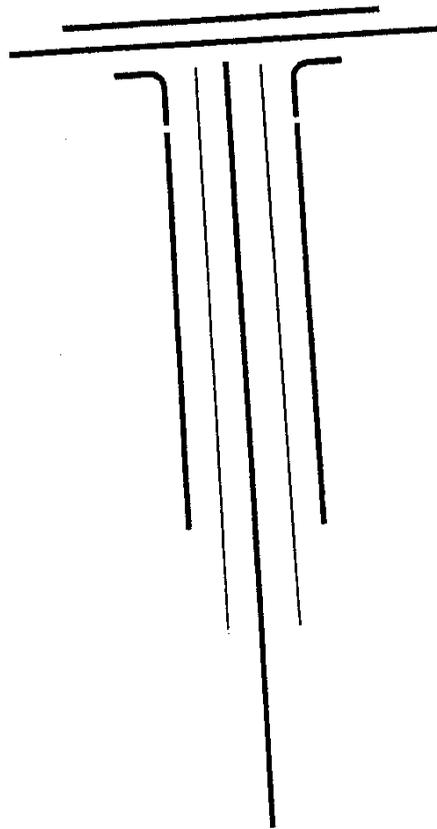
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**INTRODUCTION AND
AIM OF THE WORK**



INTRODUCTION AND AIM OF WORK

The purpose of this work is to provide information about a new non-invasive technique for detection and measurement of blood flow velocity and application of Doppler ultrasound as a qualitative tool for detecting the presence and location of Flow disturbances.

Incorporating Doppler examination with the two-dimensional image at the same time will offer anatomical information about organ and vessel architecture and flow information carried by the R. B.C.

Using the principles within this work, will help in making the transition from simple imaging to performance and interpretation of Doppler velocity measurements in great vessels.

Doppler ultrasound require an additional understanding of physics beyond that necessary for anatomic imaging, so, the second chapter is devoted to explain a nonengineering and principally nonmathematical discussion of Doppler physics. Subsequent chapters describe normal velocity patterns found in carotid vessels (as an example of other great vessels), and alternations of these patterns that occur in individuals with abnormal circulation.

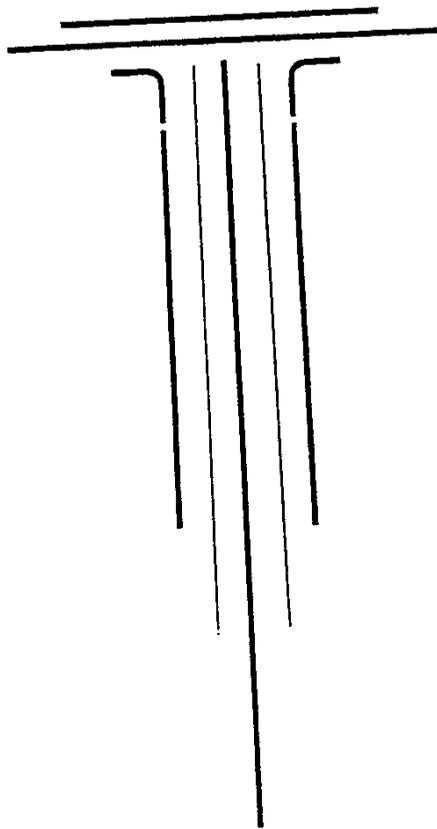
Carotid arteries were chosen to represent great vessels because, the origin of the internal carotid artery is susceptible to localized atherosclerosis as a major stenosis resulting in cerebral underperfusion.

A high incidence of strokes result from thromboembolic disease originating at the carotid bifurcation. Many trials had been attempted to better define the progression of atherosclerotic disease at the carotid bifurcation and to further identify the at-risk patient population.

Carotid arteries give also, a very good example for both normal laminar flow and pathological disturbed flow pattern.

Doppler instrumentation are still in their infancy and much wider clinical experience will be required before their proper role in diagnosis can be adequately evaluated.

**HISTORICAL NOTE AND
PHYSICS OF DOPPLER
ULTRASOUND**



HISTORICAL NOTE AND PHYSICS OF
DOPPLER ULTRASOUND

The Doppler effect was first described in detail by "Christian Johann Doppler" in 1842.

Dr. Doppler, an Austrian professor of mathematics and geometry, lived from 1803 to 1853.

The effect that he described bears his name, and thus "Doppler" is always written with a capital "D". Dr. Doppler applied the principle to shifts in red light from double stars, but not to sound.

He discovered the doppler shift when analyzing light waves from stars. He noted that the colours emitted by the stars were slightly lower in frequency (and thus longer in wavelength) than predicted by theory. He conceived that the lower frequency, called the red shift because red light has a lower frequency than yellow, green, or blue, could be explained by the frequency shift that would occur if the stars were moving away from the Earth. This concept that he developed has since been used extensively in astronomy.

Later in the same decade, Dr. Bays Ballot applied this principle to sound.

Since that time much of the sophisticated research in Doppler instrumentation has been directed towards other applications. Radar Doppler instruments have become prominent navigational and surveillance aids. It played an important role in detection of submarines in the second war and localizing their depths

The radar units used by police in traffic enforcement and ground-speed indicators used by aircraft.

The Doppler effect is even used in ultrasonic burglar alarms and automatic door openers. [Carl Jaffe (8)]

In 1956, Satomura first applied the Doppler technique to detect blood velocity. Application of Doppler ultrasound to cardiology was also attempted a decade later by "Lindstrom and Edler," who showed the Doppler frequency spectrum for mitral flow. About the same time, Kalmanson and associates published data regarding catheter velocimetry.

For the next several years, continuous wave (CW) Doppler instrumentation was used to detect blood flow in large arteries, eg. (carotid).

Franklin and associates then used continuous wave Doppler for animal studies by implanting transducer and

receiver crystal into a cuff that surrounded a blood vessel under evaluation.

Later, McCleod used phase shift circuitry and employed a zero crossing frequency meter to allow determination of blood flow direction. This device was initially used in experiments on sheep.

The next major development was the incorporation of Doppler with echocardiography, which required time sharing of pulsed Doppler and pulsed echocardiography. These concepts were developed nearly simultaneously in two independent laboratories, one headed by Baker in Washington, and the other headed by Peronneau in France.

Baker's emphasis was toward transcutaneous blood flow measurement in humans, whereas Peronneau's system was initially used in experiments on animals.

In 1972, Johnson and associates published the first American clinical paper regarding the use of Doppler, as developed by Baker, for detecting flow disturbances by audio characteristics.

The first commercial pulsed Doppler was combined with an M-mode locator system and released in 1975. This system was used by Stevenson and associates to detect specific lesions by interpreting the audio signals.

At the university of Washington, Baker and associates developed instrumentation that allowed recording of actual velocities and two-dimensional imaging. This combination allowed determination of the site at which velocity was measured and the angle between the flow and the sampling beam.

The next major technical advance was in 1979, when Gessert's application of fast fourier transform (FF.T) to spectral displays, which allowed accurate linear analysis of velocity curve profiles.

The history of Doppler ultrasound is still incomplete but Doppler is now a quantitative clinical diagnostic technique. In the remainder of this chapter the physics of doppler, its instrumentation will be discussed.

[Stanley J. Goldberg] 31