

Peripheral Vascular Diseases

AN OBJECTIVE APPROACH

By

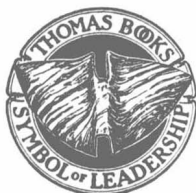
TRAVIS WINSOR, M.D., F.A.C.P.

Assistant Clinical Professor of Medicine, University of Southern California School of Medicine, Los Angeles; Director, Heart Research Foundation, Los Angeles; Staff Member, The Hospital of the Good Samaritan, Los Angeles; Staff Member, St. Vincent's Hospital, Los Angeles; Staff Member, Los Angeles County General Hospital.

With a Foreword by

BURRELL O. RAULSTON, M.D.

Dean Emeritus, University of Southern California, School of Medicine, Los Angeles, California.



CHARLES C THOMAS • PUBLISHER
Springfield • Illinois • U.S.A.

CHARLES C THOMAS • PUBLISHER
Bannerstone House
301-327 East Lawrence Avenue, Springfield, Illinois, U.S.A.

Published simultaneously in the British Commonwealth of Nations by
BLACKWELL SCIENTIFIC PUBLICATIONS, LTD., OXFORD, ENGLAND

Published simultaneously in Canada by
THE RYERSON PRESS, TORONTO

This book is protected by copyright. No part
of it may be reproduced in any manner without
written permission from the publisher.

©1959, by CHARLES C THOMAS • PUBLISHER

Library of Congress Catalog Card Number: 58-10283

With THOMAS BOOKS careful attention is given to all
details of manufacturing and design. It is the Publisher's
desire to present books that are satisfactory as to their
physical qualities and artistic possibilities and appropriate
for their particular use. THOMAS BOOKS will be
true to those laws of quality that assure a good name
and good will.

Printed in the United States of America

**Peripheral
Vascular
Diseases**



Rudolph Matas, 1860–1957

Rudolph Matas was the first to use spinal anesthesia clinically. In 1902, he devised a “radical” operation for aneurysm, “aneurysmorrhaphy” which was the first advance in this type of surgery since the days of John Hunter. He was an able teacher, a clear and original thinker and tireless investigator. He maintained an active interest in his work up to a few years prior to his death at 97 years of age. He was the first to close an arteriovenous fistula between the carotid artery and the jugular vein (1912). In his Bigelow address in 1927 he summarized the qualities that make a great surgeon, and in this summary he reflected his own image, “The surgeon must be original. He must be endowed with the spirit of invention; he must possess a faculty for investigation, or that spontaneous intuition which leads a man to seek untrodden paths and discover new truths, new methods, new procedures or forge new and unknown weapons to battle with disease or stay the hand of death.”

"Nature is written in mathematical symbols." GALILEO, 1564–1642

*It is
with grateful appreciation
that this book is dedicated
to my family*

Betty, David, Susan
Wiley and Mabel

Foreword

DURING a considerable period of years, it has been my privilege and pleasure to observe the work of DR. TRAVIS WINSOR as a teacher, clinical and experimental investigator, as well as an active practitioner.

In addition to his teaching program in the School of Medicine at the University of Southern California, he continued to pursue investigations of the peripheral vascular system, which attracted the cooperation, assistance, and support of numerous individuals, both laymen and professional.

The techniques used in this work ranged from the most simple, but wise and accurate observations, to the use of the most complicated instruments available for such studies today.

Through these efforts, there has been an accumulation of knowledge that constitutes the background of this book. The interpretations of findings, as well as the methods of diagnosis and treatment are of great value and inspiration to students, teachers, investigators and practitioners who are especially interested in the peripheral vascular system, and its related conditions.

The great efforts and time expended in the preparation of the manuscript and illustrations are justified in its presentation to the entire scientific medical world.

BURRELL O. RAULSTON, M.D.
Dean Emeritus
School of Medicine
University of Southern California
Los Angeles, California

Preface

RAPID advances in the understanding, diagnosis and treatment of abnormalities of the peripheral circulation have occurred during the past decade during which a new era has been entered, that of electronic instrumentation. The development of instruments which provide objective measurements to augment and, in some cases, to take the place of previous subjective observations has given great impetus to the study of the circulation of blood through the extremities.

Five great eras can be recognized in the development of our knowledge of the peripheral circulation. These are the eras of: (1) observation of the living; (2) dissection of the dead; (3) physiologic investigation; (4) application of optics, mathematics and physics, and (5) application of electronics. The first era began with Hippocrates, 460 B.C. to 377 B.C., who recognized and described gangrene and the effects of other peripheral vascular diseases. The second era began at the time of Leonardo De Vinci, 1452 to 1515, who noticed while dissecting that the arteries of the young were elastic and straight and those of the old were thick, rigid and tortuous. The third era began with William Harvey, 1578 to 1657, who established the scientific method for physiologic investigation and showed that blood circulated in a closed system of vessels. The fourth era occurred at the time of Antony van Leeuwenhoek, 1632 to 1723, and J. L. Poiseuille, 1799 to 1869, with the development of optics, mathematics and physics. Van Leeuwenhoek was the first to use the microscope for the systematic study of the blood vessels. Poiseuille used mathematics to describe the factors which control the flow of blood in vessels. The fifth era is that of electronics which began with the development of the vacuum tube by DeForest and is continuing to grow and expand with more and greater advances yearly.

These developments have made possible numerous instruments for the objective measurements of the peripheral circulation.

The purpose of this monograph is to present through these improved instruments an objective approach to the understanding and treatment of patients with peripheral vascular disease. This must start with a knowledge of the functional anatomy of the human circulation and nervous system and an understanding of the way in which the various organs of the body affect blood flow. Important aspects of the physical examination of the vascular system are considered in the light of various objective studies with emphasis placed on the plethysmographic examination which is a practical and informative laboratory examination and making possible objective observations of the peripheral circulation not obtainable in various other studies. The information gained from these studies is important in understanding disease, determining treatment and making comparisons of various pharmacologic agents, physical therapeutic and surgical procedures.

The various therapeutic measures employed in the field of peripheral vascular disease which have been found useful by the author are discussed in detail. Great advances have been made in the surgical treatment of peripheral vascular diseases in the form of thromboendarterectomy, arterial grafts and reconstructive surgery. Advanced instrumentation has made it possible for the internist and surgeon to advance together.

In the writing of this manuscript the immeasurable help which has been received from numerous friends is gratefully acknowledged.

Sincere appreciation is expressed to the Los Angeles County and Ventura County Heart Associations which supported many of the original studies presented. Especially important is the outstanding help of Lewis T. Bullock, M.D., Chairman of the Research Committee of the Los Angeles County Heart Association, who forcefully has shown the need for original investigation in the West and whose continued efforts have made possible funds and facilities for our own work and for the work of innumerable other investigators. From his initial ideas and efforts there has grown an ever enlarging research effort in this area. The generous help of Charles Hufnagle, M.D. made possible the establishment

of the Los Angeles County Heart Association Artery Bank which is described.

The encouragement initially provided by B. O. Raulston, M.D., Dean Emeritus of the University of Southern California, and the long, stimulating and pleasant association with George E. Burch, M.D., Professor of Medicine, Tulane University, New Orleans, Louisiana, have been important factors in the continuance of the studies reported in this monograph. Many of these studies were carried out with facilities provided by the Hospital of the Good Samaritan, Los Angeles and the cooperation of the Hospital Administration is gratefully acknowledged. The exchange of ideas and the stimulating discussions held frequently with Chester Hyman, Ph.D., Professor of Physiology, University of Southern California School of Medicine have been especially rewarding and have been a source of renewed enthusiasm. Wilbur A. Selle, M.D., Professor of Biophysics, University of California at Los Angeles, School of Medicine, assisted in getting this manuscript underway. Invaluable mathematical assistance was provided through E. K. Fisher of Lockheed Aircraft Missile Systems Division. J. Howard Payne, M.D., provided aortograms and performed many of the surgical procedures. Harold Karpman, M.D., National Heart Institute Trainee and Thomas Berne, Heart Research Fellow have given valued editorial and technical assistance.

The art work was executed by Gregg Moris and Alan Cole whose abilities have transformed many an ordinary sketchy outline into an attractive illustration. Manuel Gonzales assisted with these illustrations. The most continuous work of the book, the typing and retyping of the manuscript, has been done primarily by my most capable secretary, Mrs. Sally Cody. She has had the assistance of Miss Doris Wade.

It is hoped that this book will give a fresh approach to the study of peripheral vascular disease and will stimulate a closer association between basic scientists and physicians from which will evolve new and better instruments for the objective measurements of the peripheral circulation.

T.W.

Contents

	<i>Page</i>
Foreword	vii
Preface	ix
<i>Chapter</i>	
1. Vasomotion	3
Anatomy and Physiology of the Sympathetic Nervous System	3
Physiology of the Sympathetic Nervous System	30
References	56
2. Dynamics of the Circulation	59
Flow, Pressure and Resistance	59
References	96
3. Structure of the Vascular System	97
Components	97
Arteries	100
Veins	106
Collateral Venous Circulation	113
Lymphatics	126
Capillaries	134
4. Physiologic Transducers	135
References	147
5. Introduction to Plethysmography	151
References	156
6. Segmental Plethysmography	157
Components of the Segmental Plethysmograph	157
Techniques for Operating Instrument	159
References	179
7. Digital Plethysmography	181
The Instrument	181
Venus Occlusion Apparatus	185
Operation of Digital Plethysmograph and Venus Occlusion Apparatus	186
Classification of Waves of the Digital Plethysmogram ..	189
Normal Values and Clinical Applications	195
References	233

Chapter

	<i>Page</i>
8. Rheoplethysmography	235
References	237
9. Vasodilating Procedures	238
References	247
10. Arteriography	248
Side Effects and Their Treatment	249
Angiocardiology	251
Aortography	251
Translumbar Aortography	251
Peripheral Arteriography	260
References	273
11. Venography	275
References	284
12. Venous Pressure	287
References	293
13. Ergography	297
References	303
14. Radioisotopes	304
References	308
15. Skin Thermometry	309
The Thermal Circulation Index	318
References	335
16. Vibrometry	337
References	339
17. Sweating	340
Promotion of Sweating	340
Test for Sweating	340
References	348
18. Ophthalmoscopy	349
References	358
19. Scleral Vascular Microscopy	359
References	362
20. Capillary Nailbed Microscopy	365
References	372
21. Infrared Photography	373
References	380
22. Oscillometry	381
References	389
23. Calorimetry	391
References	393

<i>Chapter</i>	<i>Page</i>
24. Artery Bank	394
Freeze Dry Technique	394
References	400
25. Coagulation of Blood	401
References	405
26. History	409
Symptoms of Arterial Disease	410
Symptoms of Venous Disease	419
Symptoms of Capillary Disease	421
Symptoms of Lymphatic Disease	422
Symptoms Produced by Non-Vascular Structures	424
References	424
27. Physical Examination	427
General Examination	427
Peripheral Vascular Examination	428
The Presumptive Diagnosis	460
References	460
28. Classification of Peripheral Vascular Disease	462
Arteries	462
Organic	462
Functional	463
Veins	464
Organic	464
Functional	464
Capillaries	464
Lymphatics	467
Tumors	468
Blood Vessels	468
Lymph Vessels	468
29. Arteriosclerosis	471
General Considerations	471
Atherosclerosis	481
Atherosclerosis Obliterans	488
Medial Arteriosclerosis	507
Arteriolosclerosis and Hypertensive Ischemic Ulceration	509
References	511
30. Thromboangiitis Obliterans	519
References	524
31. Arteritis	526
Temporal Arteritis	526
Nonsuppurative Nodular Panniculitis	528
Disseminated Arteritis	530

<i>Chapter</i>	<i>Page</i>
Nodular Vasculitis	531
Erythema Induratum	533
Erythema Nodosum	535
Infectious Arteritis	536
Allergic Angiitis	538
Nonspecific Arteritis	540
Pulseless Disease	540
References	542
32. Collagen Diseases	547
Disseminated Lupus Erythematosus	547
Periarteritis Nodosa	555
Diffuse Scleroderma	559
Dermatomyositis	563
References	565
33. Arterial Thrombosis	571
Thrombosis of the Bifurcation of the Aorta	573
References	574
34. Arterial Embolism	576
Peripheral Embolism	576
Visceral Arterial Embolism	578
Pulmonary Embolism	579
References	585
35. Local Cold Injuries	587
Chilblains; Erythema Pernio; Pernio	587
Frostbite	589
Trench Foot	592
Immersion Foot	593
References	596
36. Ainhum	597
References	599
37. Arterial Aneurysms	601
References	607
38. Arteriovenous Fistulas	611
Congenital Fistulas	611
Acquired Fistulas	613
References	615
39. Raynaud's Disease	619
Primary Raynaud's Disease	619
Secondary Raynaud's Disease	625
References	626
40. Acrocyanosis	629
References	631

<i>Chapter</i>	<i>Page</i>
41. Livedo Reticularis	633
References	635
42. Ergotism	636
References	638
43. Neurovascular Syndromes of the Upper Extremities	639
Scalenus Anticus Syndrome	639
Cervical Rib	644
Costoclavicular Syndrome	650
Hyperabduction Syndrome	651
Thoracic Outlet Syndrome	654
Mal Position Syndrome	654
Pectoralis Minor Syndrome	654
Medical-Legal Aspects of the Neurovascular Syndromes of the Upper Extremities	654
References	658
44. Post Traumatic Syndromes	661
Major Causalgia	665
Minor Causalgia	672
Sudeck's Atrophy	674
References	675
45. Erythralgia	677
References	680
46. Diseases of the Veins	683
Physical Examination	683
Disease States	691
References	703
47. Diseases of the Capillaries	707
Increased Capillary Fragility	710
Increased Capillary Permeability	722
References	724
48. Diseases of the Lymphatic System	726
Lymphedema	727
Lymphangitis	735
References	735
49. Tumors of Blood and Lymph Vessels	739
Blood Vessel Tumors	739
Telangiectasia	746
Lymph Tumors	752
References	754

<i>Chapter</i>	<i>Page</i>
50. Treatment of the Peripheral Arterial Diseases	756
Medical Treatment	756
General Care	756
Drugs	758
Physical Therapeutic Procedures	789
Surgical Treatment	792
References	813
Index	819

Peripheral Vascular Diseases