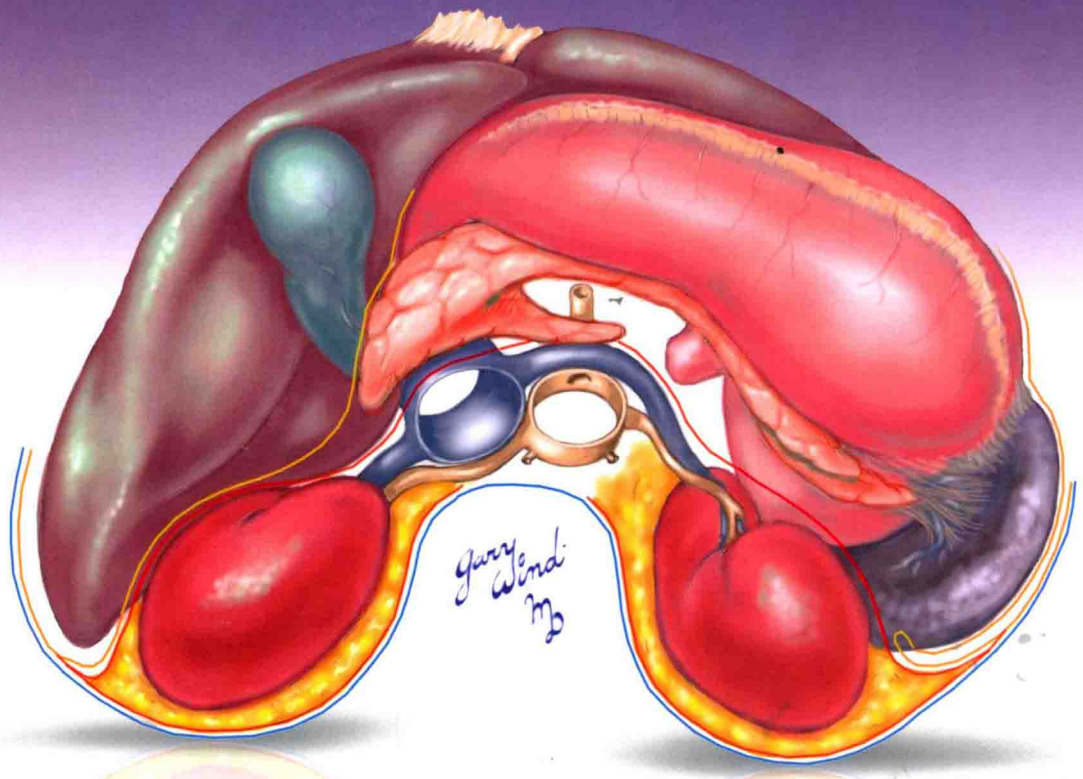
THIRD EDITION

ANATOMIC EXPOSURES IN VASCULAR SURGERY



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GARY G. WIND • R. JAMES VALENTINE

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Anatomic Exposures in Vascular Surgery

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Acquisitions Editor: Brian Brown
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Design Coordinator: Stephen Druding
Production Service: S4Carlisle Publishing Services

Published by LIPPINCOTT WILLIAMS & WILKINS a WOLTERS KLUWER business

Two Commerce Square
2001 Market Street
Philadelphia, PA 19103 USA
LWW.com

Printed in China

Library of Congress Cataloging-in-Publication Data

Wind, Gary G.
Anatomic exposures in vascular surgery / Gary G. Wind, R. James Valentine; illustrated by Gary G. Wind. — 3rd ed.
p. ; cm.
Rev. ed. of: Anatomic exposures in vascular surgery / R. James Valentine, Gary G. Wind.
Includes bibliographical references and index.
ISBN 978-1-4511-8472-3 (alk. paper) — ISBN 1-4511-8472-7 (alk. paper)
I. Valentine, R. James, 1954- II. Valentine, R. James, 1954- Anatomic exposures in vascular surgery. III. Title.
[DNLM: 1. Blood Vessels—anatomy & histology—Atlases. 2. Vascular Surgical Procedures—Atlases. WG 17]

611′.13—dc23

2012036861

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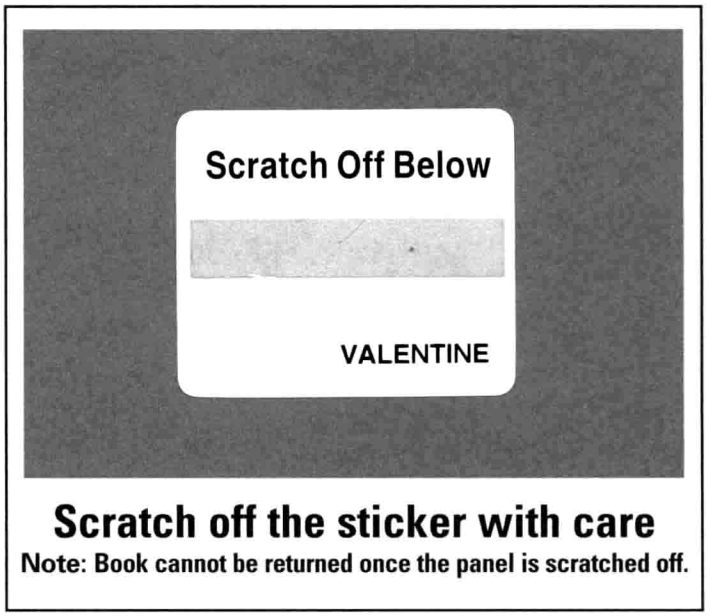

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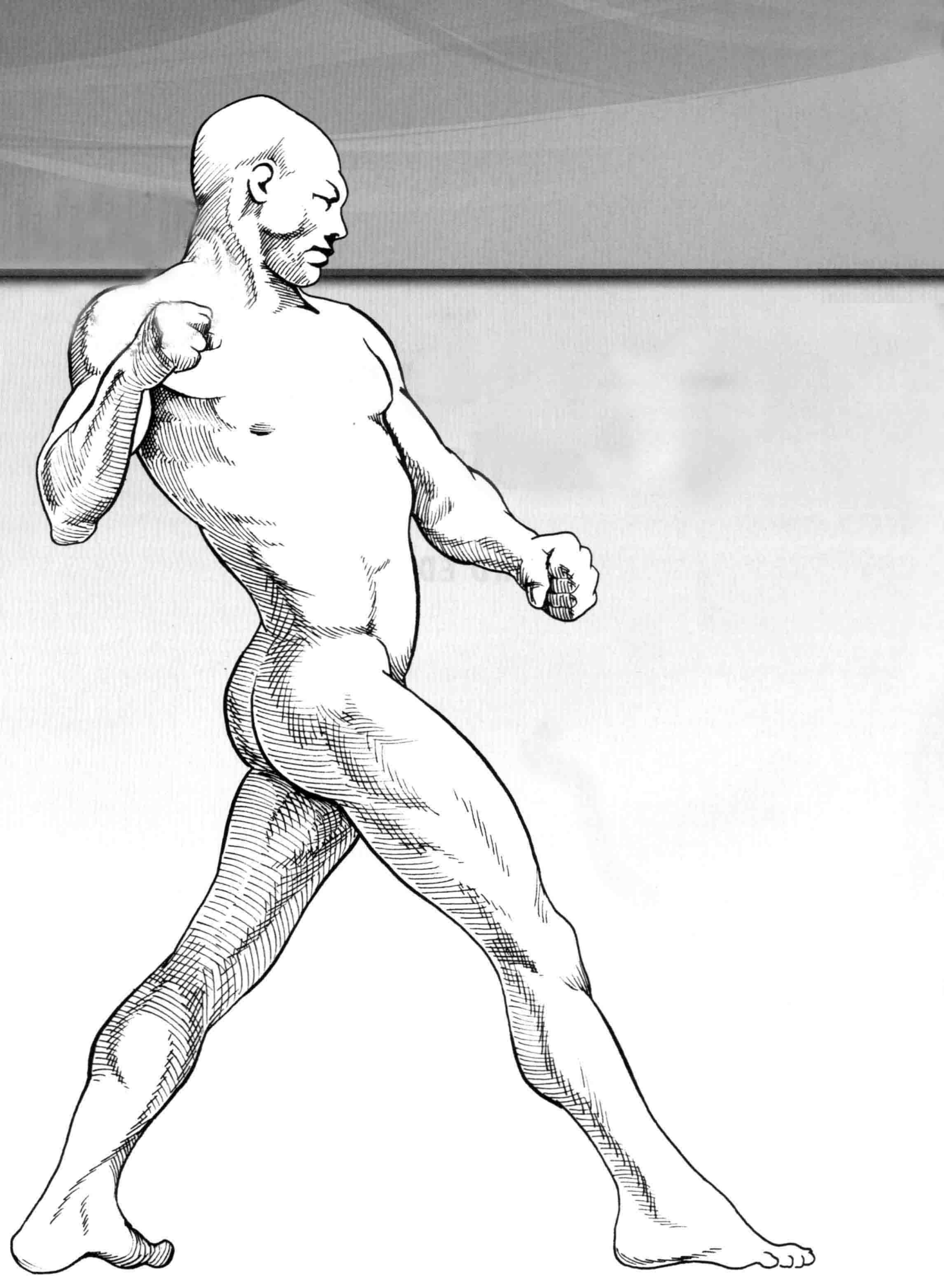

To our wives
Marilyn Gail Wind and Tracy Williams Valentine
for their patience and support

Forearm Fasciotomy:

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FOREWORD FROM THE FIRST EDITION

The illustrations are the strong point of this excellent book. These have been drawn from the perspective of a surgeon who clearly knows what is seen during a surgical operation. An anatomist illustrates the anatomy as seen in the dissecting room. Drs. Gary Wind and R. James Valentine have given us outstanding drawings of what a surgeon will see in the operating room.

Dr. Wind is experienced in the use of a microcomputer to create three-dimensional reconstructions of anatomy. These unusual visual images and models provide different concepts of conventional anatomic views. The knowledge gained from this study of many regions of the body has been used to provide the unusual and very informative illustrations that fill this book. In a standard illustration, it appears that the vertebral artery travels only a short distance before it enters the foramen in the transverse process of the sixth cervical vertebra. A surgeon who has operated on this artery at this point knows that there is a length of several centimeters before it enters the bony foramen. This book is filled with similar useful information, which has been uncovered by Dr. Wind's special anatomical reconstructions. The text is clear and concise and there is a good bibliography after each chapter. This text has obviously been written by those who know what is of importance to a clinician.

Of special interest are two sections, the introduction on embryology and the last section on vascular variation. Such variations have always been a challenge for surgeons. Embryology demonstrates the possible explanations for these variations, and the final chapter on anatomic variations will help the surgeon to expect and identify the unexpected should he or she encounter them.

This is an anatomic book written by surgeons, but the objective has not been to describe surgical procedures. It has been to describe and illustrate the anatomic relationships of blood vessels. The result is a book of great value, not only to vascular surgeons but also to anatomists, because it throws new light on an old subject—gross anatomy.

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†Dr. Charles Rob passed away in 2001. He was a preeminent pioneer of vascular surgery and one of the last of the surgical giants. The force of his personality was always evident beneath his impeccable gentlemanly persona. He will be missed by us and by the surgical world as a whole.

Gary G. Wind, M.D.
R. James Valentine, M.D.

PREFACE TO THE FIRST EDITION

> Dispel from your mind the thought that an understanding of the human body in every aspect of its structure can be given in words; for the more thoroughly you describe, the more you will confuse. . . I advise you not to trouble with words unless you are speaking to blind men.
>
> —Leonardo da Vinci

Understanding the anatomy of the blood vessels is a highly visual enterprise, given the complex ramification of the vascular tree through all the tissue planes of the body. This book is designed to convey the clinical anatomy of the blood vessels through extensive new illustrations with a minimum of words. The focus is on a concise, clear presentation of key anatomic relationships necessary to understand the vascular pattern in all areas of the body. The chapters are divided into anatomic overview and surgical approach sections.

As a monograph, this book has the advantage of a uniform concept and presentation sometimes lacking in multiauthor works. At the same time, as the work progressed we were privileged to have the advice and criticism of the eminent surgeons listed as consulting editors. The visualization of the anatomy was aided by original fresh cadaver dissection for each body region. The clinical insights are based on both experience and a thorough review of current and historical references.

The literature of a relatively young specialty such as vascular surgery naturally grows by accretion as new procedures are devised and perfected. The surgical anatomy associated with the procedures is described in variable detail in the original papers and is then condensed in surgical texts and atlases. There comes a time in this evolutionary process when a comprehensive treatment of the anatomic context of vascular surgery is beneficial. It is the purpose of this book to provide a detailed and practical guide for exposing and manipulating blood vessels with minimal trauma to the surrounding structures and to the vessels themselves.

The format of the book is designed to provide a unified, integrated concept of anatomic approaches to blood vessels. The anatomy is described in the context of the latest techniques and is organized by body region. The same anatomic descriptions should be equally applicable to new procedures as they arise. The text is intended to describe clinically relevant anatomy as concisely as possible without getting bogged down in trivial and esoteric points. The reader is credited with sufficient anatomic knowledge to be comfortable with the level of presentation and with the intellectual curiosity to look up details that pique his or her interest. Illustrations showing surgical approaches depict ideal exposure, and laparotomy pads, which would normally be present to protect wound edges, are omitted for purposes of clarity and orientation. Clinical references are listed at the end of each chapter, and anatomic references are listed at the end of the book. We hope that in this way to bring crisp clarity and unity to the anatomy of vascular surgery.

PREFACE TO THE THIRD EDITION

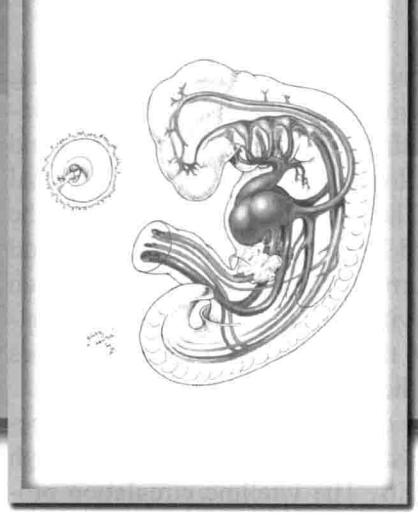
The last two decades have witnessed a surge of interest in catheter-based vascular intervention, with a corresponding decrease in the number of open vascular procedures currently being performed. As the clinical experience with open vascular exposure declines, we believe that there is an enduring need for a comprehensive text that features vascular anatomy from a surgical point of view. The original purpose of this book has not changed—it is intended to be a detailed and practical guide for exposing blood vessels with minimal trauma to surrounding structures. The volume of recent literature regarding novel exposure techniques and refined indications for specific approaches has provided the impetus for a third edition.

Based on favorable response to the previous editions, we have maintained an emphasis on clinical anatomy, focusing on detailed illustrations rather than extensive written descriptions. A key feature of this book is that all of the illustrations were drawn by a single artist, who is also a surgeon and anatomist. This uniformity has allowed inclusion of more detail in each illustration for maximal educational benefit. A major enhancement in this third edition is the use of full color for the anatomic illustrations, giving a greater appreciation of three-dimensional relationships. The procedural text and clinical references have been updated to reflect current concepts. New sections on forearm compartment syndrome/fasciotomy and vascular exposure of the lumbar spine have been added. In addition, references to web-based three-dimensional anatomy resources have been included.

As before, chapters are divided into anatomic overview and surgical exposure sections. The text is written from a surgeon's point of view, using practical descriptions based on key anatomic relationships. Trivial and esoteric details have been avoided. Related clinical discussion is based on a thorough review of the modern literature.

Perhaps, the most important point to be made about this book is that it is intended to have lasting applicability. Human anatomy will not change in the foreseeable future. Vascular procedures may wax and wane in popularity, but exposure techniques remain a standard part of any present or future operation.

CONTENTS



INTRODUCTION
Embryology of the Arteries and Veins

Development of the Blood Vessels

Overview

Between the third and eighth week of embryonic gestation (measured in postovulatory days), the blood vessels form and evolve into an approximation of the definitive human circulatory pattern. Toward the end of the third week, primitive circulation begins, propelled by the newly fused heart. Rapid changes in the fourth week set the stage for extensive remodeling that extends through the second and final month of the embryonic period. Development at the cephalad end of the embryo proceeds more rapidly than at the caudal end as the arteries and veins change and interact with the growing thoracoabdominal organs, parietes, and extremities. The incredibly complex bioarchitectural development and reorganization take place while the embryo is between 3 mm and 3 cm in size (crown-to-rump length; Fig. 1). The next significant change in the vascular pattern occurs at birth.

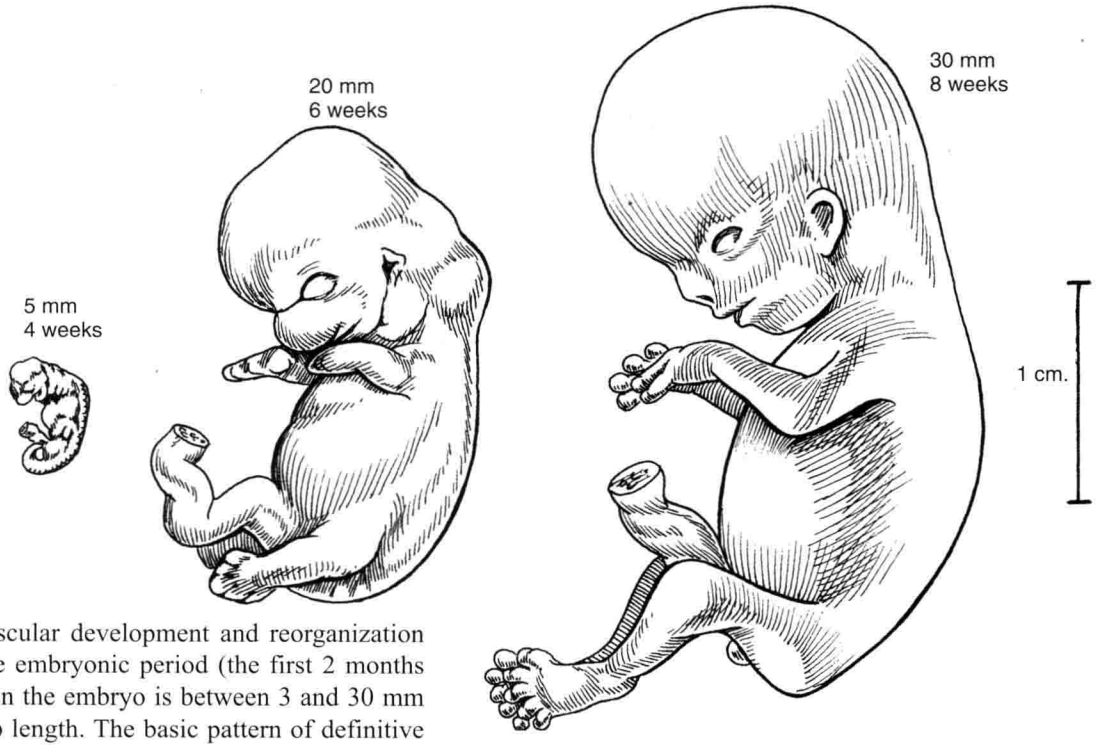


Fig. 1 Rapid vascular development and reorganization takes place in the embryonic period (the first 2 months of gestation) when the embryo is between 3 and 30 mm in crown-to-rump length. The basic pattern of definitive vessels is established by the end of this period.

Understanding the changes that take place in the evolution of the adult vascular system provides a logical framework in which to conceptualize the many variations and anomalies that one will encounter in vascular surgery.

Primordial Vessels and the Inception of Circulation

At the inception of circulation, the embryo appears as a polypoid excrescence within the chorionic vesicle (Fig. 2). The pedicle constitutes the body stalk. The head of the polyp is subtly bilobed, with the groove separating the two lobes reflecting the margins of the embryonic disk within. The dome above the 3-mm embryonic plate is the amnion, and the pendant bleb is the yolk sac.

Between these mirror-image domes, the elongating 2-mm embryonic disk rolls its lateral edges up to begin the closure of the neural groove, and the first somites appear at midbody (Fig. 3). The lining cells of mesenchymal clefts that have developed independently until this time begin to interconnect and form two pairs of longitudinal channels, one medial and one lateral. The medial channels attach to the ends of the paired heart tubes at the cephalad end of the embryo, forming the primitive aortas, which extend into distal vitelline arterial networks. The lateral set attaches to the caudal ends of the heart tubes and will become the vitelline and umbilical veins.

Within a few days, the heart has fused and begun peristaltic pulsations that propel blood through the vitelline circuits. The vitelline circulation provides nutrients from the rapidly regressing mammalian yolk sac for only a brief time before this function is assumed by the precociously maturing chorion. The umbilical vessels, extending from the vitelline complexes through the body stalk and then to the chorion, become dominant.

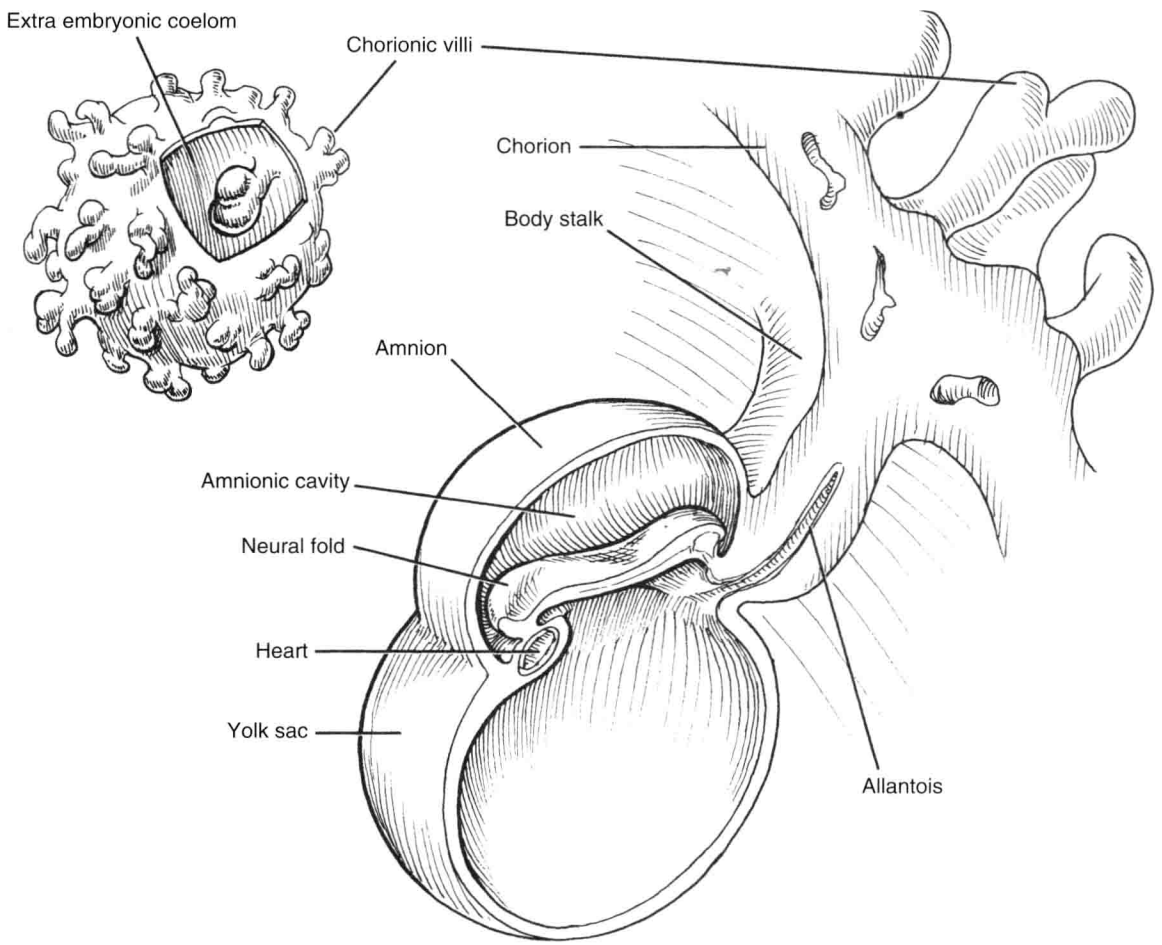


Fig. 2 At the onset of angiogenesis, the embryonic plate lies in a polypoid excrescence within the chorionic vesicle.

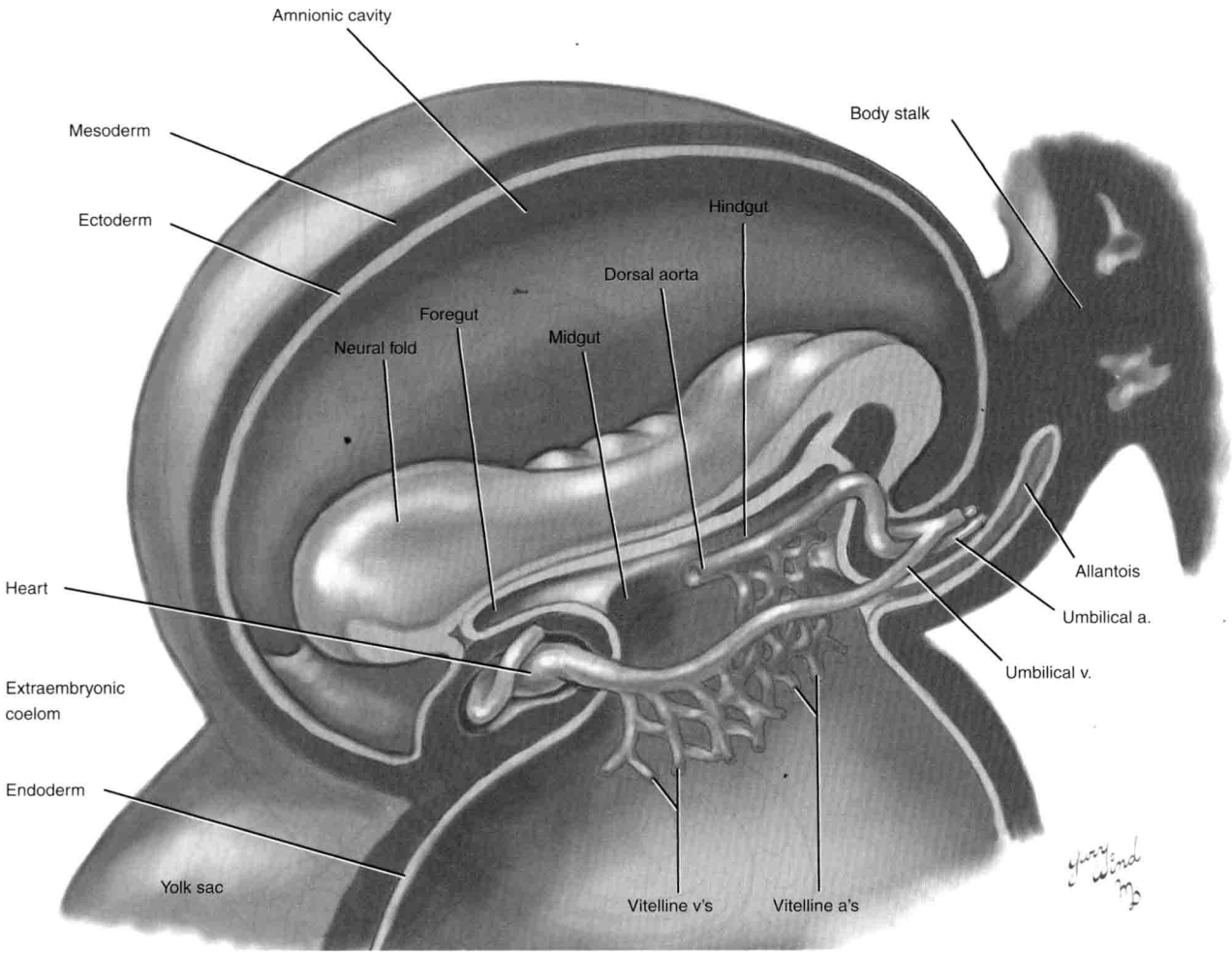


Fig. 3 The first two sets of primitive vessels attach to the ends of the newly fused heart tube.

During the fourth week, the embryo attains a length of 4 to 5 mm, develops a full complement of somites, and begins a series of changes in vascular morphology (Fig. 4). The paired aortas fuse for much of their length and develop numerous dorsal, lateral, and ventral branches. A series of five additional pairs of arterial arches pass laterally around the pharynx between the developing branchial outpouchings, connecting the cephalad apex of the heart to the remaining unfused dorsal aortas. The cephalad arches regress as fast as caudal arches are added, and the six arches undergo evolutionary changes during weeks 5 to 7 (see below). The multiple vitelline arteries regress, leaving three that will become the celiac, superior mesenteric, and inferior mesenteric arteries. Paired pre- and postcardinal veins form in the body wall and attach via common cardinal veins to the caudal horns of the heart, now known as the sinus venosus.

By the end of 4 weeks, four limb buds are evident, with the cephalad set more advanced. The remnants of the vitelline veins are forming sinusoids in the developing liver and coalescing to form the portal venous system. The subsequent simultaneous developments in the arterial and venous systems of the trunk and extremities merit separate description, keeping in mind the parallel time course of these events.

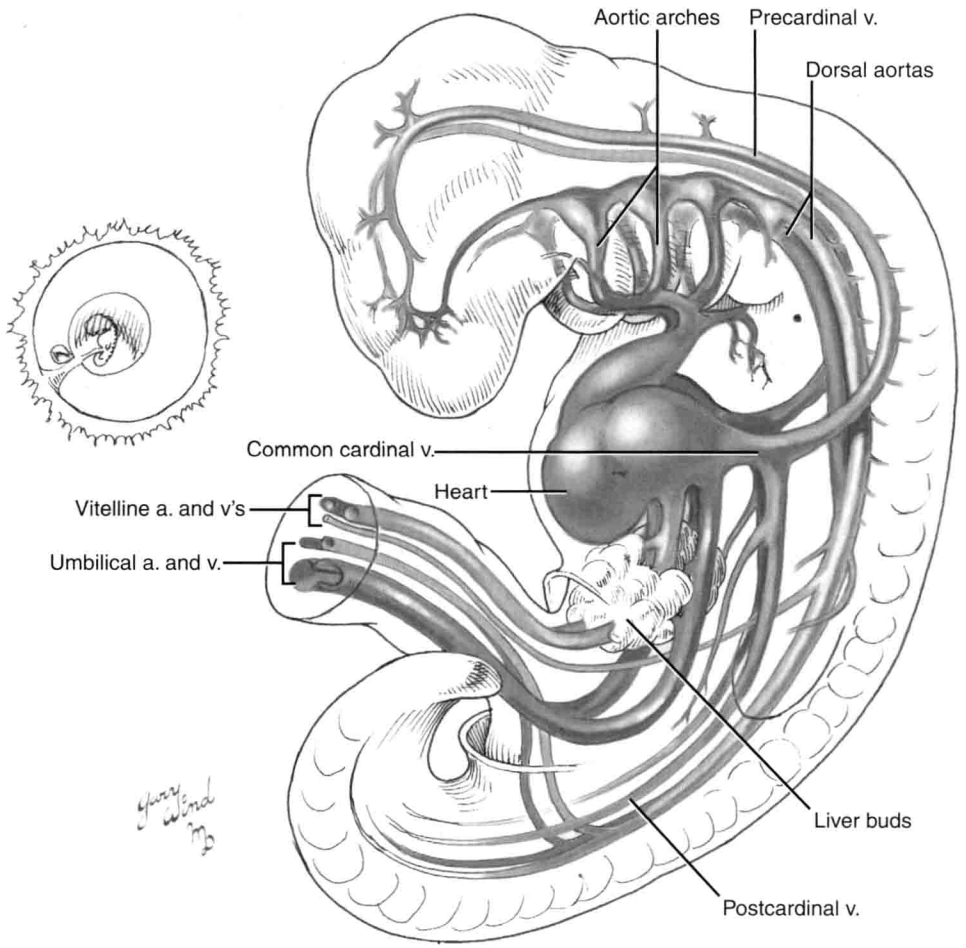


Fig. 4 In the 4-week embryo, aortic fusion has begun, arches are forming, the umbilical vessels are well defined, and the cardinal veins are formed, laying the foundations for the rapid changes of the second month.