

Vasculature of the Brain and Cranial Base

Variations in Clinical Anatomy

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Illustrated by Paul H. Dressel

2nd Edition



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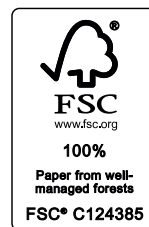
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Preface

The 2nd edition, as was the 1st, is based on hundreds of dissections of the brain and cranial base. It is the culmination of 40 years of my personal study of neurovascular anatomy and relies primarily on morbid anatomy. Frequently, even the most experienced neurosurgeon, cannot be sure of the precise anatomy, nor can the neuroradiologist be sure of the intricacies of the vasculature on an angiographic film. This is precisely the point! The illustrations and figures are meant to expand the “vision” of the neurosurgeon in the surgical field and sharpen the perception of the neuroradiologist, neuroendovascular interventionist, and neurologist.

Nothing is more striking in neurovascular anatomy than the myriad varieties of branching and configuration of ves-

sels. Even after compiling numerous variations on a vessel in the brain, one can still say that two vessels never look exactly alike. The more closely one looks at the subtleties of the vasculature of the brain, the more differences one sees. I have tried to consolidate the classifications of variations of the vasculature of the brain and cranial base and, in some cases, unavoidably had to simplify variations for clarity. The neuroendovascular correlates at the end of each chapter add a dynamic and invaluable addition to this 2nd edition text.

Walter Grand, MD
Senior Author

Introduction

This 2nd edition includes a neuroendovascular correlative section at the end of each anatomical chapter, which adds a nice clinical dimension to the anatomical atlas. This draws on the vast neuroendovascular experience of Drs. Adnan H. Siddiqui and J Mocco. The invaluable illustrations by Paul Dressel in the 1st edition of the variations of the vasculature are mostly retained in the 2nd edition. In the 2nd edition, the anatomical photographs are expanded and improved with more modern digital technical aids. Some of the anatomical photographs from the 1st edition have been deleted and replaced with improved versions. As much as possible, color photographs are used, which is an improvement over the 1st edition.

It is my firm belief that the fundamentals of microvascular anatomy and its variations are still the foundation of understanding and practicing any of the disciplines in the clinical neurosciences. Residents and students in neurosurgery, neurology, neuroradiology, and neuroendovascular interventionists should master the neurovascular anatomy as a prerequisite to performing procedures. The time to learn surgical anatomy is not at surgery or during a procedure but in the laboratory. Surgical anatomy is tedious to learn and requires repetition, but when applied clinically, one will rejoice in the knowledge.

In the 2nd edition, I again have attempted to avoid percentages of frequency, preferring to limit the terminology to “frequent,” “occasional,” and “rare.” In addition, there is no exact size of vessels in the illustrations and figures. For this, the 2nd edition again includes the Appendix (1) for relative size of individual vessels depicted in the atlas. Magnification will give different appearances of absolute size, but the relative size of one vessel or structure to another remains the same. It is unusual to measure a vessel at surgery to identify it. Generally, each series of vascular variations is based on at least 20 multiple dissections and, in some cases, on as many as 100 repetitions. No matter how many repetitions are performed, there will always be one more variation.

One must have time, patience, and documentation. Photography is good in certain situations but should be accompanied at least by a basic drawing. There is nothing more frustrating than a high-powered photograph that is incomprehensible without a drawing. Spending time on a detailed drawing and filling in the “gaps” teaches one anatomy at each phase of the learning process (Appendix 2).

Before embarking on the vascular anatomy, one must study the normal background architecture that is the framework of the vasculature of the brain and cranial base.

This involves not just a quick look at the skull or normal brain, but multiple sessions of radiographic and anatomic review of the cranial orifices and sutures, as well as the gyri and sulci of the brain. In the 2nd edition, these fundamental points are shown again in Chapter 1. Magnetic resonance images are not a substitute for viewing real brain or skull specimens.

The 2nd edition retains the principle of focused attention on visualizing the pattern, configuration, and variations of the blood supply. Frequently, a particular branch does not have a name. In certain instances, the complexity and multiplicity of the variations make naming a particular vessel problematic. Many anatomical texts do not take variations into consideration and force a rigid code of naming particular branches of a trunk vessel. Understanding patterns and variations are as important as labeling the particular vessel. The drawings are presented in a fashion that correlates as accurately as possible with an angiographic projection.

The 2nd edition again rests heavily on the wonderful artistic talents of Paul Dressel, who labored diligently to produce the original drawings, as well as the current formatting. Between the 1st and 2nd editions, many additional cadaveric brain dissections were performed by the senior author to confirm and enhance the illustrations of the 1st edition. The extensive dissections on multiple specimens would have not been possible without the support of the Department of Anatomy of the School of Medicine and Biomedical Sciences of the State University of New York at Buffalo, and Dr. Raymond Dannonhoffer, to whom we are very grateful. I am indebted to the assistance and advice of Jody Leonardo, MD, Rabih Tawk, MD, Andrea Chamczuk, MD, Gus Varnavas, MD, Russel Bartels, MD, Natasha Frangopoulos, MD, Jennifer Lin, MD, Alex Mompont, MD, Josh Meyers, MD, the Buffalo General Foundation, John Tomaszewski, MD (Chairman of the Department of Pathology and Anatomical Sciences, at Buffalo), the Department of Pathology (Buffalo General Hospital), Lucille Miller-Balos, MD (Department of Neuropathology at BGH), Peter Ostrow, MD (Department of Neuropathology at BGH), Reid Heffner, MD (Department of Neuropathology at BGH), Raymond Dannonhoffer, PhD (Administrative Coordinator, Department of Anatomy and Cell Biology at SUNYAB), Leica Microscopes (Larry Bissell), and in memory of Louis Bakay, MD. I am also thankful for the support of the Chairman of the Department of Neurosurgery, Elad I. Levy, MD.

*Walter Grand, MD
Senior Author*

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Basic Anatomy

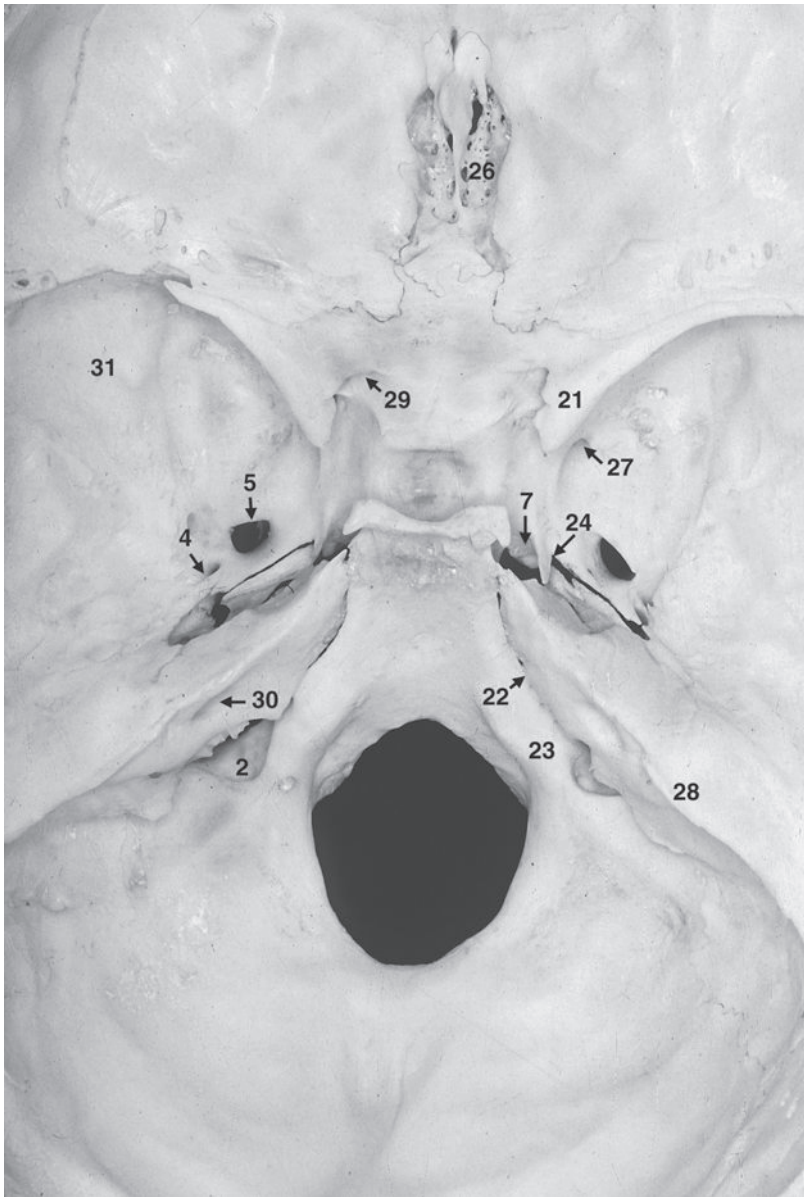


Fig. 1.1 Interior ventral view of the skull.

- 2 jugular foramen (bulb)
- 4 foramen spinosum
- 5 foramen ovale
- 7 foramen lacerum
- 21 anterior clinoid
- 22 petro-occipital fissure
- 23 jugular protuberance
- 24 lingula process
- 26 cribiform plate
- 27 foramen rotundum
- 28 petrous bone
- 29 optic foramen
- 30 internal auditory canal
- 31 temporal fossa

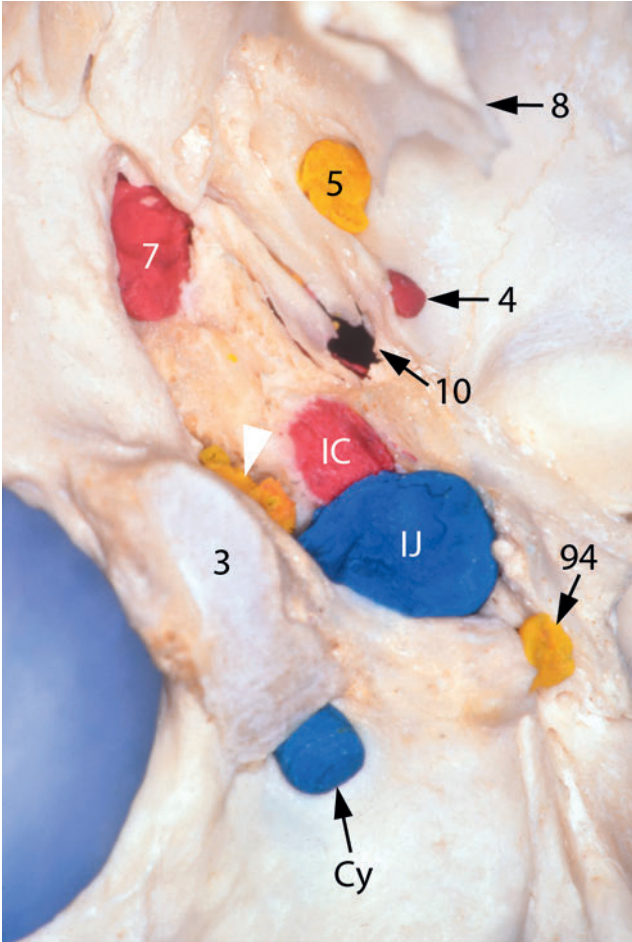


Fig. 1.2 Ventral view of the left side of the skull base.

- IJ internal jugular vein
- IC internal carotid artery
- Cy condyloid venous foramen
- 7 foramen lacerum
- 5 foramen ovale with V3
- 4 foramen spinosum (middle meningeal artery)
- 8 lateral pterygoid plate
- 3 occipital condyle
- 94 stylomastoid foramen (nerve VII)
- 10 bony eustachian tube
- Arrow IX, X, XI nerve complex at jugular neural foramen

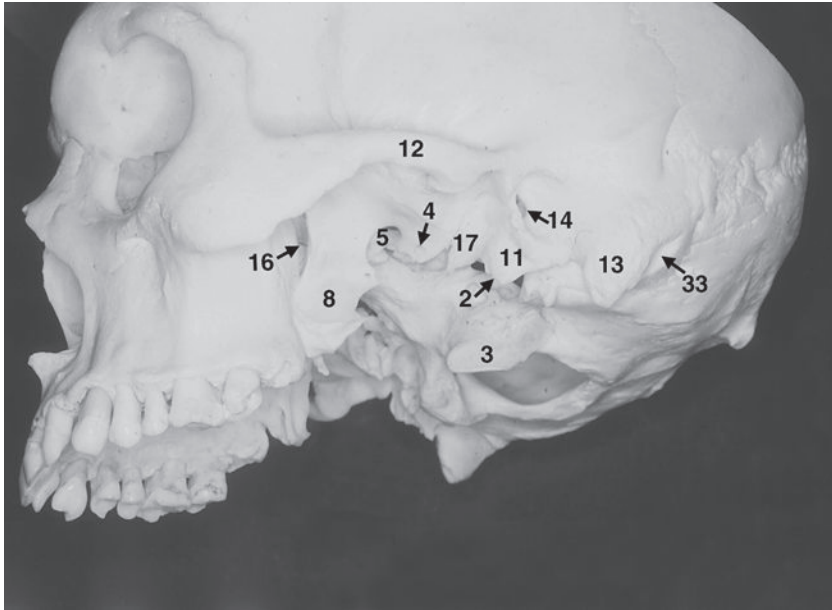


Fig. 1.3 (a) Inferior and lateral view of the skull.

- 2 jugular foramen (bulb)
- 3 occipital condyle
- 4 foramen spinosum
- 5 foramen ovale
- 8 lateral pterygoid
- 11 tympanic plate
- 12 zygomatic process
- 13 mastoid process
- 14 external auditory canal
- 16 pterygopalatine fossa
- 17 crista tympanica
- 33 hypoglossal foramen (nerve XII)

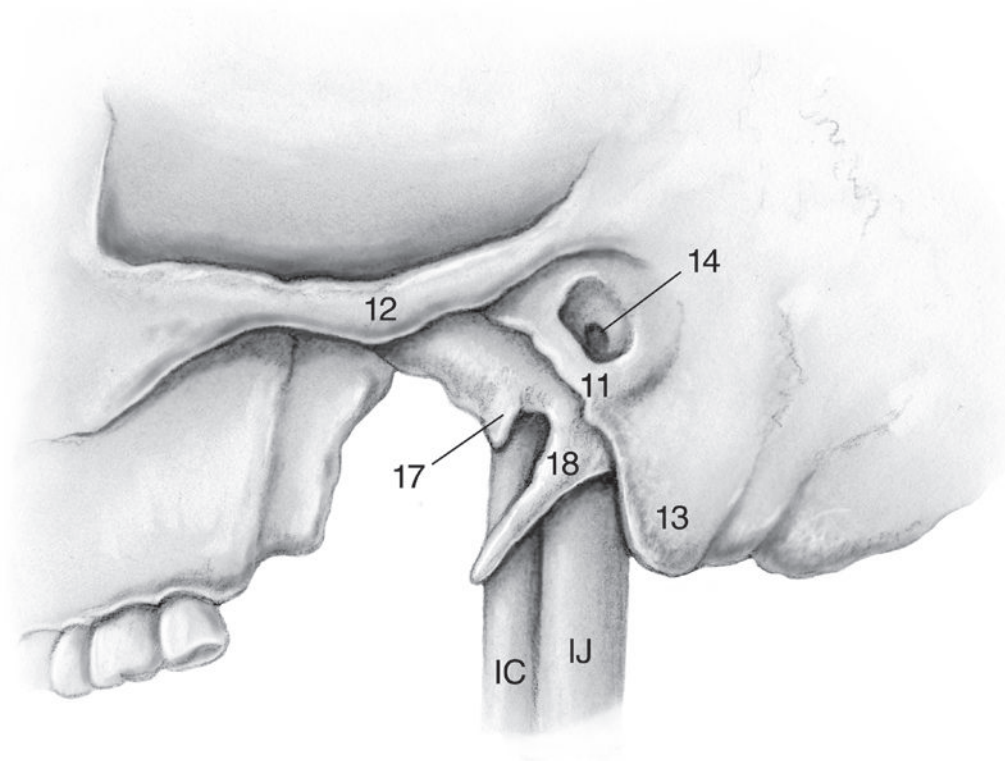


Fig. 1.3 (b) Lateral view of the left cranial base showing the relationship of the styloid process to the internal carotid artery and the internal jugular vein.

- 11 tympanic plate
- 12 zygomatic process
- 13 mastoid process
- 14 external auditory canal
- 17 crista tympanica
- 18 styloid process
- IC internal carotid artery
- IJ internal jugular vein