

Philippe Rigoard
Editor

Atlas of Anatomy of the Peripheral Nerves

The Nerves of the Limbs –
Student Edition

 Springer



ATLAS OF ANATOMY OF THE PERIPHERAL NERVES

ATLAS OF ANATOMY OF THE PERIPHERAL NERVES

THE NERVES OF THE LIMBS

—

STUDENT EDITION

Philippe Rigoard
(MD, PhD)
Professor of Neurosurgery

N3Lab, PRISMATICS: Neuromodulation & neural networks,
Poitiers University Hospital, France

 Springer

Editor
Philippe Rigoard
Spine and Neuromodulation Functional Unit
Department of Neurosurgery
Poitiers University Hospital
Poitiers
France

Translation from the French language edition 'Atlas d'Anatomie Des Membres - Nerfs Peripheriques' by Philippe Rigoard © Elsevier Masson, Issy-les-Moulineaux, 2016; ISBN : 978-2-294-74244-6

ISBN 978-3-319-43088-1 ISBN 978-3-319-43089-8 (eBook)
DOI 10.1007/978-3-319-43089-8

Library of Congress Control Number: 2017953122

© Springer International Publishing Switzerland 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Contributors

Editor, Author

Philippe Rigoard
Professor of Neurosurgery
Spine and Neuromodulation
Functional Unit
Neurosurgery Department
Poitiers University Hospital
Poitiers
France

Project Manager, Co-author

Romain David
Resident, Faculty of Medicine
Limoges University
N3Lab Laboratory
Poitiers University Hospital
Poitiers
France

Graphic Designer

Kévin Nivole
Computer Engineer
N3Lab Laboratory
Poitiers University Hospital
Poitiers
France

Co-authors

Justine Bardin
Resident
Faculty of Medicine
Poitiers University
Poitiers
France

Paul Roblot
Resident
Faculty of Medicine
Bordeaux University
Bordeaux
France

Collaborators: Clinicians

Jean-Philippe Giot
Plastic Surgeon
Hospital Centre
Grenoble
France

Line Jacques
Neurosurgeon
University of California
San Francisco
USA

Tanguy Vendevre
Orthopedical Surgeon
Poitiers University Hospital
Poitiers
France

Bénédicte Bouche
Senior Consultant
Center for Pain Relief
Trélazé
France

Eryk Eisenberg
Senior Consultant
Department of critical care
Clermont-Ferrand University Hospital
Clermont-Ferrand
France

Laurent Soubiron
Senior Consultant
Department of Anesthesiology
Poitiers University Hospital
Poitiers
France

Philippe Denormandie
Orthopedical Surgeon
Raymond Poincaré Hospital
Garches
France

Collaborators, Researchers, Graphic Designers and Technicians

Bertille Lorgeoux

Clinical Research Associate
N3Lab Laboratory
Poitiers University Hospital
Poitiers
France

Olivier Monlezun

Associate Practitioner
N3Lab Laboratory
Poitiers University Hospital
Poitiers
France

Manuel Roulaud

Clinical Study Coordinator
N3Lab Laboratory
Poitiers University Hospital
Poitiers
France

Clarisse Habbouche

Medicine Student
Faculty of Medicine of Poitiers University
Poitiers
France

Redaction Contributors

Nancy Ladmirault

Secretary of N3Lab Laboratory
Poitiers University Hospital
Poitiers
France

Carole Robert

Secretary of Radiology Department
Poitiers University Hospital
Poitiers
France

Translators

Maxime David

M.A. in Languages and Economy Post-graduate
La Rochelle University
La Rochelle
France

Lee Wesley

Pain clinic
St Thomas & Guy's Hospital
London
United Kingdom

Foreword I

There is no argument that one cannot be a surgeon without detailed knowledge of anatomy. And of all human organs and systems, the anatomy of the nervous system is by far the most complex and most fascinating – something even non-neurosurgeons would probably agree. But the fascination frequently, and reasonably so, focuses on the central nervous system; after all, the anatomy of the brain and spinal cord is inseparable from their function, and the brain functioning makes a person alive. But the peripheral nervous system is what connects the brain and spinal cord with the rest of the body, what carries information to and from it, makes us move and feel, in effect allowing us to function.

When I first heard about Dr. Rigoard's project aimed at creation of comprehensive but user-friendly atlas dedicated to the anatomy of the peripheral nervous system, I was very doubtful that he will be able to pull it through – a prominent and busy practicing neurosurgeon, who, on top of his professional life, is deeply dedicated to his family, is not expected to complete such grandiose task while maintaining a full-time clinical practice. But he proved me wrong – this atlas is a reality and its level surpasses all expectations! A combination of high-quality anatomical drawings with amazing computer graphics and deep understanding of functionality of the peripheral nervous system is the basis of this anatomical masterpiece.

When I discussed the contents of this atlas with its creator, Dr. Rigoard reminded me that there is a concept of dividing peripheral nervous system into three main components: the cranial system that contains both somatic sensory motor, special senses and vegetative part, and develops from branchial arches; the axial system that includes prototypic mixed sensory motor nerves, gets derived from metameric spinal branches, and also includes vegetative component; and, finally, the so-called exploratory system that focuses on exploration of the surrounding environment and allows one to move around and gather information from outside world using the “extensions” of the trunk called limbs. This volume of the atlas is dedicated to the latter system and is focused on the innervation of limbs starting with dedicated plexuses and continuing with major peripheral nerves.

Anatomy books are the milestones in development of modern medicine. Just few years ago, we all celebrated 500 year anniversary of the original publication of “The Fabric of the Human Body” by Andreas Vesalius – and that book is alive even now. Reading the Rigoard's atlas of the peripheral nervous system, I could not resist the temptation to compare and contrast these two treatises separated by a half of millennium: the anatomy did not change, and neither did the much needed attention to detail. What changed is our understanding of function, and, most notably, our ability to develop three-dimensional representation of anatomy, and this difference makes this anatomical atlas more practical and more useful.

Merging art and science, Dr. Rigoard and his team succeeded in creating a remarkable teaching tool that will help innumerable medical students and trainees all over the world to better understand peripheral nerves. As a matter of fact, I feel that this atlas will be most beneficial to the practicing neurosurgeons and neurologists who can use it to augment their daily practice through improved familiarity with anatomical nuances that explain a multitude of clinical conditions and guide various diagnostic and therapeutic procedures.



Professor Konstantin V. Slavin, MD, FAANS
Department of Neurosurgery
University of Illinois at Chicago, Chicago, USA
Past President, American Society for Stereotactic and Functional Neurosurgery, www.assfn.org
Director (ex officio), North American Neuromodulation Society, www.neuromodulation.org
Director-at-Large, International Neuromodulation Society, www.neuromodulation.com
Vice-Secretary, World Society for Stereotactic and Functional Neurosurgery, www.wssf.org
kslavin@uic.edu

Foreword II

The *Atlas of Anatomy of the Peripheral Nerves* written by Prof. Philippe Rigoard has an innovative approach ranging from anatomy and neurosurgery to medical imaging.

At first glance, one is immediately struck by the modern, rich iconography of this book dedicated to the nerves of the limbs.

Basing their work on real anatomical facts, the author uses computer technology in order to transfer the knowledge necessary for exploration, diagnosis and medical and surgical care.

The study of each nerve is considered in all its aspects: embryology, morphology, physiology, medicine and surgery. All of this is accompanied by new scientific acquisitions.

This work confers great honour to the author and his international team, whose members are all passionate about anatomy, computer science or innovating surgery.

I am firmly convinced that the students following initial or neurosurgery courses will highly benefit from this wonderful pedagogical book dedicated to peripheral nerves.

Pierre Kamina
Professor Emeritus of Anatomy
Poitiers University
Poitiers, France

Acknowledgements

To Jean-Philippe Giot,

For all the hours spent in front of our computers during the atlas' beginnings, discovering and then trying to familiarise with Blender to infuse my watercolour sketches of classical anatomy with a graphical virtuality and to give them a life in dynamic 3D.

To Monique,

For her exemplary tenacity and generosity she shows day to day for us. For the skill with which she coloured some figures with her left hand and also her kindness for reading the achieved atlas.

To Bénédicte Bouche,

Genuine artist of stimulation. For her unique vision of peripheral nerve stimulation, her genius, her enthusiasm and her sincerity.

To Line Jacques,

For being so generous as to supply us with some pictures of surgical views that correspond to more than 20 years of experience in peripheral nerve regeneration in Canada.

To Maxime,

The ambassador of the international version of this book. His persistence, his devotion and his very linguistic skills have proven to be very useful for making the English version of this atlas come to life. A big thank you.

To Nancy,

For her precious collaboration, her friendship and her taste for adventure.

To Prof. Françoise Lapierre,

Without whom I would never have become a neurosurgeon with a keen interest for anatomy, handicap surgery and peripheral nerves. Her day-to-day accompaniment, trust and kindness have allowed many adjustments and have allowed me to discover myself. She instilled a demanding nature as well as humility in my everyday life. She made me understand that humour could be a resource and a form of wisdom that is worth many other forms of knowledge. She asked me to explore every nook of the unexpected in order to adapt, grow and resist. Finally, more than anyone else, she made me feel the desire to give freely to learning surgeons and anatomists so as to feel accomplished through my students and realise that, ultimately, the goal of teaching is *sharing*.

To Prof. Benoit Bataille,

For the freedom he always bestowed upon me and for his support as a mentor.

To Dr. Bertrand Leriche,

Who uncovered a small part of his talent, taught me and patiently watched me decompress my first carpal tunnels and femoral cutaneous nerves, at the Hospital Centre of Saint Pierre, Island of Reunion, as a father would have. May his benevolence and kindness here be gratified.

To Prof. Konstantin Slavin,

Who welcomed me so warmly in his Department of Neurosurgery in Chicago in summer 2013. Beyond his very impressive surgical skills and worldwide recognized expertise in the neuromodulation field, I discovered a Man guided by selfless principles, inspired by Art and driven by a peculiar positive energy. He is to be remembered by his students and colleagues alike as one of this century's most brilliant pioneers of neuromodulation. I am honored for my path to have crossed his and grateful for the moments we shared exploring Neurosurgery. I will always remember him as an example and try to follow his steps, as a source of inspiration.

To Prof. Kamina,

Who welcomed me with open arms as soon as I arrived in Poitiers in 2000 and who trusted me from the beginning and suggested that I express my interest for anatomy, right since my first semester of internship in surgery, in the frame of the amphitheatres of the Faculty of Medicine of Poitiers, a chalk in the hand.

To Dr. Dominique Bastian,

My first professor of anatomy, in the Faculty of Medicine of Saints-Pères, Paris, a brilliant mind, marginalised by his avant-garde vision of modern anatomy. An exceptional draughtsman. An artist capable of accommodating us for several years, several times a week, in his office above the rooftops of the Quartier Latin to draw so many memories, paintings and charts on the walls. It was with him that the first step of popularisation of the human body allowed me to discover the extent to which humans can be considered so complex and so simple at the same time. It was with him that the vision of a structure prolonged itself in that of an animated body, when he allowed me to walk through the doors of the Gobelins School of Arts or those of the course of morphology in Ecole des Beaux-Arts.

To Prof. Vincent Delmas,

For the trust that he always granted me.

To Prof. Jean-Pierre Richer,

Prof. Jean-Pierre Faure and Dr. Cyril Breque and all the personnel of the anatomy laboratory of the medicine faculty of Poitiers University for their warm welcome. We were able to come and work regardless of the time or circumstances and always be welcome with a smile and great professionalism. Thank you for your sincerity and complicity. Thank you for always being by our side.

To Prof. Remy Guillevin for giving access to his radiology department for my team, as well as all the technicians specialised in medical electroradiology of Poitiers Hospital Centre for their kindness, their availability and their advice.

To the N3Lab:

Bertille, for her meticulous assembly work; this atlas was a revelation. She has truly bewildered us.

Manuel, for his faultless availability and his samurai spirit.

Olivier, for his management skill and day-to-day cheerfulness.

For all the students learning neurosurgery or anatomy and those pertaining to the spine department of Poitiers Hospital Centre who worked for the project of this atlas:

Guillaume

Sophie

Eleonore

Enel

Clarisse

Aziz

Paul

And particularly to two young and bright learning anatomists,
Justine Bardin and Romain David,
who managed to find the strength and courage to dive, like two conquerors, in this anatomical atlas, whilst still studying medicine, and to sublimate their watercoloured works to the highest degree to make this book unique and contemporary. May their passion of “beautiful and well-done work” be rewarded with a career as bright as they deserve.
Romain, this adventure has brought you to a revelation and has progressively propelled you from “second in command” to “navy captain”. I hope that this paternal inspiration will help you navigate across the most beautiful seas of the human anatomy, quench your thirst of discovery and go on a quest, in your turn, to find “‘seconds’ in command” that will deserve the way you share your passion and inspiration. You will then be rewarded for all the sacrifices that made you a wonderful project manager and a fellow traveller without equal.
May you hereby be gratified.

To Kevin Nivole,
For his exceptional investment in the graphical and computing conception of the atlas. We made a great anatomist of you!
This atlas owes you a lot.

To Nathalie L’Horset-Poulain and the publishing house Springer, for the trust they granted us and the allure of this relationship. May this book be the first of a long and beautiful collaboration.

To my family, my parents and my brother.

To Nathy and Manoé,
The two sunshines of my life, who brighten my vision on so many things.
I dedicate this atlas to you, as the result of intense labour and many compromises, so that it seals a chapter, a time of our lives, at the end of which so many expectations and dreams, far from work and books, must now be satisfied. Thank you for respecting my passion for all these years and, above anything else, believing with such intensity in our love.



The hanging garden

Philippe Rigoard,
New Caledonia, December 2015

Painting inspired from the tropical plants and flowers of Monique and Jean-Pierre Le Leizour's garden
Acrylic paint, oil, cardboard, personal photographs, watercolour, charcoals and felts

Preamble

PHILOSOPHICAL APPROACH OF AN ANATOMICAL GARDEN

*Is there anything more beautiful than a garden adorned with fruit trees and odoriferous plants,
at the base of which flows a crystal clear water?
The Silence Relay (Le Relais du Silence), Saintes,*

Poitou-Charentes, 2014

This enchanting garden will exhilarate our senses, offering us its multicoloured palette, and it will distil its spices reminding us that it is nature itself, as opposed to the artificial elaboration of the mind, and that it is the opposite order to the well-reasoned, the unconscious against the constructed.

Trying to decompose the morphology of a garden without altering it completely, in order to measure its beauty and savour its meanders a little more, corresponds to the challenge of producing an anatomy atlas that is intended as innovative.

The quest of this garden is the anatomical journey that is given to you in this book. It is a journey along collateral arteries and muscle frameworks, a journey at the core of the human body.

Anatomy is a science applied to medicine; it's a living discipline, a day-to-day reality. In the way that anatomy is currently taught to students, the proliferation of teaching materials and platforms is too often privileged as well as the literary and theoretical character, even though this teaching should primarily be visual and tactile. Where the main subjects are curvatures and reverse curvatures, it should be possible to learn how to draw them and how to feel them.

What is the use of anatomy?

Anatomy, from its morphological approach, starts straight at the physiological, radiological and even semiological knowledge. It is anatomy that allows a young student in medicine to learn the distinction between "normal" and "pathological". From its surgical approach, anatomy will then guide the novice as the confirmed surgeon to highlight one structure or another to realise an approach they are not used to. The anatomical basics should seal the medical skill and help the (future) doctor to build up his knowledge of mankind.

The teaching of anatomy must remain simple and in the end rather popular. The human body is a living painting.

It should focus on the progressive development of a figurative GPS* in the head of an individual and, this way, use the technological tools at our disposal nowadays, converting surface into volume, a paper sheet into layers and textures. This has led us to offer an atlas defined in three dimensions.

This atlas has been conceived in an atypical and unique way to correspond, in a manner of speaking, to an illustrated log-book, just like what a young companion may gather along his medical formation.

*GPS: global positioning system

«The hanging gardens,
They are the ideal perpetually sought and fleeting of an artist,
They are the inaccessible and inviolable refuge.... »

Jehan Alain, poet, organist and composer (1911–1940)

