Karl A. LeBlanc
Andrew Kingsnorth
David L. Sanders
Editors

Management of Abdominal Hernias

Fifth Edition

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Editors
Karl A. LeBlanc
Surgeons Group of Baton Rouge of Our Lady of the Lake Physician Group
Baton Rouge
Louisiana
USA

David L. Sanders
North Devon District Hospital
Barnstaple
United Kingdom

Andrew Kingsnorth
Peninsula College of Medicine and Dentistry (Emeritus)
Plymouth
United Kingdom

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Preface

Quantum leaps in mesh technology and minimally invasive surgery have seen the practice of hernia surgery improve beyond recognition since the first edition of this book was written 30 years ago. The pace of progress continues with the introduction of robotics and advanced techniques of abdominoplasty. Such progress results from the contributions of many individual surgeons. We would like to acknowledge our good fortune in having the benefit of such a galaxy of internationally renowned experts who have shared their experiences to compile this text.

To update each chapter and introduce new topics, an extensive review of the literature has been undertaken, in order to identify important advances which can be translated into general surgical practice. What has emerged is an in-depth consideration of all aspects of hernia management and of each type of abdominal wall hernia. Our approach has not been uniform; we have allowed the contributors to emphasise the facts that they deem important to their area of specialisation in hernia surgery. The common varieties receive extra attention and discussion. Topics covered in depth include the management of patients with co-morbidities, particularly morbid obesity, ambulatory surgery and anaesthesia and choice of mesh. The avoidance of wound dehiscence is of fundamental importance to the avoidance of abdominal incisional hernias, and a chapter has been introduced on this topic.

Although much of the content of this book will not be relevant to low-income countries due to cost considerations, because of increasing interest in globalisation and volunteerism, we have commissioned a chapter on management of giant inguino-scrotal hernia, as it would be carried out in a poorly resourced, but optimally managed, environment. For the surgeon starting out on a career specialising in abdominal wall surgery, the description of rare intraoperative and postoperative complications will reduce the risk of poor outcomes.

Finally, continued progress in the surgical treatment of hernias relies on fresh talent and an early recognition of potentially revolutionary changes in clinical practice. With this in mind, Andrew Kingsnorth and Karl LeBlanc have recruited David Sanders, a younger surgeon already experienced and specialised in hernia surgery, to assist in editing this book. Although the content is directed primarily at the specialist, individual chapters can be accessed to provide important insights for other surgical disciplines and the non-specialist.

Baton Rouge, LA, USA — Karl A. LeBlanc
Plymouth, UK — Andrew Kingsnorth
Barnstaple, UK — David L. Sanders

Preface for First Edition (1988)

Another book on hernia? Well, not quite! My intention was to produce a neat practical book on hernia, not an exhaustive text. But a book about hernias would be incomplete without mention of the past; hence, the 'practical book' has become encrusted with history and anecdote, and conceivably the book is more readable for this. Almost all the material included has already been published elsewhere—the skeleton is the section on hernia in the current edition of Rob and Smith's *Operative Surgery*, also published by Butterworths, whereas other parts have appeared in *The Lancet*, the *British Journal of Surgery*, the *Annals of the Royal College of Surgeons of England*, *Surgery*, *Surgical Review I* and *Recent Advances*. The work on economics and administration has appeared in *The Lancet*, the *Health and Social Service Journal*, various Department of Health publications and, most importantly, the Royal College of Surgeons of England Guidelines for Day Case Surgery (1985).

I am grateful to the respective editors and authorities for permission to reproduce from these articles and in some cases to expand them. Hernias, their complications and their management continue to use much surgical resources; repair of a groin hernia is the commonest operation in males and the third commonest operation in British hospitals. Sadly, the results of hernia surgery are still far from ideal. Long hospitalisation spells, perioperative complications and, above all, unacceptable recurrence rates disfigure our surgical audit. Practically every book about hernias reiterates the cliché that too often the repair of a hernia is undertaken by the inexperienced or infrequent operator—the statement has added cogency in an era of healthcare cost containment and computerised medical records. It is now easy to compare durations of stay and complication rates and then, using record linkage, to identify the recurrence receiving treatment elsewhere some years later. You no longer need a surgical training to undertake this accounting of results! The results of hernia repair are improved by specialisation. The Shouldice Clinic in Toronto dictates the gold standard. The anatomical variations and technical difficulties of hernia surgery are such that the advisability of specialist hernia units, similar to the regional cardiothoracic units in the National Health Service, merits consideration. Whereas we can debate whether primary hernia repair should remain in the province of the 'general surgeon', recurrent and incisional hernia repairs demand extra skills and such cases should always be referred to experts. The prevention of iatrogenic, incisional hernia should be a priority for abdominal surgeons and gynaecologists, yet in all series of incisional hernioplasties, surgeon failure at the initial operation is often well documented.

The use of inappropriate suture material, sloppy technique, haematoma and sepsis are the all too frequent progenitors of the troublesome incisional hernia. In setting out my stall, 20 years' experience of hernia surgery, I acknowledge the influence of teachers, particularly the late Frederick Gill, PRCSI, who persuaded me to make myself a surgeon; Austin Marsden, FRCS, who convinced me there is a hernia problem; and Sir Hugh (Lyn) Lockhart-Mummery who taught me so much about surgical technique and its gentleness. To these gentlemen I owe a major debt. Caroline Doig, Allan Kark, Nick Barwell, James Bourke and Frank Glassow have all shared their experience and interest in hernia surgery with me. Percy Payne and

Maurice Down have explained all about trusses and demonstrated these appliances to me. Above all, these two gentlemen told me much of the history of British hernia surgery which has corrected my perspective of the recent past.

My colleagues in Stockton-on-Tees and in the North East have referred many of the more complex hernias to me, hernias that have presented technical challenges but afforded me new insights into the anatomy and pathology of hernia. Former junior colleagues have contributed greatly; P. Tiwari, Ranu Singh, A. K. Sahay, Dirk Muller, Denis Quill, Peter Gillen and Bruce Waxman deserve a mention. Permanent members of our department who have a major impact on my perception of hernia surgery include Laurence Rosenberg and Greg Rubin. Mary Fell has undertaken all our socio-economic interviewing and managed all our research into these fields. Irene Anderson has checked references and done a myriad of secretarial tasks. Elizabeth Clemo and her staff at North Tees Medical Library have undertaken all the library searches. The libraries of the Royal Society of Medicine and the Royal College of Surgeons of England have tracked down all the more difficult and obscure books I needed. Alexandra Maclean kindly checked and indexed the references for me.

The photographic work has been done by Ken Watson. Peter Gill and Elizabeth Dillon have undertaken numerous X-ray and ultrasound examinations of hernias for me over the years, and both deserve my particular thanks. Angus McNay and Katherine Denham have helped me with statistical problems. I thank Ron Lawler for the photomicrographs at the Department of Medical Photography at North Tees. The artwork is by Gillian Lee, and it has been a great pleasure to work with her. Surgery books are nothing without artwork; Gillian has put as much into this venture as I have. John Lunn advised me about anaesthesia and persuaded me about other aspects of hernia surgery and surgical audit. Former registrars have assisted me very generously in preparing the various drafts of the text: Simon Raimes, Nigel Fox, Stewart Nicholson, Tom Keane and Paul Stuart deserve my special thanks for their patience and tolerance in that task. The main burden of turning all this into a book has fallen to Julie Davies. She has painstakingly converted all my handwriting into neat typescript, word processed this and finalised the ultimate manuscript. Books need publishers and sub-editors; Butterworths have supported and encouraged me throughout the enterprise. My particular thanks go to John Harrison and to Bob Pearson for all the work they have undertaken. Lastly, and most importantly, my personal secretary, Anne Lindsley, has kept our surgical service on the road despite my involvement in this project. To all of these colleagues, and to many others, I must express my thanks for their help and enthusiasm.

Note on Terminology. Hernia repair, herniotomy, herniorrhaphy and hernioplasty are terms that are almost but not quite interchangeable. Herniotomy (Gk temnein, to cut), herniorrhaphy (Gk *rhaphe,* a seam) and hernioplasty (Gk *plassein*, to mould) connote slightly different meanings. Herniotomy is appropriate to the inguinal operation in children only and I have used it solely in that context. Otherwise, sometimes herniorrhaphy or sometimes hernioplasty is correct, but to switch terms about within the book makes reading difficult. I have, therefore, settled for hernioplasty throughout, perhaps realising that effective hernia surgery requires all the skills of tissue handling and repair that plastic surgeons so rightly emphasise.

Stockton-on-Tees, UK H. Brendan Devlin

Preface for Second Edition (1998)

This second edition reflects the rapidly changing world of hernia surgery since 1988. A new, younger author has participated fully in this new edition. Three events have precipitated the need for a new edition: the concept of the 'tension-free' repair introduced by Irving Lichtenstein, the revolution caused by the laparoscope and the increased role of economics in the contemporary cost-constrained healthcare system. The realisation from the work of Raymond Read, that underlying most, or all, abdominal wall hernias is a defect in the fascia transversalis and that this layer needs replacing, is the seminal advance of replacement by prosthetic mesh introduced by Lichtenstein. This has very important messages for hernia surgeons. Incorporation of this concept into everyday practice is a powerful reason why a new book about hernias is needed. The new biocompatible plastic meshes and the widespread adoption of mesh replacement repairs in hernia surgery is an important, almost revolutionary, development of contemporary surgery. The laparoscope and its need for a role has captured patients' and surgeons' imaginations and required some overview of the use of this tool in hernia repair. Coupled with this, added cogency has been given to questions of cost and outcomes in evaluation of laparoscopic surgery. The laparoscope makes this new edition inevitable.

There is now a consensus that money will always be limited for surgery and surgeons must perforce adopt cost-efficient and cost-effective surgery. These important conclusions are spelt out in the (Revised) Guidelines for Day Case Surgery issued by the Royal College of Surgeons of England in 1992. Above all, this new edition has benefitted from the resurgence of interest in the age-old problem of hernia surgery. The authors' friendship and conversations with many hernia surgeons worldwide are reflected in this new text. European surgeons Kark, Schumpelick, Paul, Nilsson, Stoppa and Kux; transatlantic surgeons Wantz, Gilbert, Skandalakis, Bendavid, Alexander and Rutkow; Indian surgeons Sahay, Doctor and Rajan; and many others worldwide have all indirectly participated in this work.

In this second edition, the artwork is again drawn by Gillian Lee. It has been an enormous pleasure for both of us to work with her. Elizabeth Clemo and the librarians at North Tees General Hospital and Tina Craig and Michelle Gunning of the Library, Royal College of Surgeons of England, have always very willingly helped find different texts for us. Our secretaries Valerie Peel and Jill Laurence have worked fabulously to put the manuscript into shape. Our publishers, especially Nick Dunton, have been a great support throughout the whole venture. Doreen Ramage, our senior production editor, has patiently guided us throughout; we thank her particularly. Finally, we have written the book together, so whatever its faults and omissions they are our failings alone.

Stockton-on-Tees, UK — H. Brendan Devlin
Plymouth, UK — Andrew N. Kingsnorth

Preface for Third Edition (2003)

The first edition of this book was a monograph written by the late H. Brendan Devlin and was a landmark in the scientific analysis of surgery of the abdominal wall, which discarded many of the older out-of-date concepts. We are heavily indebted to Brendan not only for providing the basis for this text but also for the inspiration to follow along a line of inquiry for evidence-based material to present to our readers. At the same time we have not neglected the importance of historical and economic aspects of hernia surgery and some of our own personal views.

Andrew Kingsnorth assisted Brendan in writing the second edition of this book, and Karl Le Blanc now adds an entirely new perspective from North America with particular emphasis on the use of prosthetic materials and laparoscopic techniques. We have thoroughly revised and added to all the chapters resulting in an increase in material of approximately 50% and the addition of hundreds more up-to-date references. We have also provided the reader with clear line drawings of operative techniques, photographs and several short video clips on CD. This extra effort should allow the reader the ability to adopt and apply much of the information and operative techniques that are presented. The technological revolution that began a decade ago, and still continues to evolve, has therefore been fully recognised in this text which we believe will appeal to surgeons in training and those already experienced in managing abdominal wall hernias. It is hoped that this work will be an effective reference to all those that possess this book.

Plymouth, UK — Andrew N. Kingsnorth
Baton Rouge, LA, USA — Karl A. LeBlanc

Preface for Fourth Edition (2013)

The literature in hernia surgery is vast, and keeping abreast of developments is a never-ending task that one or two individuals may find difficult to fit into their daily routine. With this in mind, for the fourth edition of this book, we have recruited selected experts to write each chapter, so that a ray of discerning knowledge is beamed into each crevice of the hernia story to create a comprehensive and authoritative text. A detailed description of the anatomy of the abdominal wall is of utmost importance and a primary concern for planning all hernia operations. Recent technical developments will influence our decision making now and in the future. More training is needed to increase awareness of a large number of prosthetic meshes, innovative plastic procedures and the appropriate use of biologic meshes. Each requires a thorough knowledge of the literature and outcomes research rather than the mere use of a technique or product because it is new and 'seems like a good idea'.

The long-term outcomes of our patients are now an area of important consideration and can no longer be overlooked in the discussion of consent prior to surgery. This discussion includes the issue of postoperative pain, quality of life, recurrence rates and cosmesis. Hernia science is a relatively new specialty, and its future will be defined by the introduction of 'physiologic' repairs and the prosthetic meshes used. Biologic products may be used for tissue replacement, for tissue reinforcement or simply as a 'bridge' to synthetic materials that will perform as good as or better than the biologic materials.

This text strives to introduce these concepts and to educate readers about the current state of the art in hernia surgery and to prepare them for future considerations of which we should all be aware at this point.

Plymouth, UK — Andrew N. Kingsnorth
Baton Rouge, LA, USA — Karl A. LeBlanc

Contents

Contributors

Gina L. Adrales John Hopkins Hospital, Baltimore, MD, USA

Brent W. Allain Jr Surgeons Group of Baton Rouge/Our Lady of the Lake Physician Group, Baton Rouge, LA, USA

V.A. Augenstein Carolinas Laparoscopic and Advanced Surgery Program, Carolinas Medical Center, Charlotte, NC, USA

Conrad D. Ballecer Arrowhead Medical Center, Banner Thunderbird Medical Center, Peoria, AZ, USA

Andrew C. de Beaux Department of General Surgery, Royal Infirmary of Edinburgh, Edinburgh, UK

L.R. Beffa Department of Surgery, Greenville Health System, University of South Carolina School of Medicine, Greenville, SC, USA

Igor Belyansky Anne Arundel Medical Center, Annapolis, MD, USA

Stephanie Bollenbach MIHS, Phoenix, AZ, USA

Piero Giovanni Bruni Istituto Clinico Sant'Ambrogio, Day & Week Surgery Unit, Milano Hernia Center - MHec, University of Insubria, Center of Research on the Pathology and High Specialization on the Abdominal Wall and Hernia Surgery, Milan, Italy

Giampiero Campanelli Istituto Clinico Sant'Ambrogio, Day & Week Surgery Unit, Milano Hernia Center - MHec, University of Insubria, Center of Research on the Pathology and High Specialization on the Abdominal Wall and Hernia Surgery, Milan, Italy

A.M. Carbonell Department of Surgery, Greenville Health System, University of South Carolina School of Medicine, Greenville, SC, USA

Nicholas H. Carter Residency in General Surgery, Vanderbilt University Medical Center, Nashville, TN, USA

Marta Cavalli Istituto Clinico Sant'Ambrogio, Day & Week Surgery Unit, Milano Hernia Center - MHec, University of Insubria, Center of Research on the Pathology and High Specialization on the Abdominal Wall and Hernia Surgery, Milan, Italy

Leandro Totti Cavazzola Universidade Federal do Rio Grande do Sul and Hospital de Clínicas de Porto Alegre, Porto Alegre, Brazil

David C. Chen Lichtenstein Amid Hernia Clinic at UCLA, Santa Monica, CA, USA

Department of Surgery, David Geffen School of Medicine at UCLA, Los Angeles, CA, USA

S. Clarke Department of Pediatric Surgery, Chelsea and Westminster Hospital, London, UK

K.M. Coakley Carolinas Laparoscopic and Advanced Surgery Program, Carolinas Medical Center, Charlotte, NC, USA

Joachim Conze UM Hernia Centre, München, Germany

Ursula Dahlstrand Department of Clinical Science, Intervention and Technology, Karolinska Institutet and Center for Digestive Diseases, Karolinska University Hospital, Solna, Sweden

Fien Decuypere Department of Surgery, Maria Middelares, Ghent, Belgium

Sofiane El Djouzi Division of GI/Minimally Invasive Surgery, Stritch School of Medicine, Loyola University Medical Center, Maywood, IL, USA

Sheila Grant College of Engineering, University of Missouri, Columbia, MO, USA

Mary K. Hanissee Department of Surgery, University of Maryland Medical Center, Baltimore, MD, USA

Wayne John Hawthorne Sydney Medical School, The University of Sydney, Sydney, NSW, Australia

B.T. Heniford Carolinas Laparoscopic and Advanced Surgery Program, Carolinas Medical Center, Charlotte, NC, USA

Kelly-Anne Ide North Devon District Hospital, Barnstaple, UK

Leif A. Israelsson Department of Surgery and Perioperative Sciences, Umeå University, Umeå, Sweden

Department of Surgery, Sundsvall Hospital, Sundsvall, Sweden

Alfred Janson Department of Surgery, Sundsvall Hospital, Sundsvall, Sweden

Ferdinand Köckerling Vivantes Hospital Spandauv, Berlin, Germany

Michael S. Kavic Department of Surgery, St. Elizabeth Health Center, Youngstown, OH, USA

Northeast Ohio Medical University, College of Medicine, Rootstown, OH, USA

Suzanne M. Kavic Loyola University Medical Center, Maywood, IL, USA

Stephen M. Kavic University of Maryland School of Medicine, Baltimore, MD, USA

A. Khakar University Hospital Southampton NHS Foundation Trust, Southampton, UK

Andrew Kingsnorth Peninsula College of Medicine and Dentistry (Emeritus), Plymouth, UK

Ty Kirkpatrick Surgeons Group of Baton Rouge/Our Lady of the Lake Physician Group, Baton Rouge, LA, USA

Kyle L. Kleppe Department of Surgery, University of Tennessee Graduate School of Medicine, Knoxville, TN, USA

Martin Kurzer St John and St Elizabeth Hospital, London, UK

Iris Kyle-Leinhase Department of Surgery, Maria Middelares Hospital, Ghent, Belgium

Sepehr Lalezari John Hopkins Hospital, Baltimore, MD, USA

Karl A. LeBlanc Department of Surgery, Louisiana State University Health Sciences Center, Baton Rouge, LA, USA

Minimally Invasive Surgery Institute, Baton Rouge, LA, USA

Surgeons Group of Baton Rouge/Our Lady of the Lake Physician Group, Baton Rouge, LA, USA

Our Lady of the Lake Physician Group, Department of Surgery Minimally Invasive Surgery Institute, Louisiana State University School of Medicine, Baton Rouge, LA, USA

Francesca Lombardo Istituto Clinico Sant'Ambrogio, Day & Week Surgery Unit, Milano Hernia Center - MHec, University of Insubria, Center of Research on the Pathology and High Specialization on the Abdominal Wall and Hernia Surgery, Milan, Italy

Vishy Mahadevan The Royal College of Surgeons of England, London, UK

Flavio Malcher Celebration Center for Surgery, Celebration, FL, USA

L. Michael Brunt Section of Minimally Invasive Surgery, Washington University School of Medicine, St. Louis, MO, USA

Department of Surgery, Washington University School of Medicine, St. Louis, MO, USA

St. Louis Blues Hockey Club, St. Louis, MO, USA

R. Miller Chelsea and Westminster Hospital, London, UK

Andrea Morlacchi Istituto Clinico Sant'Ambrogio, Day & Week Surgery Unit, Milano Hernia Center - MHec, University of Insubria, Center of Research on the Pathology and High Specialization on the Abdominal Wall and Hernia Surgery, Milan, Italy

Filip E. Muysoms Department of Surgery, Maria Middelares Hospital, Ghent, Belgium

Pär Nordin Department of Surgery, Östersund Hospital, Östersund, Sweden

Michael Ohene-Yeboah Department of Surgery, School of Medicine and Dentistry, College of Health Sciences, University of Ghana, Accra, Ghana

Dilip Patel Department of Radiology, Royal Infirmary of Edinburgh, Edinburgh, UK

Benjamin S. Powell Department of Surgery, University of Tennessee Health Science Center, Memphis, TN, USA

Bruce Ramshaw Department of Surgery, University of Tennessee Graduate School of Medicine, Knoxville, TN, USA

University of Tennessee Medical Center, Knoxville, TN, USA

Wolfgang Reinpold Department of Surgery and Reference Hernia Center, Gross Sand Hospital Hamburg Wilhelmsburg, Hamburg, Germany

H. Reza Zahiri Anne Arundel Medical Center, Annapolis, MD, USA

J. Scott Roth Center for Minimally Invasive Surgery, Gastrointestinal Surgery, University of Kentucky, Lexington, KY, USA

David L. Sanders North Devon District Hospital, Barnstaple, UK

Udai S. Sibia Anne Arundel Medical Center, Annapolis, MD, USA

Maciej Śmetański 2nd Department of Radiology, Medical University of Gdańsk, Gdańsk, Poland

Department of Surgery and Hernia Center, District Hospital in Puck, Puck, Poland

Brian M. Stephenson Department of General Surgery, Royal Gwent Hospital, Aneurin Bevan University Health Board, Newport, UK

Nathaniel F. Stoikes Department of Surgery, University of Tennessee Health Science Center, Memphis, TN, USA

Wen Hui Tan Section of Minimally Invasive Surgery, Washington University School of Medicine, St. Louis, MO, USA

Department of Surgery, Washington University School of Medicine, St. Louis, MO, USA

Helen J. Thomson Pinderfields Hospital, Wakefield, UK

Hanh Minh Tran The Sydney Hernia Specialists Clinic, Sydney, NSW, Australia

Mai Dieu Tran The Sydney Hernia Specialists Clinic, Sydney, NSW, Australia

S. Ulyett North Devon District Hospital, Barnstaple, UK

Rudolf Vertriest Department of Plastic Surgery, Maria Middelares, Ghent, Belgium

Guy R. Voeller Department of Surgery, University of Tennessee Health Science Center, Memphis, TN, USA

David L. Webb Department of Surgery, University of Tennessee Health Science Center, Memphis, TN, USA

Adam S. Weltz Anne Arundel Medical Center, Annapolis, MD, USA

Alastair Windsor University College Hospital, London, UK

About the Editors

Karl A. LeBlanc MD, MBA, FACS, FASMBS, *General, bariatric and abdominal wall surgeon, Baton Rouge, LA, USA, 1984-present. Attended the Louisiana State School of Medicine in Shreveport, LA, and USA from 1974–1978, followed by a General Surgical Residency from 1978–1983. From 1983–1984, he returned to his hometown of Breaux Bridge, LA, USA but saw the need to pursue his career in a larger city. He remains active in the private practice of general surgery, specializing in herniology and bariatric surgery. He is Professor of Surgery at the Louisiana State School of Medicine Department of Surgery and Associate Medical Director of Surgery of the Our Lady of the Lake Physician Group.*

Born in a rural area of southern Louisiana known for its "Cajun" heritage, he pursued his undergraduate education in nearby Lafayette, LA at the University of Southwestern Louisiana. Even at that early age, he was interested in the medical field. During his surgical residency, the interest in hernia was sparked and this has been with him ever since. During this residency, he was able to become familiar with laparoscopic surgery and used it for diagnostic purposes. Once the laparoscopic era of general surgery began, he rapidly engaged in the advancement of this wonderful tool. His research led to his performance of the world's first laparoscopic incisional hernia repair in 1991.

He is a founding member of the Americas Hernia Society and has served as its President. He sits on the Editorial Board of the journals *Hernia* and the *Journal of the Society of Laparoendoscopic Surgery* and a peer reviewer for numerous national and international journals. He has lectured internationally on numerous topics. He has edited or co-edited five surgical texts, some of which has been translated into Turkish and Chinese. He has authored numerous articles and/or book chapter contributions. Research continues to be an area of interest and he serves a principal investigator of several projects at this time.

Andrew Kingsnorth JP, BSc (Hons), MB BS, MS, FRCS, FACS (1948-) *General, pancreatic and abdominal wall surgeon, Derriford Hospital, Plymouth, UK and Professor of Surgery Peninsula College of Medicine, 1996–2013. Qualified at the Royal Free Hospital School of Medicine in London in 1973 and undertook postgraduate training in Norwich, Oxford, Harvard, Edinburgh and Cape Town. Appointed consultant surgeon, senior lecturer and subsequently reader in surgery at the University of Liverpool (1987–1996) before moving to Plymouth.*

Born into the austerity of post-War Britain, Andrew was brought up in rural Kent and educated at Sevenoaks School where he acquired a lifelong interest in voluntary service and internationalism. He has been Arris & Gale Lecturer (1983) and Hunterian Professor (2007) at the Royal College of Surgeons of England. He is Past-President of the Pancreatic Society of Great Britain and Ireland, Founding President of the British Hernia Society, Past-President of the European Hernia Society and President of the Section of Surgery of the Royal Society of Medicine.

In 1993 he chaired the Royal College of Surgeons of England working party that introduced the first national *Guidelines for the Management of Adult Inguinal Hernia*. In 1998 he established the Plymouth Hernia Service, the first specialist hernia unit in a public hospital, and pioneered the Lichtenstein operation in the UK. In 2007, he was the first surgeon outside India to use low-cost mosquito net mesh for hernia repair in low-resource countries. With Dr. Ravindranath Tongaonkar (q.v.) and David Sanders (q.v.) he has carried out clinical and laboratory research to support the global use of mosquito net mesh hernioplasty. Andrew has championed the Chevrel (q.v.) prefascial, onlay incisional hernia repair with a series of over 500 cases.

Between 2001 and 2014, Andrew participated in over 30 humanitarian surgical missions to Eastern and Central Europe, Central Asia, The Far East, SE Asia, Africa and South America. In 2005 he established a Hernia charity which is now the largest and most active such organisation in the world (www.herniainternational.org.uk). In 2010, *The Times of London* in a survey of top doctors, noted that Andrew was "regarded as the UK's expert on hernias".

Andrew retired from academic and clinical practice in 2013, but continues to lecture occasionally and acts as Director of Hernia International.

David L. Sanders BSc(Hons), MBChB, FRCS, MD, PGDipMedEd*, received his undergraduate degree from the University of Edinburgh in 2003. He received postgraduate training in the South West of England and a trauma fellowship in South Africa. His doctorate thesis was on the influence of mesh and fixation techniques on infection in abdominal wall hernia repair. In 2016 he was appointed consultant upper GI surgeon and specialist in abdominal wall reconstruction at North Devon Hospital, Barnstaple, Devon, UK.*

David specializes in surgery of the gallbladder, anti reflux, hiatal surgery and hernia surgery. He is an internationally recognized expert in the field of abdominal wall reconstruction with numerous publications in the field of hernia surgery and several book chapters. He has given numerous invited lectures on the topic both nationally and internationally. David is on the board of the British Hernia Society, Chaired the National Institute for Clinical Excellence approved commissioning guidance for groin hernia, was involved in developing the RightCare patient decision aid for inguinal hernias and is on the European working group that developed the Abdominal Wall Closure Guidelines and the International Hernia Guidelines. David is the editor of the Bulletin of the Royal College of Surgeons of England.

Hugh Brendan Devlin CBE, MA, MD, MCh (Dublin), FRCS (England), FRCS (Ireland), FRCS (Edinburgh), FACS (1932–1998) *Consultant Surgeon, North Tees General Hospital, Stockton-on-Tees. Director, Surgical Epidemiology and Audit Unit, Royal College of Surgeons of England. Research Associate, Department of Surgery, University of Newcastle upon Tyne, Council Member, Royal College of Surgeons of England*.

Brendan pioneered the use of surgical audit. When he was appointed to Stockton-on-Tees in 1970 the hospital was run down and morale was low. Four years later, he commissioned the new North Tees General Hospital and worked hard to put it on the surgical map. This he did, by his reputation as a teacher and by his publications, which always dealt with common conditions. His first success was to organise better postoperative care for patients with colostomies. He became Chairman of the British Standards Institution Committee on Stoma Appliances and founded the British Colostomy Society.

Brendan's enduring interest however was in hernia and he was the most prominent exponent of the Shouldice tissue repair in the UK during the 1970s. Realizing that too often hernias were being repaired by partially trained juniors using techniques that had been proven to be inadequate, he set up a multi-centre audit of hernia surgery. This generated guidelines, innumerable publications and this classic textbook (initially a monograph), the second edition of which was written jointly with Andrew Kingsnorth (q.v.) and published shortly before his untimely death in 1998.

In 1982 together with John Lunn, Brendan set up the Confidential Enquiry into Perioperative Deaths (CEPOD). The study became a national one (NCEPOD), providing annual reports. The report on the management of emergency hernia surgery revealed preventable causes of perioperative deaths, such as lack of intensive therapy beds and lack of staff and resources at night. He was elected to the Council of the Royal College of Surgeons in 1986. There he set up and chaired the clinical audit committee. As Chairman of the examination committee he reformed FRCS examinations.

Brendan travelled widely to examine and to give lectures. He gave the Arris and Gale lecture in 1970, the Bradshaw lecture and oration in 1996, and a Hunterian oration in 1997. He was a member of many distinguished societies and on the editorial board of many prestigious surgical journals. He was appointed Commander of the British Empire (CBE) in 1994.

After his retirement he continued to work for the King's Fund on the commissioning of medical services in London and the organisation of audit.

Part I

General Topics

General Introduction and History of Hernia Surgery

1

Andrew Kingsorth and David L. Sanders

Ancient and Renaissance Hernia Surgery

The high prevalence of hernia, for which the lifetime risk is 27% for men and 3% for women [87], has resulted in this condition inheriting one of the longest traditions of surgical management. Descriptive anatomy of the anterior abdominal wall dates back over 6000 years, to the beginning of civilization, the Valley of the Nile and the ancient Egyptian papyri. These texts, often by unknown authors, were written in a time when medicine was magico-religious and the first steps in inductive reasoning were being taken. The Egyptians (1500 BC), the Phoenicians (900 BC) and the Ancient Greeks (Hippocrates, 400 BC) diagnosed hernia. During this period a number of devices and operative techniques have been recorded. Attempted repair was usually accompanied by castration, and strangulation was usually a death sentence. The word 'hernia' is derived from the Greek (hernios), meaning a bud or shoot. The Hippocratic school differentiated between hernia and hydrocele—the former was reducible and the latter transilluminable [88]. The Egyptian tomb of Ankh-ma-Hor at Saqqara dated to around 2500 BC includes an illustrated sculpture of an operator apparently performing a circumcision and possibly a reduction of an inguinal hernia [94] (Fig. 1.1). Egyptian pharaohs had a retinue of physicians whose duty was to preserve the health of the ruler. These doctors had a detailed knowledge of the anatomy of the body and had developed some advanced surgical techniques for other conditions and also for the cure of hernia. The mummy of the pharaoh Merneptah (1215 BC) showed a complete absence of the scrotum, and the mummified body of Rameses 5th (1157 BC) suggested that he had had an inguinal hernia during life with an associated faecal fistula in the scrotum and signs of attempts at surgical relief.

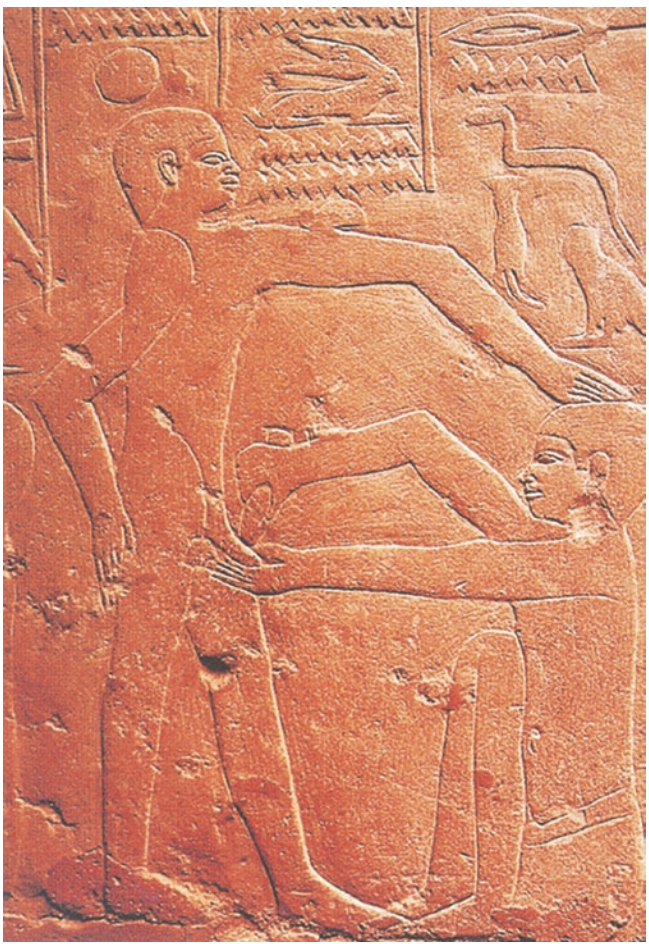

Fig. 1.1 Egyptian tomb of Ankhmahor (Saqqara). The operator (*bottom right*) rubs in something with an instrument and seems to perform a reduction of an inguinal hernia

Greek and Phoenician terracottas (Figs. 1.2 and 1.3) illustrate general awareness of hernias at this time (900–600 BC), but the condition appeared to be a social stigma, and other than bandaging, treatments are not recorded. The Greek physician Galen (129–201 AD) was a prolific writer and one of his treatises was a detailed description of the musculature of

A. Kingsorth (✉)
Peninsula College of Medicine and Dentistry (Emeritus), Plymouth, UK
e-mail: kingsnorthandrewn@gmail.com

D.L. Sanders
North Devon District Hospital, Barnstaple, UK

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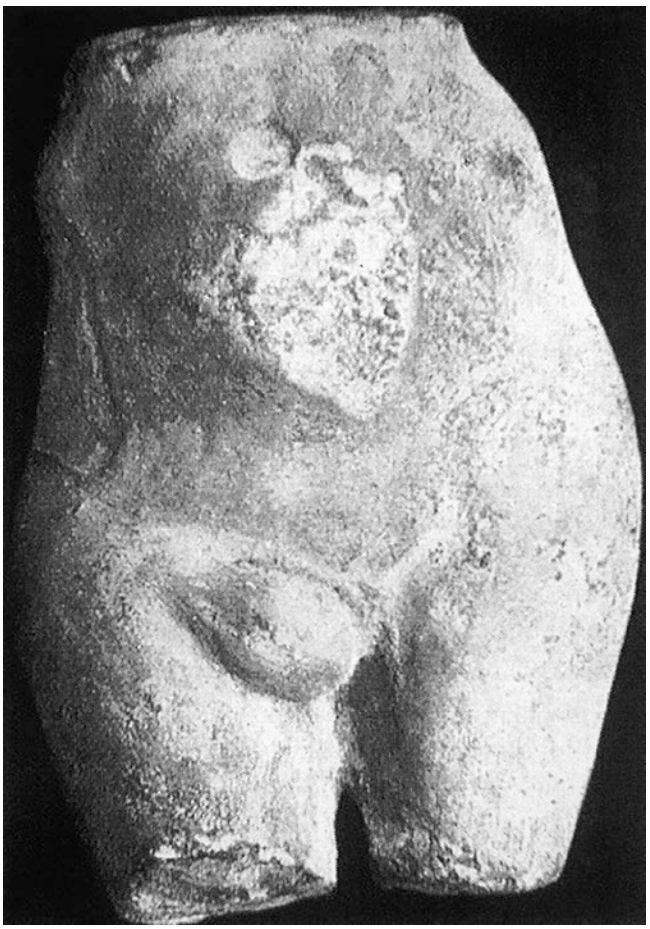

Fig. 1.2 Terracotta ex voto shows femoral hernia (from Geschichte der Medizin (1922))

Fig. 1.3 Phoenician terracotta figure (female) shows umbilical hernia (fifth–fourth century BC) (from Museo Arquelogico, Barcelona, Spain)

the lower abdominal wall in which he also describes the deficiency of inguinal hernia. He described the peritoneal sac and the concept of reducible contents of the sac.

Celsus (AD 40) was a prolific writer, and although he had no medical training, he documented in encyclopaedic detail the Roman surgical practice: taxis was employed for strangulation, trusses and bandages could control reducible hernia, and operation was only advised for pain and for small hernias in the young. The sac could be dissected through a scrotal incision, the wound then being allowed to granulate. Scar tissue was perceived as the optimum replacement for the stretched abdominal wall. A common method of treating hernia at this time was to reduce the contents of the sac and then attempt to obliterate it by a process of inflammation and gangrene by applying pressure to the walls of the sac through clamping the hemiscrotum between two blocks of wood. The last of the Graeco-Roman medical encyclopaedists, Paul of Aegina (625–900 AD), distinguished complete scrotal from incomplete inguinal herniation or bubonocele. For scrotal hernia, he recommended ligation of the sac and the cord with sacrifice of the testicle. Paul was the last of the great surgeons who wrote several books, which gave detailed descriptions of operative procedures including inguinal hernia.

Aulus Cornelius Celsus (first century AD) who first described the importance of surgical closure of the abdominal wall [104]. The procedure was termed 'gastrorrhaphy' originating from the Greek 'gastir' meaning abdomen and 'rhaphy' meaning suture. In fact, what Celsus was describing was a layered closure of the abdominal wall to prevent an incisional hernia. A century later, Aelius Galenus (Fig. 1.2), better known as Galen of Pergamon, a Roman of Greek origin and arguably the most prominent physician of the Greco-Roma period, provided a detailed description of mass closure of the abdominal wall [105]:

> In stitching the needle should be thrust from without inwards through skin and rectus muscle, and then from within outwards through the muscle and skin, repeating this until the wound is closed. Some operators include the peritoneum in the stitches, but this is not usual. The dressing should be soft wool dipped in oil moderately warm and cover the space between the flanks and armpit.

It seems that Galen was aware of the risk of incisional hernia following abdominal surgery, and he describes in detail the paramedian incisions, in order to prevent a hernia from developing [105], an incision which was used commonly until the late twentieth century:

> A wound in this situation is less dangerous than in the mid-line, since the thin aponeuroses are lacking. In the mid-line stitching is accomplished with difficulty and the intestines are more likely to protrude and be hard to replace.

The works of Galen were later translated into Latin and helped to form the basis of modern surgery.

The Middle Ages (AD500–AD1500)

In the Middle Ages, the notable techniques of Greco-Roman surgery were largely lost. This was an age of faith and scholasticism. During this period, different types of abdominal wall hernia were rarely differentiated. However, Arnaud de Villeneuve, a French physician and surgeon, described an epigastric hernia in 1285, and another Frenchman, Guy de Chauliac (1300–1368), wrote *De ruptura*, which classified different types of hernias and distinguished between umbilical and epigastric hernia; however in his classification, they were not given these names [106, 107].

The drawing of the Vitruvian Man by Leonardo da Vinci (circa 1487) is considered to be one of the world's greatest works of art. It is da Vinci's representation of ideal human proportions described by the ancient Roman architect Vitruvius in Book III of his treatise *De Architectura*. The left inguinal region of the Vitruvian Man demonstrates a spherical fullness above his groin, above and medial to the pubic tubercle. This corresponds to the classical manifestation of an inguinal hernia. Leonardo da Vinci made the drawing in the coronal plane to illustrate the geometrical dimensions of the human body through the observation of living subjects and cadaveric dissection [108] (Fig. 1.4).

During the dark time of the Middle Ages, there was a decline of medicine in the civilized world, and the use of the knife was largely abandoned, and few contributions were made to the art of surgery, which was now practised, by itinerants and quacks. With the rise of the universities such as the appearance of the school of Salerno in the thirteenth century, there was some revival of surgical practice [94]. At this time three important advances in herniology were made: Guy de Chauliac, in 1363, distinguished femoral from inguinal hernia. He developed taxis for incarceration, recommending the head-down, Trendelenburg position [58]. Guy was French and studied in Toulouse and Montpelier and later learned anatomy in Bologna from Nicole Bertuccio. Guy wrote extensively about hernia in his book Chirurgia principally about diagnosis and methods of treatment (Fig. 1.5). He described four surgical interventions, one of which was a herniotomy without castration, another consisting of cauterization of the hernia down to the os pubis and third consisting of transfixion of the sac to a piece of wood by a strong ligature. His fourth method however was conservative treatment with bandaging and several weeks of bed rest accompanied by enemas, bloodletting and special diet. At the time he was the authoritative expert on hernia.

Franco's book *Traites des Hernies* [61] standardized the practice of hernia surgery at the time and diminished the influence of the itinerant practitioners (Fig. 1.6). Franco popularized the punctum aurium and using this instrument made a small incision in the upper scrotum, isolated the hernia sac from the spermatic cord and then encircled it with a gold thread, thus sparing the testis. He chose gold thread because this was considered to be the best nonreactive material. In spite of the known hazards and high mortality of operating on a strangulated hernia, Franco advised early intervention and rejected the conservative measures employed such as bloodletting and tobacco enemas. As a result he saved numerous patients with life-saving operations. He wrote many up as case reports illustrating his management and surgical techniques. He recommended reducing the contents and closing the defect with linen suture (Fig. 1.7). His beautifully written manuscript was rediscovered and published again in 1925 by Walter van Brunn. As shown in the illustration, the unusual feature of the book was the patients posing in everyday attire as if they were going about their everyday life.

In 1559 Stromayr, a German surgeon from Lindau, published a remarkable contribution to surgery. His book *Practica Copiosa* describes sixteenth-century hernia surgery in great detail and is comprehensively illustrated. Stromayr differentiated direct and indirect inguinal hernia and advised excision of the sac and of the cord and testicle in indirect hernia [96]. Having differentiated and classified the two types of inguinal hernia, Stromayr recommended a testis sparing procedure for the direct type. His operation for high ligation of an indirect sac at the internal ring is illustrated in Fig. 1.8. Stomayr also advanced the technology of trusses, which he designed to be adapted to the rigours of everyday life. The Renaissance brought burgeoning anatomic knowledge, now based on careful cadaver dissection. William Cheselden successfully operated on a strangulated right inguinal hernia on the Tuesday morning after Easter 1721. The intestines were easily reduced and adherent omentum was ligated and divided. The patient survived and went back to work [54] (Fig. 1.9).

Without adequate interventional surgery, some patients survived hernia strangulation when spontaneous, preternatural fistula occasionally followed infarction and sloughing of a strangulated hernia. Cheselden's Margaret White survived for many years 'voiding the excrements

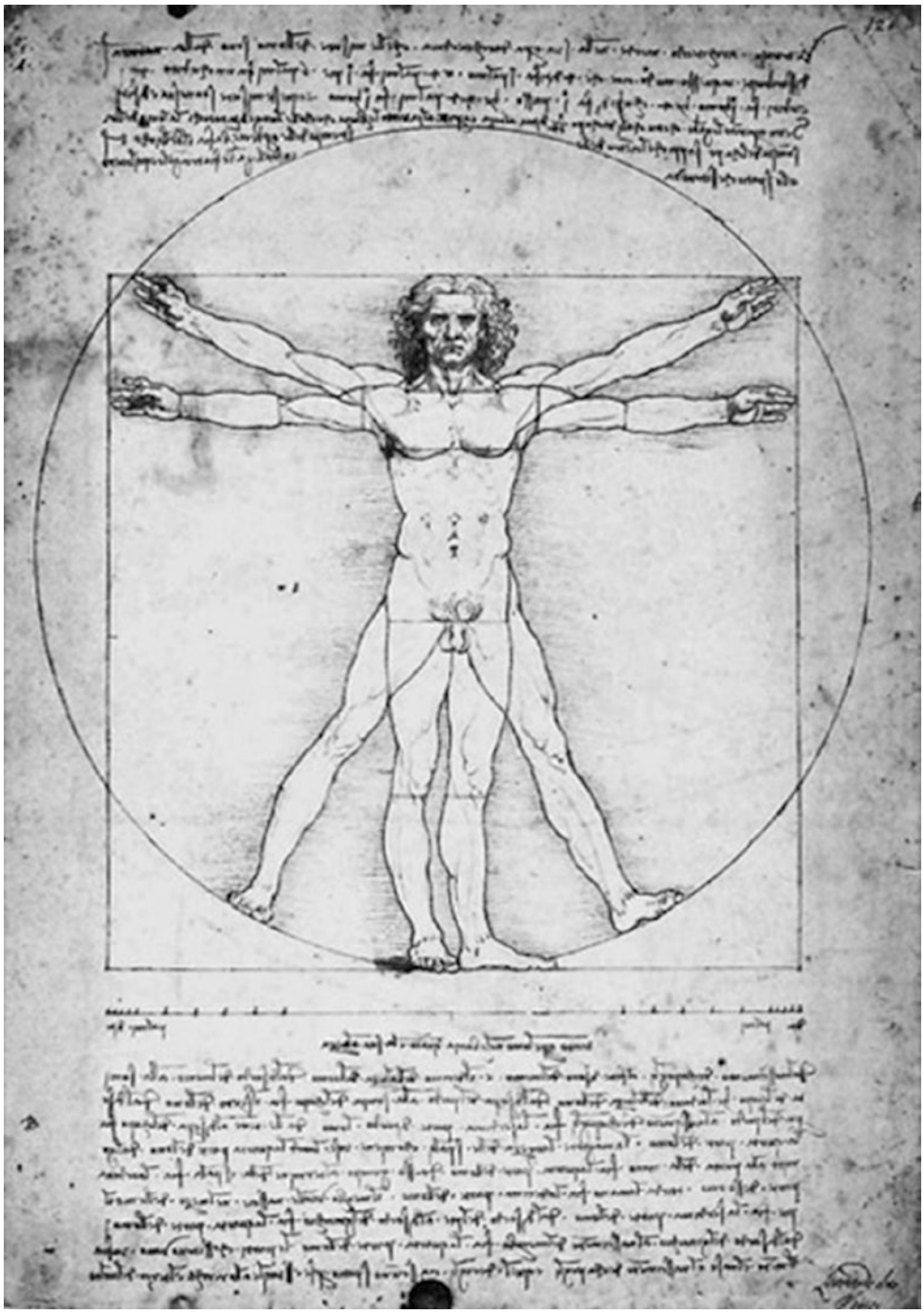

Fig. 1.4 Vitruvian Man (from Ashrafian)

through the intestine at the navel' after simple local surgery for a strangulated umbilical hernia [54]. The closure of such a fistula in the absence of distal bowel pathology was described by Le Dran, who had noted that it was quite common for poor people with incarcerated hernias to mistake the tender painful groin lump for an abscess and incise it themselves. He found that these painful wounds with faecal fistulas required no more than cleaning and dressing. Often the wound would heal, nature preferring to send the faeces along the natural route to the anus [72] (Fig. 1.10).

The Anatomical Era

The great contribution of the surgical anatomists was between the years 1750–1865 and was called the age of dissection [94]. The main contributors were Antonio Scarpa

Fig. 1.5 The visit of surgical patients in Chirurgia. Guy de Chauliac, fifteenth-century manuscript (from the Bibliothèque Nationale, Paris, France)

and Sir Astley Cooper and few major advances in our knowledge of the anatomy of the groin have been made since this time. The names of these great anatomists are Pieter, Camper, Adrian van der Spieghel, Antonio Scarpa (Fig. 1.11), Percival Pott, Sir Astley Cooper, John Hunter, Thomas Morton, Germaine Cloquet, Franz Hesselbach, Friedrich Henle and Don Antonio Gimbernat.

The Dutchman Camper was a polymath who described a fascia, which is sandwiched in between the skin and deep fascia and can only be separated from this fascia below the inguinal ligament where the space between them accommodates lymph glands and cutaneous vessels of the groin. Below the external ring, Camper's fascia becomes the dartos muscle of the scrotum, which like the platysma is a muscle of the superficial fascia. Camper was the author of the definitive surgical text on hernia. Camper also contributed to anatomical descriptions of the foot, upper limb and axilla. His explanation of the aetiology of inguinal hernias significantly affected surgical practice at the time [109].

Adrian van der Spieghel (1578–1625) was educated at the University of Padua, and he occupied the chairs of anatomy at the University of Modena and later Pavia. He was Flemish

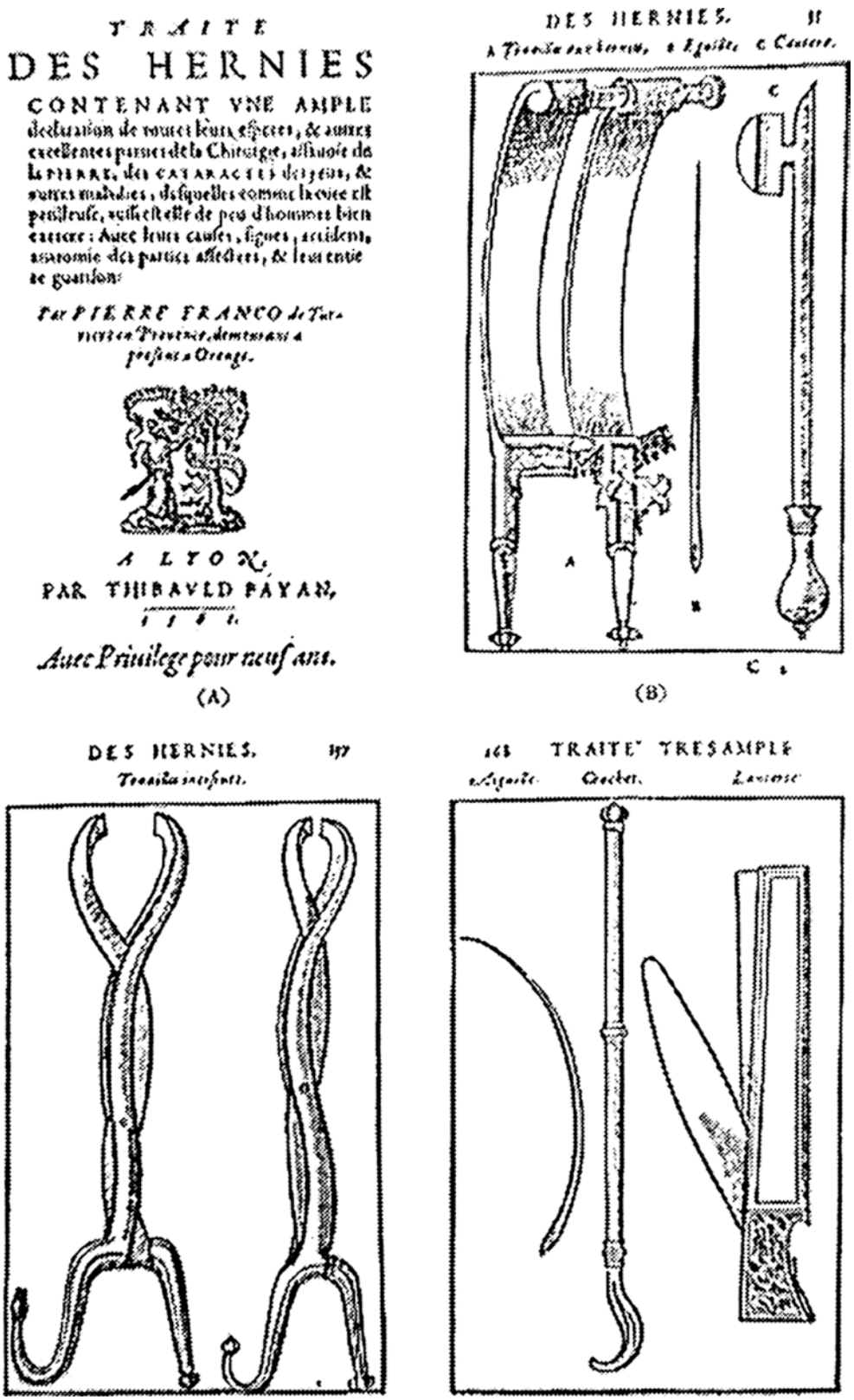
TRAITE
DES HERNIES
CONTENANT VNE AMPLE
A LYON,
PAR THIBAVLD PAYAN,
Auec Priuilege pour neuf ans.
(A)
DES HERNIES. 11
(B)
DES HERNIES. 137
168 TRAITE' TRESAMPLE

Fig. 1.6 Frontispiece and surgery instruments in Traités des Hernies (by Pierre Franco, Vincent, Lyon [61])

and another polymath. He was privileged to have two of the most accomplished anatomists of that period, Fabricius ab Aquapendente and Yulius Casserius, as his teachers. He first described Spiegel's lobe (caudate lobe) of the liver and the linea semilunaris (Spiegel's line) on the lateral side of the rectus abdominis muscle. Spigelian hernia (lateral ventral

Fig. 1.7 Woman with femoral hernia. In Die Handschrift des Schmitt- und Augenartztes. Caspar Stromayr (by Walter von Brunn (1925))

hernia) was named after him. He was a renowned physician in his time and was the first to give a detailed description of malaria. He made significant contributions as a botanist: the genus *Spigelia*, which has six species, is named after him [110].

Sir Percival Pott described the pathophysiology of strangulation in 1757 and recommended surgical management (Fig. 1.12): 'I am perfectly satisfied that the cause of strangulated hernia is most frequently a piece of intestine (in other respects sound and free of disease) being so bound by the said tendon, as to have its peristaltic motion and the circulation through it impeded or stopped' [86]. Pott was trained at St Bartholomew's Hospital and wrote the manuscript *A Treatise on Rupture*. This publication brought him into conflict with the Hunters who accused him of plagiarism for his description of congenital hernia, which they claimed to have described 2 years previously. He emphasized that the hernia sac was peritoneum continuous with the general peritoneal

Fig. 1.8 The dissection of the sac and cord in an indirect hernia, carried to the level of the internal ring (in von Brunn (1925))

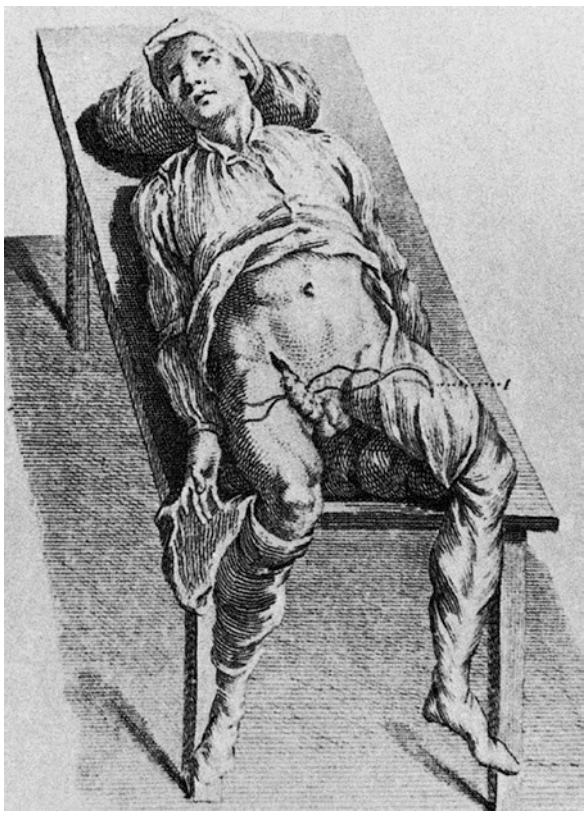

Fig. 1.9 Ligation of strangulated omentum in a strangulated right scrotal hernia. The wound then granulated. The patient survived and the hernia did not recur (operation by Cheselden in 1721 [7])

Fig. 1.10 Development of a preternatural colon fistula (colostomy) after strangulation of an umbilical hernia. The wound was trimmed. The patient survived many years 'voiding' the excrements at the umbilicus (operation by Cheselden about 1721 [7])

Fig. 1.11 Antonio Scarpa (1752–1832) professor of surgery and anatomy in Pavia, Italy

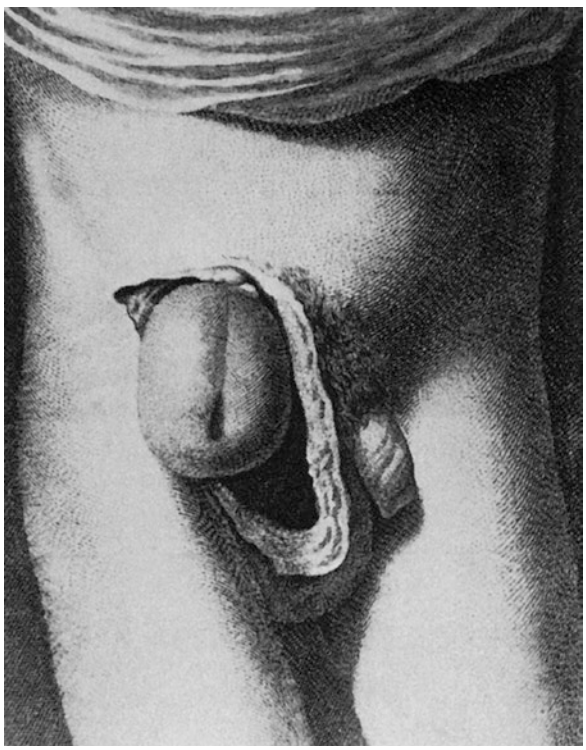

Fig. 1.12 Intestine strangulated by the 'tendon' so that the venous circulation through it is stopped, leading to gangrene (described by Pott in 1757 [9])

cavity and had not been in any way ruptured or broken, which until that time was the popular theory of causation of hernia.

Fifty years later Astley Cooper (Fig. 1.13) implicated venous obstruction as the first cascade in the circulatory failure of strangulation: 'By a stop being put to the return of blood through the veins which produces a great accumulation of this fluid and a change of its colour from the arterial to the venous hue.' Nevertheless ligature, the insertion of setons and castration remained the mainstays of treatment prior to the publication of Astley Cooper's monograph in 1804 [56] (Fig. 1.14). Sir Astley Cooper (1768–1841) trained at St Thomas' Hospital, London, and became a surgeon at Guy's Hospital and from 1813 to 1815 was Professor of Comparative Anatomy of the Royal College of Surgeons. Cooper published six magnificent books, two of which covered the subject of hernia, which were liberally illustrated by his own hand from dissections he had performed personally. Cooper was a charismatic lecturer and socialite and had an

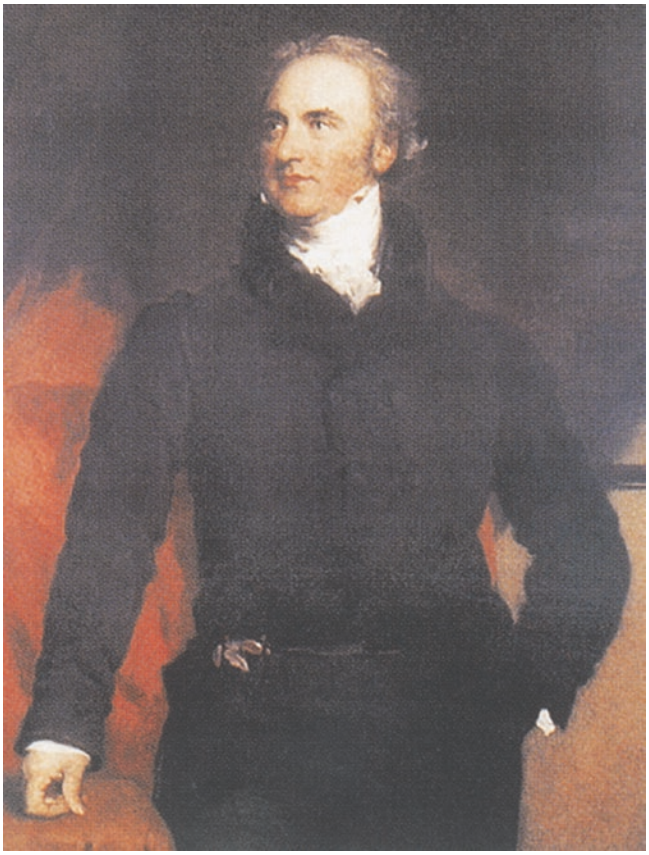

Fig. 1.13 Sir Astley Paston Cooper (1768–1841). Surgical anatomist, London, England

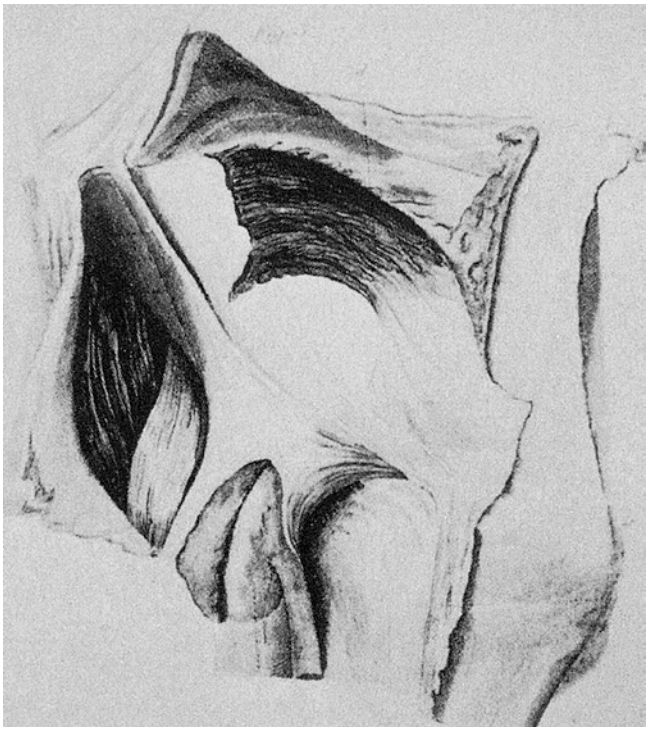

Fig. 1.14 Anatomy of the fascia transversalis. Cooper [56] demonstrated the fascia extending behind the inguinal ligament into the thigh to be the femoral sheath. He first recognized the fascia transversalis and its importance in groin herniation

extensive surgical practice, which included being sergeant surgeon to King George IV. Cooper's recognition of the transversalis fascia positions him as one of the most important contributors to present day surgery which emphasizes this layer as being the first layer to be breached in groin hernias.

John Hunter (1728–1793) was born in Glasgow but became a pupil at St Bartholomew's Hospital to Percival Pott and later served as a surgeon at St George's Hospital where he established his well-known anatomy lessons and later the Hunterian museum which is now housed in the Royal College of Surgeons of England. Hunter's contribution was to define the role of the gubernaculum testis that directed the descent of that organ with the spermatic vessels into the scrotum around the time of birth. Thomas Wharton (1813–1849) also a London surgeon working at the North London Hospital, in his short life wrote three anatomical texts, two of which were the subject of inguinal hernia and the groin. He first gave an accurate description of the conjoined tendon of the internal oblique and transversus muscles and their termination and attachment to the outer portion of the rectus sheath.

The first accurate description of the iliopubic tract, an important structure utilized in many sutured repairs for inguinal hernia, was made by Jules Cloquet (1790–1883). Cloquet was Professor of Anatomy and Surgery in Paris and surgeon to the Emperor. Cloquet researched the pathological anatomy of the groin in numerous autopsy dissections and their reconstruction in wax models. He was the first to observe the frequency of patency of the processus vaginalis after birth and its role in the production of a hernia sac later in life. Franz Hesselbach was an anatomist at the University of Wurzburg who described the triangle now so important in laparoscopic surgery which originally defined the pathway of direct and external and supravesical hernias (Fig. 1.15). The triangle as defined today is somewhat smaller. Friedrich Henle (1809–1885) was another German latterly working in the University of Gottingen. Henle described an important ligament running from the lateral edge of the rectus sheath and fusing with the pectineal ligament. This structure when present could be utilized to anchor sutures in herniorrhaphy. Finally Don Antonio Gimbernat (1742–1790) was a Spanish surgeon working in Barcelona and also surgeon to King Charles III and President of the College of Surgeons of Spain. Gimbernat not only defined the lacunar ligament as a distinct anatomical structure but also showed how its division in strangulated femoral hernia was usually the point of obstruction and allowed reduction of the contents of the sac. His publication *Nuevo metodo de operar en la hernia crural* was translated from Spanish into English by Thomas Beddoe 2 years later with additional plates for his new method of operating on femoral hernia.