A History of Plastic Surgery

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With 407 Figures

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They are holding *Anatomiae Universae* by Mascagni published in Pisa in 1823, one of only three existing copies. *Courtesy of C. de L. Flaminio Farnesi, Pisa*

Dedication

This book is dedicated to the memory of Gustavo Sanvenero-Rosselli (1897–1974) the first Italian plastic surgeon of the modern age, pioneer of European Plastic Surgery and passionate bibliophile.

Gustavo Sanvenero-Rosselli was born in Savona in 1897. After training in ear, nose and throat surgery he went to Paris in 1927 to work with Lemaitre and Ferris Smith, who had a special interest in facial clefts. When the unit known as the "Padiglione dei Mutilati del Viso" opened in Milan he was appointed as its first director in 1929. This was the first hospital devoted solely to plastic surgery in Italy and became a National referral centre. It was visited by many foreign surgeons including Johannes Esser who, with Sanvenero, planned to open an International Centre for Injuries of the Face in Florence. The start of World War II put an end to their plan.

Sanvenero was a Member of the Editorial board of *La Revue de Chirurgie Plastique* in Belgium from 1931. This subsequently became *Revue de Chirurgie Structive*. In 1939 he founded the Italian *Plastica Chirurgica* which disappeared during the war. He was one of the founding members of the Italian Society of Plastic Surgery in 1934 and of the International Confederation of Plastic Reconstructive and Aesthetic Surgery (IPRAS) in Sweden in 1955. He organized a large number of congresses including the Third Congress of the European Society in 1938 in Milan. In 1966 he was the President of the Fourth International Congress of the IPRAS in Rome. His contributions to plastic surgery were many, particularly in the field of facial clefts, and he wrote many articles and two books.

He started collecting rare books in the 1930s when there were many on the market and little demand. His library competes with that of his friend Jerome P. Webster at Columbia University in New York. When he brought his first Tagliacozzi he did not dare tell his family since the price was that of an apartment in Milan!

He died in 1974 aged 77. His memory is preserved by the Foundation established by his nephew Riccardo Mazzola. It houses an extended library and organizes seminars and live surgical courses.

Foreword

Dear Readers,

You have in your hands a work that should become a milestone of our understanding of medical history. In it Professor Paolo Santoni-Rugiu and Mr Philip Sykes trace the development of plastic surgery and much of medicine in general, over three millennia. With his extensive knowledge of clinical plastic surgery, no one could be better placed than the senior author to gather this valuable material from historical documents. As well as using the great historical libraries of Italy, the authors were able to refer to the many books in the Sanvenero-Rosselli Foundation in Milan. This library contains a unique collection of ancient and rare surgical texts and original manuscripts which were acquired over many years by the late Professor Sanvenero-Rosselli. His nephew, Professor Riccardo Mazzola has added to the collection and is now its curator.

They have also gathered material from The Gillies' Archive at Queen Mary's Hospital, Sidcup, UK where Major Gillies, later to become Sir Harold, and his team treated the wounded from World War I and performed over 15,000 reconstructive operations on badly injured servicemen. The libraries of the British Association of Plastic Surgery and of the Royal College of Surgeons in London have also kindly opened their doors to the authors.

The book is cleverly organised in three groups of chapters: The Basis of Plastic Surgery (Chapters 1–6), Reconstructive Surgery of Various Organs (Chapters 7–11) and Cosmetic Surgery (Chapters 12–15). The first section deals with anatomy and the healing of wounds, discusses old and new plastic surgical procedures, and outlines the history of anaesthesia. The second covers the methods used from ancient times to reconstruct various areas of the body and is the most extensive. The last section discusses the history of cosmetic surgery and the origin of present day procedures.

The pages ring with the names of giants of the medical sciences such as Hippocrates, Leonardo da Vinci, William Harvey and Iginio Tansini, to say nothing of plastic surgeons from the nineteenth and twentieth centuries.

We plastic surgeons can be justifiably proud of our heritage. The book reveals the breadth of our speciality, covering as it does conditions of the whole body and many basic areas such as wound healing and surgical techniques as well as the ever popular topic of cosmetic surgery. New procedures are being introduced all the time, yet, incredible though it may seem, there are some that have been in use for thousands of years. This book deserves a place in every plastic surgeon's library as it teaches that all medical skill is based on the intuition, dedication and hard work of previous generations. It will enlighten and inform every reader.

Sirpa Asko-Seljavaara, MD
Former Professor of Plastic Surgery
at Helsinki University
Member of the Finnish Parliament

Preface

Why write a book about the history of plastic surgery? The publishers asked the same question and it is difficult to give a simple answer. Mountain climbers accept that the challenge is sufficient to make the effort worthwhile. There is personal satisfaction while travelling and euphoria at the end. This book has been such a journey.

There are several excellent short accounts of the history of plastic surgery in general and specific areas of the speciality in particular but the fact that a book had not appeared recently was an incentive.

In truth these were not the main reasons why the senior author embarked on this task during his early retirement. There was no one point when the decision to write a book was taken. The idea developed gradually while preparing papers on historical topics using the resources in the Sanvenero-Rosselli foundation in Milan, sometimes in cooperation with its curator Dr Riccardo Mazzola. The Italian influence on nasal reconstruction is exceptional and this is where the historical interest began.

Reading old and sometimes obscure works frequently served to confirm that very little is new and opportunities have been missed in the past. The old literature was fascinating and so the exploration continued.

A study of early anatomy followed and then moved to cleft lip and palate. One topic led to another and gradually the beginnings of a book emerged. Some knowledge of the important basic works made progress easier. This is possibly why the book is not written chronologically as one might expect. It begins with the basics, proceeds to the reconstruction surgery of different areas and ends with the origins of cosmetic surgery.

A similar approach was chosen to Antony Wallace in his excellent book published in 1984 and it seemed a good idea to follow his lead. The giants of the early days made advances in many fields so inevitably their names recur in several chapters. This does at least serve to emphasize their importance.

The book does not aim to be a work of any great scholarship but more a personal interpretation of the different events which contributed to the birth of the speciality. The numerous illustrations please the publishers, perhaps because they encourage sales. We feel that they and the footnotes will add some interest but they are not intended to make this a coffee table text.

Our speciality has become increasingly sophisticated in recent times. This answered the problem about where to stop. One could fill a whole book with the developments of the last 25 years alone and this has been resisted. For better or for worse we have drawn the line around the advent of microsurgery although unavoidably some mention is made about the beginnings of this new era. Where the origins of plastic surgery lie is a matter of opinion and we have purposely chosen a title commencing with the indefinite article together with a suitably vague historical time span!

We have not attempted to be comprehensive and have omitted some specialized clinical areas which plastic surgeons share with other disciplines. Burns, maxillofacial and cranio-facial surgery together with hand surgery have been left out even though they developed from the same basic origins.

Because of their historical importance some priority has been given to topics which are now rarities. Nasal reconstruction, for example, has been allocated a whole chapter because of its contribution to the development of plastic surgery principles. This and other ideas, largely dating from the Renaissance, receive a good deal of attention and we hope that different nationalities will not feel left out. There have been many significant contributions from the rest of Europe, Asia and the Americas. We trust we have done them justice.

As amateur historians our reference list will not bear close scrutiny by an experienced academic especially where very old books are concerned. This deficiency will be obvious to those who are familiar with the scholarly

works of authors like Tom Patterson. His translations of the Zeis Index and his own work on the literature from 1864 to 1920 are masterly and have been very valuable to us. This is also true of the historical works of Frank McDowell.

We have tried to be accurate and take full responsibility for the inevitable errors which have crept in. Citing very rare old books is hazardous for all but the expert. Different editions frequently exist as do pirated copies. Some authors published different books on similar topics within a short period. We have attempted to choose the most appropriate work but where books and papers by the same author have equal merit we have attempted to include them all.

The senior author started this book in English about ten years ago and despite revisions of the text by the co-author the result did not make easy reading. The book was re-written in Italian and then translated by experts. It is interesting to note that each chapter became shorter, sometimes by as many as five pages. We hope it is also easier to digest.

The authors' friendship extends back 30 years to microsurgical training in Melbourne. It has continued professionally and socially over the years in Italy and the UK. When serious illness overtook the senior author his recovery and convalescence allowed time for both of us to enjoy each other's company and to work on the book. This was no hardship and our friends and family were very tolerant of the hours we spent working together.

Another reason helped us decide to continue with the project. In the last decade traditional plastic surgery has changed. Many operations that were exclusively performed by a plastic surgeon are now carried out by other specialists who have learnt the techniques. Plastic surgeons have also combined with other disciplines to provide a comprehensive service in specialized clinical areas. There are now *super specialists* in all the areas that once combined to form plastic surgery. Like general surgery, plastic surgery as we knew it, no longer exists. This progress is inevitable and necessary. By recalling the past we hope this book will provide present and future plastic surgeons some knowledge of the origins of our speciality.

Paolo Santoni-Rugiu and Philip Sykes
Keswick, Cumbria
October 2006

Acknowledgements

We wish to acknowledge the help and encouragement we have received from many people. Above all this book would not have been possible without access to the Library of the Sanvenero-Rosselli Foundation in Milan and we are indebted to Riccardo Mazzola for his permission and assistance in using all the facilities in that institution. His help was invaluable and the constructive criticism he offered from the onset kept us on the right path. The secretary of the foundation, Danila Beatrice, provided unstinting help during our visits to Milan and but for her assistance we would have been lost amongst the bookshelves.

Sirpa Asko-Seljavaara has written the foreword and given sound advice and encouragement. We thank her sincerely.

Brian Morgan shared his knowledge and made available material from the Antony Wallace Archive of the British Association of Aesthetic and Reconstructive Plastic Surgeons. Andrew Bamji, Curator of the Gillies Archive at Queen Mary's Hospital, Sidcup, Kent, supplied illustrations and a wealth of entertaining information about the origins of plastic surgery during the First World War.

Lisa Chang and Shona Dryburgh did an expert job translating the text from the Italian. Colette Derrick helped assemble and type the reference list.

We are also indebted to our colleagues Ron Pigott, Grazia Salimbeni, Hamish Laing, Alessandro Massei and Daniele Gandini who have all been helpful in different ways. Ravin Thatte of Mumbai helped interpret various Sanskrit texts and Raju Usgaocar of Goa searched them out for us. We thank them sincerely.

For technical support we are particularly grateful to Leopoldo Nicotra, who miraculously extracted high definition illustrations from old slides and photographs. Others who gave their help are Roberto Zuchelli, David Mart, Pablo Patanè, Rosanna Prato, Michael Connick, Maggie Climie and the photographic department at Morriston Hospital, Swansea. Gabriele Schröder and Ellen Blasig at the publishers have always been ready to give advice when problems arose.

Finally, several institutions have provided information or allowed us to use material from their collections and we are particularly grateful to the University of Padua, the Museum of Piacenza, the Royal College of Surgeons of England and the Worshipful Company of Barber Surgeons in London.

Last but not least we express our gratitude to our families. The project has taken several years, involved many trips abroad and taken hours incarcerated at the computer keyboard. They have always given uncomplaining support.

Contents

1 The Anatomical Foundations of Surgery 1
The Pre-Scientific Period 3
The Scientific Period 12
The Modern Period 35

2 Healing of Wounds and the Development of Surgery 39
The First Surgical Repairs 40
The Closing of Wounds: Sutures and Bandages 42
Controlling Bleeding 44
Other Contributions to Greco-Roman Medicine 46
After the Decline of the Roman Empire 49
The Contributions of the Arabs 50
The Contribution of the Scuola Salernitana .. 52
The Late Middle Ages and the Renaissance .. 53
Professional Societies and Their Role in the Development of Surgery 57
Battlefield Surgery 59
Ambroise Paré and His Revolutionary Treatment of Wounds 61
Other Contributions During the Sixteenth Century 64
Astrology, Alchemy, Magnetism and Other Novelties 67
Blood Transfusions and Other Developments 69
The Role of Scientific Societies 71
The Revival of the Skin Flap and the Discovery of Grafts 71
Infection 71
The Role of Surgical Instruments 74

3 Skin Flaps 79
Local Flaps 85
Distant Flaps 88
The Rebirth of the Skin Flap 89
Developments Before and During the Nineteenth Century 90
The Tubed Flap 95
The Vascular Flap 104
The Advent of Vascular Microsurgery and the Free Flap 110
Myocutaneous Flaps 112
Further Developments: Fasciocutaneous Flaps, Skin Expansion 117

4 Skin Grafts 121
The First Clinical Experiments 124
Reverdin's Pinch Graft: The First Breakthrough 127
Thin Grafts 129
The Return of the Full-thickness Graft 131
Further Progress in Skin Grafts 132
Split Skin Grafts 134
Homografts and the Rejection Phenomenon 136
Graft Viability and Preservation 137

5 Grafts of Other Tissues 141
Bone Grafts 143
Early Bone Grafting 146
Cartilage Grafts 147
Fat Grafting 151

6 Some Notes on Anaesthesia 157
Inhalation Anaesthesia 160
Intravenous Anaesthesia 163
Local Anaesthesia, Regional Anaesthesia and Other Breakthroughs 163
Further Developments 164

7 Nasal Reconstruction 167
Antiquity 168
The Renaissance 173

The Decline of Rhinoplasty 195
The Revival of Reconstructive Surgery 198

8 Cleft Lip and Palate 213
The Cleft Lip 214
The Cleft Palate 233

9 Reconstruction of the External Genitalia 251
Circumcision 253
Posthioplasty or Reconstruction of the Prepuce 255
Hermaphroditism 257
Vaginal Malformations 258
Hypospadias 263

10 Ear Reconstruction 277
Ear Reconstruction After Trauma 278
Congenital Malformations 281
Total Reconstruction of the Auricle 283

11 Skull Reconstruction 287
The Earliest Corrections of Skull Defects ... 288
Treatment of Skull Trauma 289
The First Reconstructions 290
Repair with Bone Grafts 294
Alloplastic Implants 296
Facial Fractures 296

12 Introduction to Cosmetic Surgery 299
The Aesthetic Effect of Accepted Surgery ... 301
The Introduction of Paraffin 301
The First Purely Cosmetic Operations 302
Facial Reconstruction and the Influence of the First World War 303
The Use of the New Techniques for Cosmetic Purposes 303
The Role of the Professional Associations ... 304
The Growth of Cosmetic Surgery 305
Liberation from Quackery 305

13 Cosmetic Rhinoplasty 307

14 Facial Rejuvenation 319
Cosmetic Treatment in the Pre-surgical Era 320
The First Operations on the Eyelids with Cosmetic Effects 320
The Evolution of Face-lifting 322

15 Cosmetic Surgery of the Breast 329
Breast Reduction 330
Breast Augmentation 345
Abdominoplasty 348

References 351

Subject Index 375

Chapter 1

The Anatomical Foundations of Surgery

Contents

The Pre-Scientific Period 3
Anatomy During Classical Antiquity .. 3
The Middle Ages 6
The Role of the Earliest Universities in the Teaching of Anatomy 9
The Scientific Period 12
Before Vesalius 12
The University of Padua Before Vesalius 14
The Birth of the Anatomical Illustration 15
The Revolutionary Reforms of Andrea Vesalius (1514–1564) 21
The Successors to Vesalius in Padua .. 25
Other Schools of Anatomy in Italy 28
Anatomy Outside Italy After Vesalius 29
The Modern Period 35

Fig. 1.1 Henry de Mondeville (1260–1320) lecturing to students. The illustration is taken from a fourteenth century illuminated manuscript of his book *Chirurgie*, probably the first on surgery published in France. *By permission of the Bibliotheque Nationale de France, Paris*

The surgeon Henry de Mondeville (c.1260–1320) (Fig. 1.1) [682, 731], who had under his care the sovereigns Philippe le Bel and his son Louis X of France and whom we will encounter frequently in our survey of the origins of plastic surgery, affirmed at the beginning of his text *Chirugie*: "No craftsman should work on an object without knowing it. Being the human body the object of the whole medical art, of which surgery is one of the instruments, it is obvious that a surgeon who practises incisions on the different areas of the body and on its limbs without being aware of their anatomy will never operate well." This declaration, made more than 700 years ago underlines the close relationship that exists between anatomy and surgery and the fact that without a sufficient knowledge of anatomy the practice of surgery, and of plastic surgery in particular, could never have evolved over the centuries.

The history of anatomy may be divided into the following three periods:

- The Pre-Scientific Period, extending from the Palaeolithic Age to the middle of the fifteenth century, during which anatomical observation was intermingled with philosophical speculation. Dissections were infrequent and in general conducted on animals; human dissections were extremely rare. Findings were documented in the form of drawings.
- The Scientific Period, from the second half of the fifteenth century to the nineteenth century. During this period various factors converged to transform anatomy into a modern science, some of the most important being:
  - A. The increasing accuracy of anatomical drawings, produced by artists in the form of woodcuts and engravings that were not only detailed and accurate, but of high artistic quality. Well-known artists began to take an interest in the human body and were asked to illustrate anatomical texts. Among them were Jacopo Bellini, van Calcaar, Paolo Veronese, Giambattista Piazzetta and Leonardo da Vinci. A crucial figure in this period was Andrea Vesalius, a great innovator who completely revised the methods that were used to teach anatomy.
  - B. The spread of the practice of human dissections. There were obstacles from the onset. The Church was in opposition and Academics considered the use of cadavers to be a lowly occupation. Dissection gradually won acceptance, leading to a more profound knowledge of anatomy and more accurate drawings.
  - C. The development of printing, which made possible the reproduction and wider dissemination of anatomical illustrations.

The Scientific Period can be further divided into the times before and after the reforms of Vesalius.

- The Modern Period, from the nineteenth century to the present day. For the last 200 years anatomical studies have focused with increasing precision on specific organs, systems and regions such as the lymph vessels, the cutaneous vascular system, and the strata and substrata of the skin. Many of these studies, as we will see, would have direct consequences for the development of plastic surgery.

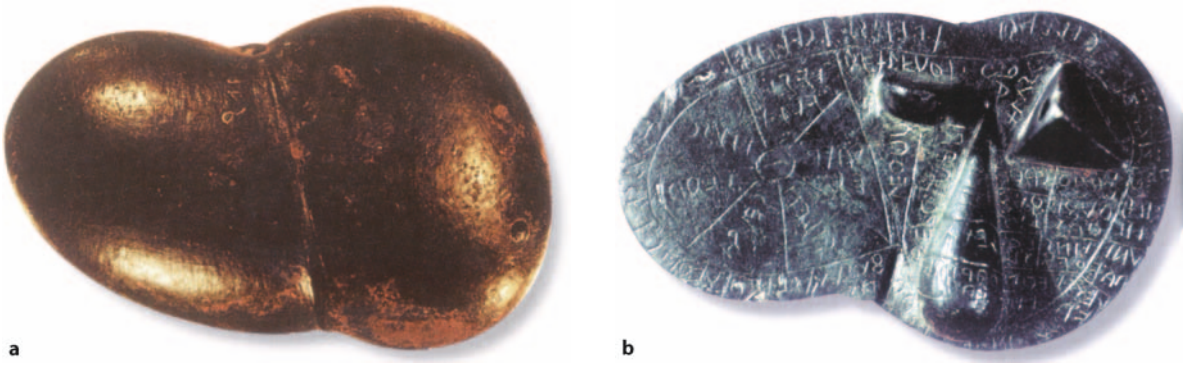

Fig. 1.2a,b A bronze Etruscan sheep's liver found near Piacenza in Italy during the nineteenth century and dated around the third century B.C. It was probably used for religious purposes. The accurate detail highlights the Etruscan's knowledge of anatomy. *Courtesy of the Musei Civici di Palazzo Farnese, Piacenza*

The Pre-Scientific Period

Man's interest in anatomy dates back to prehistoric times, although it was not originally motivated by the desire to acquire scientific knowledge that could be applied to the practice of medicine. In the Palaeolithic Age, for example, our ancestors knew perfectly well where the hearts of their victims were located, as is shown on wall paintings in the caves of Paindal in Spain and Niaux in the Ariège Mountains of France. The study of anatomy started in Classical times as highlighted by the statement of Charles Singer [932]: "In anatomy the Greeks had no predecessors."

While we have no proof that dissections were conducted in antiquity—certainly not on humans, or in the pursuit of medical knowledge—some notions of anatomy did exist. A few rather crude representations have come down to us, such as the bronze model of a liver discovered in the ruins of a Babylonian temple in Mesopotamia and dating from approximately 2000 B.C. Another is the bronze model of a sheep's liver (Fig. 1.2a, b) found at an Etruscan settlement near Piacenza in Italy. It dates from the third century B.C. and shows the gall bladder as well as the two principle lobes on the anterior surface with the caudate lobe beneath. The Etruscans were very familiar with the anatomy of the liver since another in terracotta was found in Faleri, north of Rome. Again it dates from around the fourth to third century B.C. and is kept in the Etruscan Museum at Villa Giulia in Rome. It is possible that the use of these artefacts was mainly religious but they testify of an accurate knowledge of anatomy.[1]

The ancient Egyptians began recording anatomical observations around 2900 B.C. Given their well established practice of mummification, they had ample opportunity to study the viscera of the human body and it is not surprising that some practitioners attempted to make a record of their observations. Thus, stylized representations of the heart, lungs and trachea can be found among Egyptian hieroglyphs and carved on amulets. W.M.F. Petrie [795], F.L. Griffith [396], N. de G. Davies [221]. Unfortunately, it is not possible to determine whether these represent fortuitous observations made during the mummification procedure, or if they were the result of dissections carried out for the purposes of study, although the latter hypothesis seems somewhat unlikely.

Anatomy During Classical Antiquity

The birth of anatomy as a science may be traced back to the Hellenistic period. It is no coincidence that many

1 The use of the liver by priests for auspicious predictions was not uncommon [Carini AM, Govi E (2000) *Il Fegato di Piacenza*. Pallazzo Farnese, Piacenza]. Another terracotta liver, found in Mesopotamia, now in the British Museum, was used by the Caldeans but its anatomical accuracy is not of the high standard as the Etruscan model.

Fig. 1.3 Hippocrates (ca. 460–370 B.C.). Portrait taken from *Les Oeuvres* by Ambroise Paré. *Courtesy of Riccardo Mazzola, M.D., Milan*

beautiful bronze statues cast in accurate anatomical detail were produced during this epoch and the island of Sicily, which was encompassed in the Greek sphere of influence, made significant contributions to the development of this science.

Important observations were made by Alcmaenon, who lived in Sicily around 500 B.C. It is certain that he dissected animals and it appears that the original discovery of the auditory tube, which would later be named after the sixteenth century anatomist Bartolomeo Eustachius, can be attributed to him. He also conducted the earliest studies in embryology, and has left us a description of the head of the fetus.

The most common subject of early observations was the anatomy of the vascular system. Acron, Pamanias, Empedocles of Agrasi (all c.480 B.C.) and Philiston of Locri (c.380 B.C.) were all Sicilians who left behind interesting traces of their work. We have a diagram illustrating the circulatory system by Diogenes of Apollonia (c.400 B.C.), whose *Regimen* was included in the *Corpus Hippocraticus* [932]. Anaximenes (c.580 B.C.) described the functions of the *pneuma* in the following terms: "Just as our soul, being of air, sustains us, so the pneuma and air pervade the entire world", while Empedocles held the theory that "blood is life" and the hypothesis that the heart was the most vital organ in the vascular and respiratory systems. He used the term *pneuma* to designate the soul and life, which he identified with air and the act of breathing [932]

Hippocrates of Cos (c.400–355 B.C.) (Fig. 1.3) [434–437] was without question the most important figure in anatomy and medicine in ancient Greece. We know very little about his life except that he was born on the island of Cos and his father Eraclides was a physician who established a celebrated school of medicine on the island. Not all of the fifty-nine works contained in what is referred to as the *Corpus Hippocraticus* are by his hand. There is strong evidence to suggest that at least forty of them (including some of the most famous, such as *On the Sacred Illnesses*, *Head Injuries* and *Fractures and Dislocations*) are apocryphal and were actually written by his students [932]. In any event the *Corpus* covers the entire field of medicine as it was practised during the time of Hippocrates. No less than nine of the works are dedicated exclusively to anatomy and another nine to surgery. Aldo Mieli [666].[2] Many demonstrate an astonishing knowledge of the human organs. For example, we find the first description of the brain as an organ divided into two symmetrical lobes, although curiously the Greeks were persuaded that the

2 Of pertinence to anatomy are Hippocrates' works *De Anatomia*, *De Corde* (*On the Heart*), *De Carne* (also known as *De Musculi*), *De Glandulis*, *De Natura Ossium*, *De Natura Hominis*, *De Natura Pueri* and finally *De Morbis*. Many details regarding the anatomy of human organs and systems were based on the dissections of goats. Among his other writings, *The Aphorisms*, *Treatise on Prognoses*, *Epidemic Diseases*, *Diet in Acute Diseases*, *On Injuries to the Head*, *Luxations*, *Fractures and Ulcers* and finally *On Airs, Waters and Places* deserve mention.

right lobe received blood directly from the liver while the left lobe was fed by blood from the spleen.

Beginning in the second half of the fourth century B.C., medicine was strongly influenced by the philosopher Aristotle (384–322 B.C.) [32] who wrote a number of treatises on animals [3] and during the course of his reflections on natural history elaborated a theory of "organic evolution". He is considered to be the founder of the discipline of comparative anatomy and the first scientist to record his observations in the form of anatomical drawings. The earliest work on embryology can also be attributed to Aristotle. In it he discusses the processes of reproduction in different animals and his theories concerning them. He succeeded in studying a 3-day-old chick embryo and describing its development. Aristotle does not appear to have ever conducted human dissections, but he nevertheless has left descriptions, with clear schematic diagrams, of the aorta and the male and female genito-urinary systems, with names assigned to each of the organs.

The influence of Aristotle on the science of anatomy lasted for many centuries. The philosopher was tutor and then friend to Alexander the Great, who founded the Egyptian city of Alexandria with its legendary library of 700,000 volumes. Thanks to this institution Alexandria became the centre of culture and learning in the antique world. At least two famous anatomists were active there around 250 B.C. One was Herophilus of Chalcedon who, according to Claudius Galen (131–221 A.D.) [348–354] "was the first to carry out dissections on the corpses of both man and animals". This assertion was not quite exact, since dissections—especially on animals—were being conducted long before Herophilus, but he certainly was the first to write about his studies in a scientific manner, in his work *On Anatomy* and then in his treatise *On the Eyes*.[4] The breadth of his research has justly earned Herophilus the title of "the father of anatomy". Another illustrious Alexandrian and contemporary of Herophilus, Erasistratus of Chios, is regarded as "the father of physiology" because in his studies he sought to understand not only the structure but also the functioning of the body's organs [932].

Fig. 1.4 Aulus Cornelius Celsus (second century A.D.), author of *De Medicina*. *Courtesy of FMR Art.spa, Bologna*

For religious reasons the ancient Romans disapproved of the dissection of both human beings and animals. Their knowledge was therefore based entirely upon the texts of their Greek predecessors. In Egypt under Roman rule the antique practice of dissection which had been perpetuated in the city of Alexandria was interrupted. Notwithstanding this Aulus Cornelius Celsus (25 B.C. to 50 A.D.) (Fig. 1.4) has left us surprisingly accurate anatomical descriptions, some of which—for example, his

3 See, for example, *The History of Animals* and *On the Parts of Animals*.

4 Herophilus is also known for having written a text on obstetrics and for identifying the brain as the seat of the intelligence, thus challenging Aristotle who retained that the soul was located in the heart. Herophilus also made the distinction between the motor and sensory nerves, describing the whole as a "miraculous network".

studies on the genitalia [5] and the skeleton[6]—are of special interest to plastic surgery [167, 168]. Apart from the works of Celsus, however, the medical literature in Latin during the first one hundred and fifty years A.D. is almost non-existent, although it must not be forgotten that all educated Romans could read and write in Greek.

A genuine revival of the study of medicine took place in Rome with the advent of Galen whose influence was destined to last for centuries. The son of a celebrated mathematician and architect, Galen was born in Pergamum, a city with a well-known medical school located in the province of Anatolia, which was then under Greek rule. At the age of twenty Galen went to Smyrna to study under Pelope and it was there that he wrote his first work *On the Movement of the Thorax and Lungs*. After spending several years in Alexandria, he returned to Pergamum at the age of twenty-eight. Four years later he moved permanently to Rome, where he eventually became personal physician to the emperor Marcus Aurelius.

According to Galen, the physician who lacked a firm grounding in anatomy was like an architect working without a blueprint, and he therefore dedicated much of his time to giving public anatomical demonstrations using animals, in particular monkeys. Garofalo and Vegetti [359]. The dissection of human cadavers was prohibited in Rome for religious reasons, although Bettman and Hench [89] claim that Galen carried out at least one dissection, on a man who had died by drowning. In any case Galen's knowledge of animal anatomy must have been encyclopaedic if it is true that he even dissected an elephant and a hippopotamus. He was quite aware of the anatomical differences between animals and man, and may in a certain sense be regarded as a comparative anatomist *ante litteram*. While in Alexandria he had carried out unprecedented studies on the skeleton (*On the Bones, for Beginners*), gathering data for the first known description of the marrow of the long bones. Other fundamental works on the motor apparatus followed, including *On the Anatomy of the Muscles*, which is considered to be his most important contribution to the study of anatomy.[7] Galen's systematic classification of the cranial nerves—a truly astonishing achievement for his time—would remain in use until the seventeenth century. Other noteworthy contributions included his accurate and detailed descriptions of the pulmonary artery (which he called the "arterial vein") and the recurrent laryngeal nerve with its intricately branching course, not to mention his fascinating comparative studies of the hands of the monkey and man (Fig. 1.5).

In the tradition of Aristotle, Galen believed that nothing was created by Mother Nature without a reason and therefore each organ must have been constructed so as to best fulfil the function for which it was designed [359, 932]. He wrote: "Indeed, the theory of finalism can be applied to the study of animal organs. Each part, being perfectly adapted to its end, could not have been constructed in any other manner than it was."

The teachings of Galen would remain a reference point for almost fifteen centuries; his authority was undisputed and all medical questions were resolved on the basis of his teachings. Unfortunately, this meant that his errors were perpetuated as well and in time became an obstacle to progress in medicine. Andrea Vesalius, in the sixteenth century, was one of the first to dare to challenge Galen's way of thinking.

The Middle Ages

After Galen interest in anatomy declined in the Western world. The cultural heritage of Athens, Rome and Alexandria instead passed into the safekeeping of the Nestorians in Mesopotamia and later the Arabs, who would go on copying and teaching from the classical texts during the centuries corresponding to the Dark Ages in Europe. For this entire period however, which lasted until the year 1000, the respect of both Arab and Oriental cultures for the bodies of the deceased was such that no human dissections could be carried out (Figs. 1.6a, b, 1.7a, b).

In western Europe after the fall of the Roman Empire the study of medicine was carried on almost exclusively in the monasteries and under the strict control of the Church. Given that Catholic doctrine included the com-

5 See *De Medicina*, Book VII, Chapters 28, 36, 37 and 45.

6 See *De Medicina*, Book VIII, Chapters 17–32.

7 While still a young man Galen wrote many other important works such as *Anatomical Procedures* (in 16 books of which only 9 have come down to us) and *The Anatomy of the Uterus*. He later also wrote a work entitled *On the Use of the Parts of the Body*.

Fig. 1.5 Guy de Chauliac (1300–1368) lecturing to students with his predecessors Galen, Avicenna and Hippocrates in the background. From an illuminated manuscript in Guy's book *Chirurgie*, probably commissioned by Duke Charles d'Orleans, dated 1461. *By permission of the Biblioteque Nationale de France, Paris*

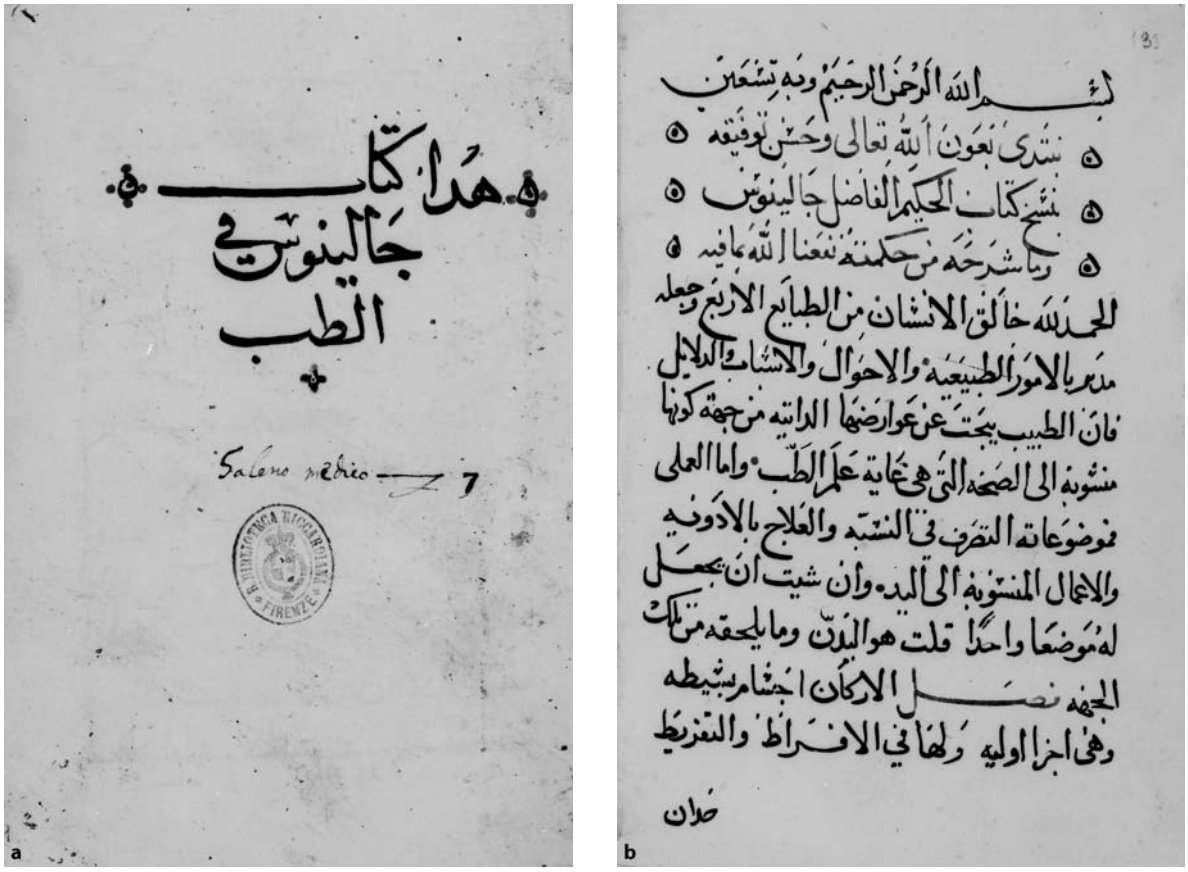

Fig. 1.6a,b Arabic translation of the works *Liber Sapientiae* by Hippocrates (Kitāb Hikmat Abuqrāt) from the Middle Ages. The translator was probably Abū Zakariya Yahyă (777–857 A.D.), doctor to Califf Hărūn ar-Rašīd who appointed him leader of a group charged with translating the Greek manuscripts acquired in Asia Minor and Egypt. *By permission of the Dipartimento per i Beni Archivistici e Librari Biblioteca Riccardiana, Florence*

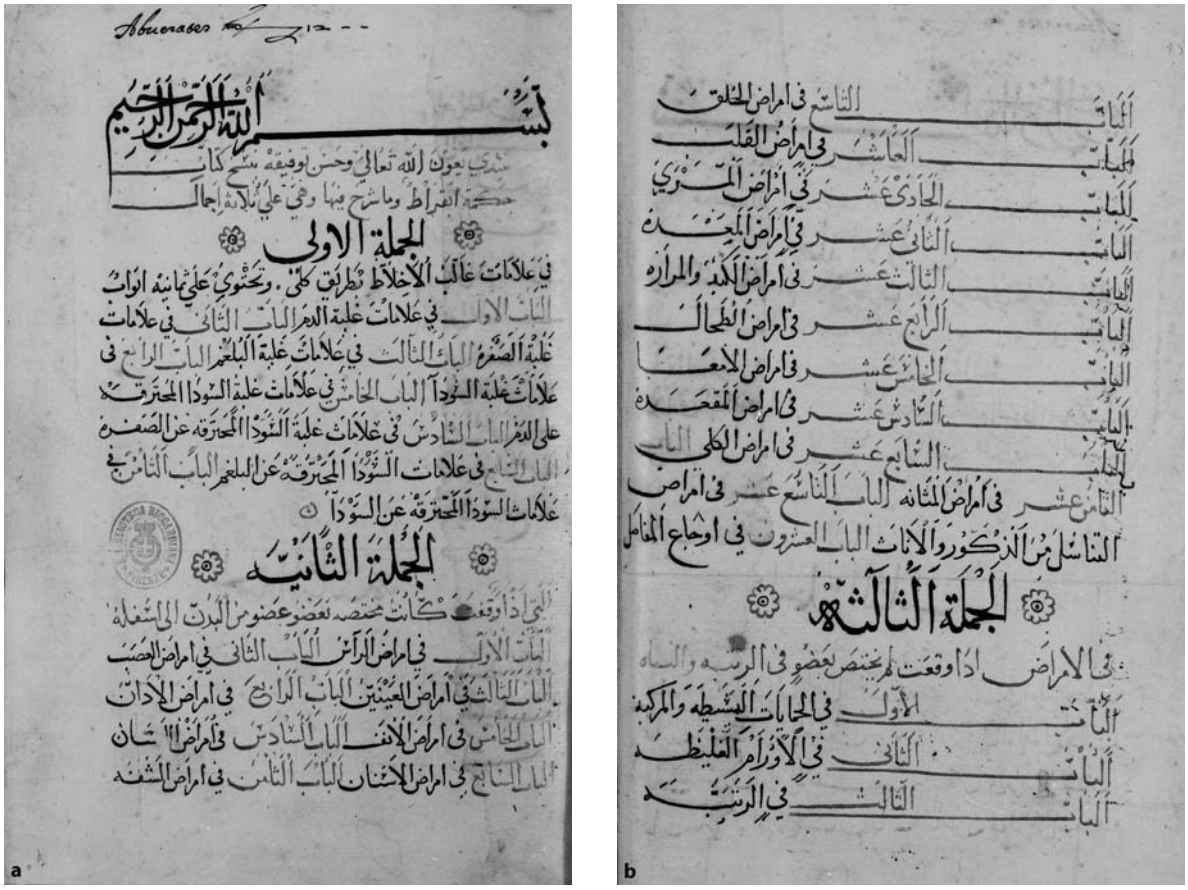

Fig. 1.7a,b Arabic translation of the works of Galen *De Arte Medica* (Kitāb Galīnūs fi't-Tibb) from the Middle Ages. Most of the original works of Galen in Greek have been lost. Those we have were preserved through the Middle Ages by the Arabic translations. The translator was probably Girğis ibn Gibrā īl, a member of the "House of the Wisdom", created in 830 A.D. in Bagdad by al-Ma'mūn, son of the mythical Califf Hārūn ar Rašīd. Many of the classic texts were translated in this House. *By permission of the Dipartimento per i Beni Archivistici e Librari Biblioteca Riccardiana, Florence*

mandment *Ecclesia abhorret a sanguine*, any procedure regarded as being unusually cruel, including dissection, was strictly prohibited. Scholasticism, the medieval system of theology and philosophy based on Aristotelian logic and the writings of the early Church Fathers, dominated medical studies as it did all the other branches of knowledge.

In Italy there was one noteworthy exception to the rule that bound the practice of medicine to the religious orders, the famous *Scuola Salernitana*. The Arab tradition had been kept alive in southern Italy and above all in Sicily, which for a long period of time remained under the influence of the Arabs. According to Bettman and Hench [89] the *Scuola Salernitana* was founded in Salerno near Naples sometime around the ninth century by four physicians of different religious faiths: one Greek Orthodox, one Jew, one Arab Muslim and one Italian Catholic. This made it possible for the school to develop unhampered by medieval superstition and above all free from the influence of the Church.[8] In this haven the

8 At the Council of Reims in 1131 the Catholic Church prohibited the practice of medicine outside the monasteries. Who knows if this was one of the reasons why Constantine, one of the founders of Western medicine (who brought many medical texts from his native Tunisia to Salerno), abandoned his profession and joined the Benedictine order in the Abbey of Montecassino.

practice of surgery flourished, and the school counted such illustrious figures as Roger of Salerno and Rolando of Parma among its teachers. The study of anatomy did not reach such impressive heights, however.[9] This seeming anomaly can be explained in part by the fact that, despite its name, the *Scuola Salernitana* was a clinic whose principle function was not teaching but the treatment of patients. In 1240 King Frederick II founded the University of Naples where dissections were permitted and this contributed to the gradual decline in importance of the *Scuola*, although it remained in existence until the Napoleonic era.

The Role of the Earliest Universities in the Teaching of Anatomy

During the thirteenth century an important development took place in the teaching of medicine which until that time, at least in the West, had been, like the arts, based on a direct relationship between teacher and student without the existence of true schools. In reality there had been schools in the past in Mesopotamia and Arabia for the teaching of medicine, but in Europe the sole example was the *Scuola Salernitana*. Eventually in the thirteenth century, European universities began to teach medicine, including anatomy (Fig. 1.8). This included the renowned university of Bologna, which had already been in existence for more than one hundred years. Unlike many of its sister institutions, the *studio* of Bologna had not been founded by ecclesiastic charter and its teachers and students were regarded with some suspicion by the Church. The faculty of law succeeded in maintaining a considerable degree of independence from the ecclesiastic authorities, becoming completely autonomous in 1306 and this contributed significantly to the development of a school of anatomy at the university. In fact, the jurists themselves requested dissections in order to gather evidence for their cases and what began as a medical-legal procedure led to increasing scientific knowledge.

Fig. 1.8 The first page of Guy de Chauliac's *Chirurgia Magna* which also contains the writings of the ten most celebrated surgeons of the time, including Mondeville and Lanfranchi. *Courtesy of Riccardo Mazzola, M.D., Milan*

The founder of the school of anatomy in Bologna was Ugo Borgognoni of Lucca (1170–1240), whose work was continued by his son Theodorico of Cervia (1205–1298). Theodorico managed to have human dissections included for the first time as an integral part of the medical curriculum, even if cadavers were extremely difficult to obtain and when available, could only be used for a limited period of time due to the lack of means for their preservation [979]. In the absence of human cadavers, dissections were conducted on animals, most often pigs. The advances introduced by Theodorico were consolidated by Guglielmo da Saliceto (1215–1276), who described for the first time the motor nerves that govern the con-

9 The earliest surviving documents relating to the *Scuola Salernitana* date from 848 and concern Giuseppe da Salerno and another physician by the name of Josan. The oldest text produced by the school has been attributed to a certain Alfano (1058–1083) and is entitled *De Quatuor Humoribus Corporis Humanis* (*The Four Humours of the Human Body*).

traction of the voluntary and involuntary muscles [880, 881].[10]

Taddeo Alderotto of Florence (1223–1303) continued Theodorico's practices, while his student and successor Henry de Mondeville [682, 731] introduced the use of anatomical diagrams, carefully prepared on the basis of actual dissections, as a teaching instrument. These proved to be an invaluable aid to the students, who could in this way review what they had learned during the faculty's all too rare anatomy demonstrations.[11] Detailed and accurately drawn, these charts were considered by de Mondeville to be absolutely fundamental in the education of future surgeons.

By the end of the 1300s dissections had become an accepted and officially recognized procedure in Bologna, although cadavers remained difficult to come by. This situation favoured the introduction by Mondino de Liucci (1270–1326) innovations which generated significant impetus and helped transform anatomy into a genuine science [683–685].

Mondino was born, it seems in 1275, to a Florentine family; his father was a pharmacist. He studied medicine in Bologna where Taddeo Alderotti, a fellow Florentine, was teaching and received his degree in 1300. After further studies under Henry de Mondeville, he became a professor and taught medicine at the university of Bologna from 1306 to 1326. During this time he managed to institute the rule that lessons in anatomy should always be conducted on the basis of human dissections (Fig. 1.9) or when this was not possible, studies on animals, preferably monkeys or pigs. He realized that lectures illustrated with diagrams such as those prepared by his professor Henry de Mondeville were not sufficient. Mondino did not sully his hands personally during the anatomical demonstrations; instead he sat in an imposing chair and from there directed an assistant called an *ostensor*, who indicated the lines of dissection to a *demonstrator* who carried out the actual manual labour of cutting the cadaver (Fig. 1.10). This lofty approach to the teaching of anatomy would persist until the arrival of Vesalius, who prided himself on conducting his dissections in person.

Fig. 1.9 The Anatomical Theatre of the University of Bologna dated 1637. The picture shows the "Baldacchino degli Spellati" (Canopy of the Skinned men) added in 1734. *PJS*

Nonetheless, with Mondino's reforms anatomy was taught more systematically and dissection became the fulcrum of the discipline. Thanks to this *Restauratore dell'Anatomia*, as he was regarded by his contemporaries,

10 Guglielmo da Saliceto's work *Vulgare in Chirurgia* contains many sections that are of relevance to plastic surgery. We may cite from Book II his descriptions of treatments for injuries of the nose (chapter III) and the auricle (chapter VI). Guglielmo was an advocate of the use of the scalpel for surgical procedures in a period when, due to the influence of the Arab school of medicine, cautery was the preferred practice.

11 Henri de Mondeville's famous anatomical diagrams which he prepared for his lessons as professor at Montpellier, are now conserved at the Bibliotheque Nationale de France.

Fig. 1.10 Mondino de Liucci (1270–1326) lecturing in Bologna. He was the first anatomist to base his lectures on dissections rather then on diagrams. He did not perform the dissection himself but directed the *ostensors* and *demonstrators* from a chair. The picture, a woodcut, is taken from *Fascicula Medicinae* by John de Ketham (fifteenth century Italian School). This is probably the first illustrated book dealing only with anatomy and the first with colour illustrations. *Fondazione Giorgio Cini, Venice, Italy. Archives Charmet – Bridgeman Art Library*

Italy maintained its primacy as the most important centre for anatomical studies until the Renaissance.[12]

Traditionally the subject of anatomy had been covered in texts on surgery, but in 1316 Mondino wrote *Anathomia*,[13] perhaps the first work exclusively devoted to anatomy. Mondino's medical principles did not depart radically from those of Galen and the Arab authorities, but his teachings differed in that they were always based upon direct observation and dissections. Since there were no techniques available for the conservation of cadavers, he was obliged to conduct his demonstrations as quickly as possible. Depending upon the season, the longest delay he could afford was four days. For this reason his lessons could not be carried out systematically and organs were examined one by one as they were exposed during the course of the dissection. Nevertheless Mondino did manage to follow a logical sequence and during the dissection customarily delivered "four lectures on the body. The first concerned the nutritive organs because they were the ones that tended to putrefy the most quickly; second the 'spiritual' organs [the head and brain], third the natural organs [for example, the thoracic cavity], and finally the fourth on the extremities and the spinal column" [684, 685].

The cadavers obtained were generally those of executed criminals, a practice which would continue in Bologna until the sixteenth century. Mondino complained bitterly of the lack of corpses and experimented with various solutions to compensate for this dearth of bodies. For example, he developed a procedure for drying specimens in the sun, an approach that was particularly effective for the preservation of tendons, ligaments and bones. Skeletons were obtained by maceration, a practice that would continue for many centuries. Mondino introduced many other innovations. He was probably the first anatomist to inject coloured liquids into the blood vessels which when solidified, made it possible to study the circulatory system. In his work *De Omnibus Humanii Corporus Interioribus Membris*, printed in 1513, he

12 It was in 1300 and hence during the time of Mondino that Pope Boniface VIII issued his famous papal bull *de Sepoltura* which excommunicated anyone who conserved skeletons by boiling their bones. In reality this practice arose for a completely different reason. The remains of persons of rank who died far from home, particularly during the Crusades, were cleaned in this way so that they could be brought home for burial. The papal bull was not directed against anatomists in particular, but could not be ignored by them.

13 *Anathomia* was published in Padua in 1476 by the printer Pietro Maufer.

Fig. 1.11 The Archigimnasium of the University of Bologna was built in 1562. Since 1637 it has housed the Anatomical Theatre. It was bombed in World War II. *PJS*

provides a description of the palate and its role in the process of speaking.

Much of Mondino's work was inspired by his study of the Arab medical literature and many of the terms devised by him, such as *basilica*, *cephalica*, *saphena* and *retina*, reflect this. Certainly the University of Bologna (Fig. 1.11) was remarkably advanced for its time, the *Studio Generale* having boldly asserted its right to self-governance and its independence from the Church: "The students wanted to practise Medicine without having to don the cleric's habit" [89]. Medicine was taught on the basis of scientific logic, rather than by theoretical deduction as was still the practice in many other European universities. The professor of anatomy was required to perform two official dissections during the course of the year while his four assistants were responsible for the remainder. Unofficial demonstrations could be held on request at the home of the professor or one of his assistants, but for these the students had to furnish their own cadaver and pay an honorarium.

It may be said that Mondino's innovations marked the end of the Pre-Scientific Period and opened the way for the pre-Vesalian Scientific Period, at the end of which we find the masters who were destined to transform the science of anatomy.

The Scientific Period

Before Vesalius

During the fourteenth and fifteenth centuries many eminent figures such as Berengario da Carpi, Alessandro Benedetti, Leonardo da Vinci and Johannes de Ketham helped to lay the foundations for the scientific era of anatomy.

Berengario da Carpi (1460–1530), the son of a well-known Bolognese physician and surgeon, was the first of these. After completing his studies and receiving his degree on 3 August 1489, Berengario held the chair in anatomy and surgery at Bologna from 1502 to 1527. He was the author of two important works, *Isagoge Breves Perlucide in Anatomiam Humana Corpori* and *Carpi Commentarii*, in which we find the first description of organs such as the appendix, the thymus, the vas deferens and the synovia [75–77]. Of particular relevance to the area of plastic surgery, given their important role in breast reconstruction today, is his description of the abdominal muscles. Furthermore Berengario described the differences between the male and female pelvis[14] with excellent illustrations that were probably prepared by Ugo da Carpi, a talented painter in Bologna (Fig. 1.12a, b). Berengario's treatise on cranial trauma [74], written after

14 See in *Isagoge Breves Perlucide in Anatomian Humani Corpori* (published in Bologna in 1522), Chapter II entitled *Anatomia Ventris Medii*. The same work contains interesting descriptions of the reproductive organs. The illustrations, which were the work of Ugo da Carpi, are noteworthy.

Fig. 1.12 Diagrams of **a** the venous circulation of the arm and **b** abdominal muscles, from the *Isogae* by Berengario da Carpi. *Courtesy of Riccardo Mazzola, M.D., Milan*

he had treated Lorenzo de' Medici for a head injury, is also of interest and we will consider it in more detail in our chapter on cranioplasty.[15]

Among the many distinguished anatomists who taught at the University of Bologna was Giulio Cesare Aranzid (1628–1694). He conducted pioneering studies on the human fetus and also deserves credit for having discovered and encouraged the gifted Gaspare Tagliacozzi, whom he seems to have taught the procedure of rhinoplasty. Other prestigious figures include Giovanni Alfonso Borelli (1608–1679) and Marcello Malpighi (1628–1694), but not long afterwards the study of anatomy, followed by that of surgery, experienced a decline in Italy as attention shifted to another area. Indeed, once the organs of the human body had been identified and their structure determined, it was inevitable that physicians should begin to ask themselves how they functioned; thus, the study of physiology was born.

15 See *De Fractura Calvariae sive Crani*, published in Bologna in 1516, where in Part II, Chapter IV the author provides an account of his operation on Lorenzo de' Medici for a skull fracture caused by a gunshot wound.

Fig. 1.13 Portrait of A. Benedetti (1460–1525). *Courtesy of the Mayor of Legnago, Verona*

Fig. 1.14 Frontispiece of Alessandro Benedetti's *Anatomia*. He designed and started the construction of the famous Anatomical Theatre of the University of Padua. *Courtesy of Riccardo Mazzola, M.D., Milan*

The University of Padua Before Vesalius

During the second half of the fifteenth century Padua, like Bologna, experienced a significant revival in the teaching of medicine, which initially took the form of a rediscovery of the classical authors and the re-publication of their texts in Latin. Editions of the works of Hippocrates and Galen appeared in 1544 (the works of Celsus had already been printed in Florence in 1478), while many other texts were discovered *ex novo* and interpreted in the light of the most recent scientific knowledge.

This development grew out of the general movement known as *Humanism*, and one of its proponents was Alessandro Benedetti (1460–1525) (Fig. 1.13). Born in Legnago near Verona, Benedetti attended the university of Padua and completed his studies in 1475, after which he practised surgery for seventeen years in the Greek archipelago, where he also mastered the Greek language. In 1490 he was nominated professor of anatomy and surgery at the university of Padua, and was able to dedicate himself to the task of translating some of the most important medical texts from Antiquity. These authorities

are amply cited in his *Anatomiae sive Historia Corporis Humanis* (Fig. 1.14), which was published in 1502 [70, 71].[16] Benedetti fully embraced the reforms of Mondino and his lessons were always based on direct observation.

The author of numerous books, he also designed and began constructing the famous anatomy theatre of Padua (Fig. 1.15) whose form was inspired by that of the Roman amphitheatre, in particular the Arena of Verona.[17] He became extremely well known and served as the personal physician to many eminent figures in the Republic of Venice, as well as the Emperor Maximilian I of Germany.

Fig. 1.15 Anatomical Theatre of Padua. The building was started by Alessandro Benedetti and completed in 1591 by Gerolamo Fabricius ab Aquapendente (1533–1619) (Fig. 1.30). This was the theatre where Vesalius gave his lectures. *University of Padua, Italy, Giraudon – Bridgeman Art Library*

The Birth of the Anatomical Illustration

During the second half of the fifteenth century the practice of human dissection became more widely accepted and spread beyond Padua and Bologna, reaching such a point that even scientists and physicians not directly involved in the teaching of medicine could perform the procedure [815]. For example, public dissections were often held in the city of Venice, which did not even have a school of medicine.

During this period a mutually beneficial collaboration between artists and anatomists arose. Artists could finally satisfy their curiosity regarding what lay beneath the surface of the living form, while anatomists had their observations recorded in drawings that were both accurate and artistic. In this way artists developed an interest in the morphology of the human body at a time when the spread of the technique of printing facilitated the diffusion of their work. It seems that for a certain period artists regularly attended dissections. In one of his accounts Vesalius describes: "… questi pittori e scultori che svolazzano attorno a me durante le dissezioni" ("these painters and sculptors who flutter around me during the dissections").

Among those who profited from the more liberal intellectual climate was Leonardo da Vinci (1452–1519), who produced anatomical drawings of astonishing accuracy and also demonstrated a lively curiosity with regard to the functioning of individual organs, in particular muscles and bones [550–552]. Born in the Tuscan village of Vinci in 1452, the illegitimate son of a local nobleman, Leonardo moved to Florence when he was still quite young. There he joined the studio of Andrea Verrocchio

16 As we will see in the chapter on nose reconstructions, in *Anatomiae sive Historia Corporsi Humanis* (Volume IV, Chapter 39, *De naso*) Benedetti describes a procedure for the reconstruction of the nose almost one hundred years before Tagliacozzi.

17 This famous anatomy theatre was completed by Fabrizio ab Aquapendente in 1591. An exact copy may be seen at the University of Uppsala in Sweden—the *Gustavianum* constructed by Olof Rudbeck in 1622. Rudbeck had studied anatomy in Padua, where he initiated his research on the lymph vessels. Other remarkable anatomy theatres are to be found in Leiden (1596) and Bologna (1637).

(1435–1488), a famous Florentine artist who understood how important it was for a painter and sculptor to have a thorough knowledge of anatomy. When he was invited to Milan by the ruling Sforza family in 1483, Leonardo took advantage of the opportunity to conduct dissections at the Ospedale Maggiore, producing five drawings of the human skull between 1487 and 1493. He continued his studies, eventually dissecting the entire human body, and produced his first anatomical work, *La Figura Umana*. When Leonardo left Milan and returned to Florence in 1506, he began collaborating with Marcantonio della Torre (1481–1512) on an anatomy treatise, but this project was interrupted by the premature death of the physician, thus depriving us of what would certainly have been a most fascinating work.

Leonardo emphasized the importance of the anatomical drawing in teaching: "How could you describe this heart in words without having to fill an entire book? In addition, the more details you write on the subject the more you risk confusing the mind of the reader." Irrefutable support for this argument can be found in his meticulous scientific drawings. For the plastic surgeon, Leonardo's two drawings of the palate showing every detail of the musculature of the soft palate (*velum palatinum*) are of enormous interest, but the quality of his other studies of the human body can never cease to amaze us (Fig. 1.16). He completed more than one hundred drawings of the heart, lungs, brain, uterus and muscles, which are all the more remarkable because we know that he conducted his dissections by candlelight. With endless inventiveness Leonardo developed various techniques to help him in his studies. For example he injected coloured wax into organs before sectioning them and this made possible his detailed studies of the cerebral ventricles. He also constructed wire cages around various joints so that he could study the movement and function of the muscles.

Leonardo was the first scientist to study the fetal membranes. He boiled eyes in albumin so that they could be sectioned for examination. The modern convention of illustrating the bones in three views, anterior, lateral and posterior, was introduced by Leonardo. Another field in which he excelled was angiology; in one drawing of the interior of the heart we can recognize such details as the septomarginal trabecula (muscle bundle) of the right ventricle, which was first described in anatomical texts many centuries later.

If Leonardo's purpose, at least initially,[18] was to establish an anatomical basis for his paintings, there is no doubt that very quickly his scientific curiosity took over. Hence his drawings are works of art, but also incomparable anatomical studies which were so useful in the teaching of anatomy that it is said even Vesalius was inspired by his work.[19]

Up until this time the highly inaccurate diagrams compiled by the anatomists themselves were copied by scribes who had no specific knowledge of anatomy and therefore added error to error. For this reason, until the fifteenth century when artists began to make their contribution, anatomical illustrations were poor. Indeed very little had changed since the time of Aristotle, who in his *Generatione Animalium* suggested the use of paradigms, schemata and diagrams to illustrate the anatomy of the body.

As Louis Choulant [178] wrote, the requirements of teaching were best met by: "an ideal human figure based on the constant use of proportions" and this model was generally followed after Mondino. Choulant divided the evolution of the anatomical illustration into six stages:

- The period before Berengario da Carpi (1521), when knowledge of anatomy was still based on schematic drawings.
- The period from Berengario to Vesalius (1521–1543), during which more accurate illustrations, made possible by the technique of woodcut engravings, were introduced.
- The period from Vesalius to Casserio (1543–1600), when the practice of dissection spread and increasing

18 Many famous artists of the period, including Andrea Mantegna (1431–1506) and Luca Signorelli (1445–1523), shared Andrea Verrocchio's conviction that a knowledge of anatomy could be useful in their work.

19 When Leonardo died his drawings were conserved by his student Francesco Melzi. The son of Melzi sold most of these to the sculptor Pompeo Leoni, who later took them with him to Spain. Two volumes remained there on the sculptor's death and were only recently rediscovered in the National Library of Madrid. A third volume was sold in 1630 to Lord Thomas Howard, Count of Arundel and adviser on matters of art to King Charles I; it is now conserved at the Royal Library of Windsor in England.

Fig. 1.16 The muscles of the arm, hand and face by Leonardo da Vinci. (RL19012v) *The Royal Collection © 2005, Her Majesty Queen Elizabeth II*

numbers of artists began to take an interest in anatomy. The quality of woodcut illustrations improved markedly.

- The period from Casserio to Albinus (1627–1737), as anatomical drawings became increasingly accurate and were reproduced in the form of highly artistic engravings.
- The period from Albinus to Sömmering (1737–1770) witnessed the zenith of the anatomical drawing, which was now exact in every detail and meticulously reproduced through the medium of the copperplate engraving.
- From Sömmering to the present day. With the introduction of the technique of lithography, anatomical illustrations became technically perfect, but their artistry was lost.

In Germany at the end of the fifteenth century, for example, modest booklets on medicine were published in the form of almanacs. *Der Tierkreiszeichenmann* or *The Zodiac Man* (Fig. 1.17) depicted "the different parts of the human body which are influenced by different planetary conjunctions, [and] indicated the appropriate times for blood-letting and purging under each sign of the Zodiac,

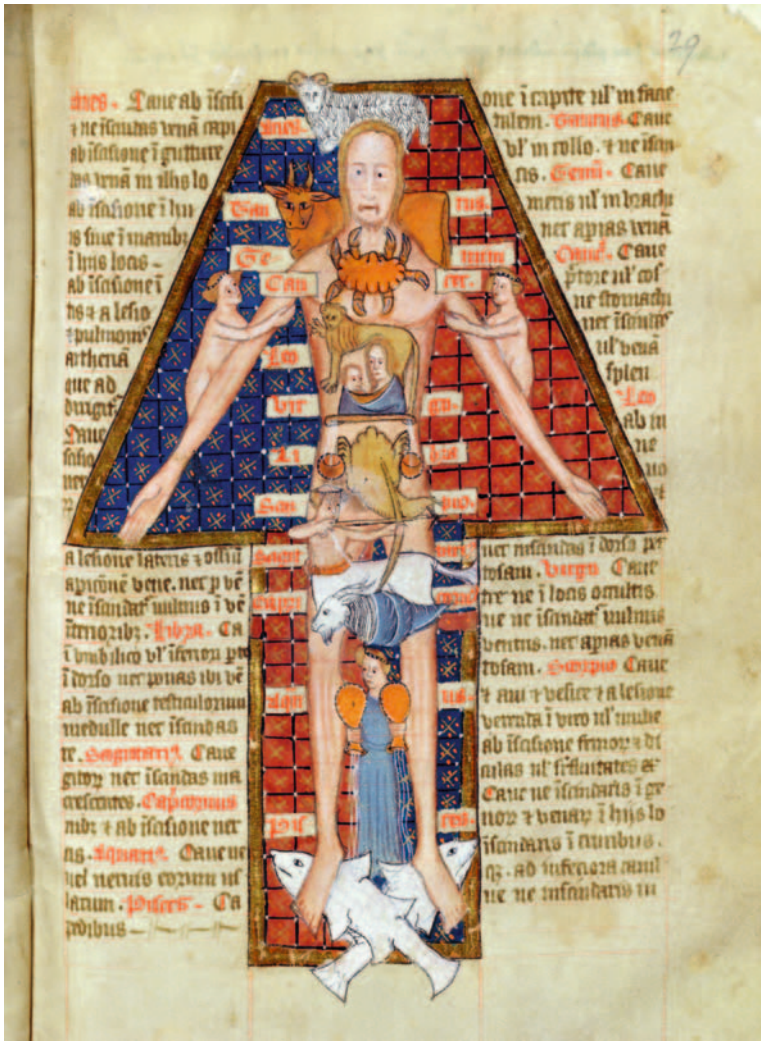

Fig. 1.17 Zodiac Man, from a calendar or astrological notes, fourteenth to fifteenth century English (on parchment). © *Corpus Christi College, Oxford, UK – Bridgeman Art Library*

with gloomy prognostications of terrible diseases" [360, 361]. The anatomical illustrations are reasonably accurate as is much of the information in the accompanying text, apart from the horoscopes.

Soon however, scientific texts with much more reliable anatomical images were being published and disseminated. Some of the first noteworthy illustrations appeared in the fifteenth century in Johannes de Ketham's *Fascicula Medicinae* [491].[20] He was a lecturer in anatomy in Vienna who diligently compiled six pre-existing anatomical texts, including that of Mondino, into a single work which was published in Latin in Venice in 1491. Heralded in Italy as the most outstanding book of the period, the first edition included five full-page

20 The identity of Johannes de Ketham has been questioned since his name does not appear in history of medicine except for this book. It has been suggested that the collector of the *Fascicula* is probably to be identified as an obscure professor of anatomy in Vienna by the name of Hans von Kircheim. The first edition was printed by the brothers Giovanni and Gregorio de Gregori in Venice in 1491. In the second edition, translated into Italian and printed in February 1494 by the same de Gregori, the name of Ketham has disappeared.

woodcuts, while the second edition contained no less than ten. One of these illustrations is quite famous. It portrays the professor of anatomy Pietro di Montagnana of Padua surrounded by the books of Pliny, Aristotle, Galen, Avicenna, and others, with three patients in the background.[21] It appears that the painter of these illustrations was the Venetian Gentile Bellini (1429–1507) or one of his students.

The illustrations in de Ketham's book were not only far more accurate than anything that came before, they also reflected the transition from a medieval to a modern concept of the science of anatomy. For example, de Ketham was the first to label the various parts of his figures with lines running to explanatory notes in the margins. Another fine woodcut (XXIII) illustrates an anatomy class. In it we can see the professor presiding over his students from a raised seat, with the *ostensor* and the *demonstrator* carrying out the dissection, and a skeleton in the background. *Fascicula Medicinae* was an immediate success because it made available to the general public for the first time a text containing accurate anatomical illustrations and it was soon translated into Italian and Spanish.[22] The originality of the illustrations is questionable [624].

Another work that deserves mention is an anatomical drawing of the abdominal muscles executed by Pietro de Abano (1250–1315) for his treatise *Conciliator*, which was published posthumously in 1497 [1].

In addition to Johannes de Ketham of Vienna, several other prominent anatomists could be found working outside Italy during the period preceding Vesalius. One of these was the surgeon Hieronimus Brunschwig of Strasbourg (1450–1534) who in 1479 published a work on wounds, fractures and other surgical problems that included excellent anatomical descriptions, particularly of the skeleton [138, 139]. It confirmed the close link between anatomy and surgery and was translated into English and other languages.

Another German working in the same period was Johannes Dryander (1500–1560) who after studying in Paris was eventually appointed professor at Marburg. In 1536 he obtained permission to conduct dissections from the prince of Hesse, to whom he dedicated his book *Anatomia Capitis Humani* (Fig. 1.18). One year later Dryander published the first part of his projected *opus magnum* on the subject, *Anatomia Hoc Est, Corporis Humani Dissectiones Pars Prior…* [252], but unfortunately the second part was never completed (Fig. 1.19). The two works that have come down to us present the results of his studies on the anatomy of the head. One series of illustrations shows the various layers of the scalp including, for the first time, the *galea capitis* and the *pericranium* (see figures in Chapter 11). Also of interest is an engraving of the soft and hard palates together with the floor of the mouth (see figure in Chapter 8), which is similar to, although less accurate than Leonardo's drawing.[23]

In 1541 Dryander published *Anatomia Mundini*, an updated version of Mondino's *Anathomia* illustrated with a fresh set of woodcuts drawn from other sources. Eighteen were copied from the *Commentaria* that Berengario wrote on Mondino's work in 1521, another twenty

21 The nine other woodcuts in the second edition illustrate: (1) Pietro and his students examining a urine sample; (2) diagrams of the four humours and twenty-three varieties of urine; (3) the bleeding of a patient; (4) the Zodiac; (5) a pregnant woman seated with her genitals exposed for examination; (6) an injured man; (7) a sick man; (8) a physician examining a patient with the plague; and (9) an anatomy session, with Mondino seated in state, overlooking the *demonstrator* and the *ostensor* who are carrying out the dissection (Fig. 1.10).

22 *Fascicula Medicinae* was generally believed to be the first illustrated text on anatomy and it is certainly the first to be printed in colour. The inexperience of the printer can be easily demonstrated by the less than accurate distribution of the colours (one of the hand of the professor in painted in red, and so is one of the hands of the *demonstrator* while the yellow of the chair is very irregular). Further research, however, suggests that some of the illustrations were copied, or at least inspired, by the illustrations on medical subjects to be found in various medieval manuscripts. Furthermore, a dissection scene by Bartolomeo Anglico (c.1200–1240) published in the encyclopaedia *De Proprietatibus Rerum* in 1491 [see 624] and other works conserved in the Bibliotheque Nationale de Paris, certainly date to an earlier period.

23 The illustrations are signed with the initials "GVB", "VB" or simply "G" which identify, at least according to Choulant, various engravers of the school of Brosamer.