*Orthotomic Surfaces; Parallel Surfaces.*

20. The three sets of surfaces may be such that the three surfaces through any point of space whatever intersect each other at right angles; and they are in this case said to be orthotomic. The term curvilinear coordinates was almost appropriated by Lamé, to whom this theory is chiefly due, to the case in question: assuming that the equations $p=f_1(x,y,z)$, $q=f_2(x,y,z)$, $r=f_3(x,y,z)$ refer to a system of orthotomic surfaces, we have in the restricted sense $p$, $q$, $r$ as the curvilinear coordinates of the point.

An interesting special case is that of confocal quadric surfaces. The general equation of a surface confocal with the ellipsoid $\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1$ is $\frac{x^2}{a^2+\theta}+\frac{y^2}{b^2+\theta}+\frac{z^2}{c^2+\theta}=1$; and, if in this equation we consider $x, y, z$ as given, we have for $\theta$ a cubic equation with three real roots $p, q, r$, and thus we have through the point three real surfaces, one an ellipsoid, one a hyperboloid of one sheet, and one a hyperboloid of two sheets.

21. The theory is connected with that of curves of curvature by Dupin's theorem. Thus in any system of orthotomic surfaces each surface of any one of the three sets is intersected by the surfaces of the other two sets in its curves of curvature.

22. No one of the three sets of surfaces is altogether arbitrary: in the equation $p=f_1(x,y,z)$, $p$ is not an arbitrary function of $x, y, z$, but it must satisfy a certain partial differential equation of the third order. Assuming that $p$ has this value, we have $q=f_2(x,y,z)$ and $r=f_3(x,y,z)$ determinate functions of $x, y, z$ such that the three sets of surfaces form an orthotomic system.

23. Starting from a given surface, it has been seen (No. 16) that the normals along the curves of curvature form two systems of torses intersecting each other, and also the given surface, at right angles. But there are, intersecting the two systems of torses at right angles, not only the given surface, but a singly infinite system of surfaces. If at each point of the given surface we measure off along the normal one and the same distance at pleasure, then the locus of the points thus obtained is a surface cutting all the normals of the given surface at right angles, or, in other words, having the same normals as the given surface; and it is therefore a parallel surface to the given surface. Hence the singly infinite system of parallel surfaces and the two singly infinite systems of torses form together a set of orthotomic surfaces.

*The Minimal Surface.*

24. This is the surface of minimum area—more accurately, a surface such that, for any indefinitely small closed curve which can be drawn on it round any point, the area of the surface is less than it is for any other surface whatever through the closed curve. It at once follows that the surface at every point is concavo-convex; for, if at any point this was not the case, we could, by cutting the surface by a plane, describe round the point an indefinitely small closed plane curve, and the plane area within the closed curve would then be less than the area of the element of surface within the same curve. The condition leads to a partial differential equation of the second order for the determination of the minimal surface: considering $z$ as a function of $x, y$, and writing as usual $p, q, r, s, t$ for the first and second differential coefficients of $z$ in regard to $x, y$ respectively, the equation (as first shown by Lagrange) is $(1+q^2)r-2pqs+(1+p^2)t=0$, or, as this may also be written, $\frac{d}{dy}\frac{q}{\sqrt{1+p^2+q^2}}+\frac{d}{dx}\frac{p}{\sqrt{1+p^2+q^2}}=0$. The general integral contains of course arbitrary functions, and, if we imagine these so determined that the surface may pass through a given closed curve, and if, moreover, there is but one minimal surface passing through that curve, we have the solution of the problem of finding the surface of minimum area within the same curve. The surface continued beyond the closed curve is a minimal surface, but it is not of necessity or in general a surface of minimum area for an arbitrary bounding curve not wholly included within the given closed curve. It is hardly necessary to remark that the plane is a minimal surface, and that, if the given closed curve is a plane curve, the plane is the proper solution; that is, the plane area within the given closed curve is less than the area for any other surface through the same curve. The given closed curve is not of necessity a single curve: it may be, for instance, a skew polygon of four or more sides.

The partial differential equation was dealt with in a very remarkable manner by Riemann. From the second form given above it appears that we have $\frac{qdx-pdy}{\sqrt{1+p^2+q^2}}$ = a complete differential, or, putting this $=d\zeta$, we introduce into the solution a variable $\zeta$, which combines with $z$ in the forms $z\pm i\zeta$ ($i=\sqrt{-1}$ as usual). The boundary conditions have to be satisfied by the determination of the conjugate variables $\eta, \eta'$ as functions of $z+i\zeta$, $z-i\zeta$ or, say, of $Z, Z'$ respectively, and by writing $S, S'$ to denote $x+iy$, $x-iy$ respectively. Riemann obtains finally two ordinary differential equations of the first order in $S, S', \eta, \eta', Z, Z'$, and the results are completely worked out in some very interesting special cases.

The memoirs on various parts of the general subject are very numerous; references to many of them will be found in Salmon's *Treatise on the Analytic Geometry of Three Dimensions*, 4th ed., Dublin, 1882 (the most comprehensive work on solid geometry); for the minimal surface (which is not considered there) see Memoirs xviii. and xxvi. in Riemann's *Gesammelte mathematische Werke*, Leipsic, 1876; the former—"Ueber die Fläche vom kleinsten Inhalt bei gegebener Begrenzung," as published in *Gött. Abhandl.*, vol. xiii. (1866-67)—contains an introduction by Hattendorff giving the history of the question. (A. CA.)

SURGEONS, COLLEGE OF. See SOCIETIES.

# SURGERY

## PART I.—HISTORY.

SURGERY in all countries is as old as human needs. A certain skill in the stanching of blood, the extraction of arrows, the binding up of wounds, the supporting of broken limbs by splints, and the like, together with an instinctive reliance on the healing power of the tissues, has been common to men everywhere. In both branches of the Aryan stock surgical practice (as well as medical) reached a high degree of perfection at a very early period. It is a matter of controversy whether the Greeks got their medicine (or any of it) from the Hindus (through the medium of the Egyptian priesthood), or whether the Hindus owed that high degree of medical and surgical knowledge and skill which is reflected in Charaka and Suśruta (commentators of uncertain date on the Yajur-Veda; see SANSKRIT, vol. xxi. p. 294) to their contact with Western civilization after the campaigns of Alexander. The evidence in favour of the former view is ably stated by Wise in the Introduction to his *History of Medicine among the Asiatics* (London, 1868). The correspondence between the *Suśruta* and the *Hippocratic Collection* is closest in the sections relating to the ethics of medical practice; the description, also, of lithotomy in the former agrees almost exactly with the account of the Alexandrian practice as given by Celsus. But there are certainly some dexterous operations described



in Suśruta (such as the rhinoplastic) which were of native invention; the elaborate and lofty ethical code appears to be of pure Brahmanical origin; and the very copious materia medica (which included arsenic, mercury, zinc, and many other substances of permanent value) does not contain a single article of foreign source. There is evidence also (in Arrian, Strabo, and other writers) that the East enjoyed a proverbial reputation for medical and surgical wisdom at the time of Alexander's invasion. We may give the first place, then, to the Eastern branch of the Aryan race in a sketch of the rise of surgery, leaving as insoluble the question of the date of the Sanskrit compendiums or compilations which pass under the names of two representative persons, Charaka and Suśruta (the dates assigned to these ranging as widely as 500 years on each side of the Christian era).

Ancient Hindu practitioners.

The *Suśruta* speaks throughout of a single class of practitioners who undertook both surgical and medical cases. Nor were there any fixed degrees or orders of skill within the profession; even lithotomy, which at Alexandria was assigned to specialists, was to be undertaken by any one, the leave of the rajah having been first obtained. The only distinction recognized between medicine and surgery was in the inferior order of barbers, nail-trimmers, ear-borers, tooth-drawers, and phlebotomists, who were outside the Brahmanical caste.

Surgical instruments.

Suśruta describes more than one hundred surgical instruments, made of steel. They should have good handles and firm joints, be well polished, and sharp enough to divide a hair; they should be perfectly clean, and kept in flannel in a wooden box. They included various shapes of scalpels, bistouries, lancets, scarifiers, saws, bone-nippers, scissors, trocars, and needles. There were also blunt hooks, loops, probes (including a caustic-holder), directors, sounds, scoops, and forceps (for polypi, &c.), as well as catheters, syringes, a rectal speculum, and bougies. There were fourteen varieties of bandage. The favourite form of splint was made of thin slips of bamboo bound together with string and cut to the length required. Wise says that he has frequently used "this admirable splint," particularly for fractures of the thigh, humerus, radius, and ulna, and it has been subsequently adopted in the English army under the name of the "patent rattan-cane splint."

Operations.

Fractures were diagnosed, among other signs, by crepitus. Dislocations were elaborately classified, and the differential diagnosis given; the treatment was by traction and countertraction, circumduction, and other dexterous manipulation. Wounds were divided into incised, punctured, lacerated, contused, &c. Cuts of the head and face were sewed. Skill in extracting foreign bodies was carried to a great height, the magnet being used for iron particles under certain specified circumstances. Inflammations were treated by the usual antiphlogistic regimen and appliances; venesection was practised at several other points besides the bend of the elbow; leeches were more often resorted to than the lancet; cupping also was in general use. Poulticing, fomenting, and the like were done as at present. Amputation was done now and then, notwithstanding the want of a good control over the hæmorrhage; boiling oil was applied to the stump, with pressure by means of a cup-formed bandage, pitch being sometimes added. Tumours and enlarged lymphatic glands were cut out, and an arsenical salve applied to the raw surfaces to prevent recurrence. Abdominal dropsy and hydrocele were treated by tapping with a trocar; and varieties of hernia were understood, omental hernia being removed by operation on the scrotum. Aneurisms were known, but not treated; the use of the ligature on the continuity of an artery, as well as on the cut end of it in a flap, is the one thing that a modern surgeon will miss somewhat noticeably in the ancient surgery of the Hindus; and the reason of their backwardness in that matter was doubtless their want of familiarity with the course of the arteries and with the arterial circulation. Besides the operation already mentioned, the abdomen was opened by a short incision below the umbilicus slightly to the left of the middle line, for the purpose of removing intestinal concretions or other obstruction (laparotomy). Only a small segment of the bowel was exposed at one time; the concretion when found was removed, the intestine stitched together again, anointed with ghee and honey, and returned into the cavity. Lithotomy was practised, without the staff. There was a plastic operation for the restoration of the nose, the skin being taken from the cheek adjoining, and the vascularity kept up by a bridge of tissue. The ophthalmic surgery included extraction of cataract. Obstetric operations were various, including cæsarean section and crushing the fœtus.

Medical treatment.

The medication and constitutional treatment in surgical cases were in keeping with the general care and elaborateness of their practice, and with the copiousness of their materia medica. Ointments and other external applications had usually a basis of ghee (or clarified butter), and contained, among other things, such metals as arsenic, zinc, copper, mercury, and sulphate of iron. For every emergency and every known form of disease there were elaborate and minute directions in the śâstras, which were taught by the physician-priests to the young aspirants.

Training of practitioners.

Book learning was considered of no use without experience and manual skill in operations; the different surgical operations were shown to the student upon wax spread on a board, on gourds, cucumbers, and other soft fruits; tapping and puncturing were practised on a leathern bag filled with water or soft mud; scarifications and bleeding on the fresh hides of animals from which the hair had been removed; puncturing and lancing upon the hollow stalks of water-lilies or the vessels of dead animals; bandaging was practised on flexible models of the human body; sutures on leather and cloth; the plastic operations on dead animals; and the application of caustics and cauteries on living animals. A knowledge of anatomy was held to be necessary, but it does not appear that it was systematically acquired by dissection. Superstitions and theurgic ideas were diligently kept up so as to impress the vulgar. The whole body of teaching, itself the slow growth of much close observation and profound thinking during the vigorous period of Aryan progress, was given out in later times as a revelation from heaven, and as resting upon an absolute authority. Pathological principles were not wanting, but they were derived from a purely arbitrary or conventional physiology (wind, bile, and phlegm); and the whole elaborate fabric of rules and directions, great though its utility must have been for many generations, was without the quickening power of reason and freedom, and became inevitably stiff and decrepit.

The Chinese appear to have been far behind the Hindus in their knowledge of medicine and surgery, notwithstanding that China profited at the same time as Tibet by the missionary propagation of Buddhism. Surgery in particular had hardly developed among them beyond the merest rudiments, owing to their religious respect for dead bodies and their unwillingness to draw blood or otherwise interfere with the living structure. Their anatomy and physiology have been from the earliest times unusually fanciful, and their surgical practice has consisted almost entirely of external applications. Tumours and boils were treated by scarifications or incisions. The distinctive Chinese surgical invention is acupuncture, or the insertion of fine needles, of hardened silver or gold, for an inch or more (with a twisting motion) into the

seats of pain or inflammation. Wise says that "the needle is allowed to remain in that part several minutes, or in some cases of neuralgia for days, with great advantage"; rheumatism and chronic gout were among the localized pains so treated. There are 367 points specified where needles may be inserted without injuring great vessels and vital organs.

Cupping-vessels made of cow-horn have been found in ancient Egyptian tombs. On monuments and the walls of temples are figures of patients bandaged, or undergoing operation at the hands of surgeons. In museum collections of Egyptian antiquities there are lancets, forceps, knives, probes, scissors, &c. Ebers interprets a passage in the papyrus discovered by him as relating to the operation of cataract. Surgical instruments for the ear are figured, and artificial teeth have been found in mummies. Mummies have also been found with well-set fractures. Herodotus describes Egypt, notwithstanding its fine climate, as being full of medical practitioners, who were all "specialists." The ophthalmic surgeons were celebrated, and practised at the court of Cyrus.

Greek. As in the case of the Sanskrit medical writings, the earliest Greek compendiums on surgery bear witness to a long organic growth of knowledge and skill through many generations. In the Homeric picture of society the surgery is that of the battlefield, and it is of the most meagre kind. Achilles is concerned about the restoration to health of Machaon for the reason that his skill in cutting out darts and applying salves to wounds was not the least valuable service that a hero could render to the Greek host. Machaon probably represents an amateur, whose taste had led him, as it did Melampus, to converse with centaurs and to glean some of their traditional wisdom. Between that primitive state of civilization and the date of the first Greek treatises there had been a long interval of gradual progress. The surgery of the *Hippocratic Collection* (age of Pericles) bears every evidence of finish and elaboration. The two treatises on fractures and on dislocations respectively are hardly surpassed in some ways by the writings of the present mechanical age. Of the four dislocations of the shoulder the displacement downwards into the axilla is given as the only one at all common. The two most usual dislocations of the femur were backwards on to the dorsum ilii and forwards on to the obturator region. Fractures of the spinous processes of the vertebræ are described, and caution advised against trusting those who would magnify that injury into fracture of the spine itself. Tubercles (*φύματα*) are given as one of the causes of spinal curvature, an anticipation of Pott's diagnosis. In all matters of treatment there was the same fertility of resource as in the Hindu practice; the most noteworthy point is that shortening was by many regarded as inevitable after simple fracture of the femur. Fractures and dislocations were the most complete chapters of the Hippocratic surgery; the whole doctrine and practical art of them had arisen (like sculpture) with no help from dissection, and obviously owed its excellence to the opportunities of the palæstra. The next most elaborate chapter is that on wounds and injuries of the head, which refers them to a minute subdivision, and includes the depressed fracture and the *contrecoup*. Trephining was the measure most commonly resorted to, even where there was no compression. Numerous forms of wounds and injuries of other parts are specified. Ruptures, piles, rectal polypi, fistula in ano, and prolapsus ani were among the other conditions treated. The amputation or excision of tumours does not appear to have been undertaken so freely as in Hindu surgical practice; nor was lithotomy performed except by a specially expert person now and then. The diagnosis of empyema was known and the treatment of it was by an incision in the intercostal space and evacuation of the pus. Among their instruments were forceps, probes, directors, syringes, rectal speculum, catheter, and various kinds of cautery.

Hippocratic surgery.

Between the Hippocratic era and the founding of the school of Alexandria (about 300 B.C.), there is nothing of surgical progress to dwell upon. The Alexandrian epoch stands out prominently by reason of the enthusiastic cultivation of human anatomy—there are allegations also of vivisection—at the hands of Herophilus and Erasistratus. The sum and substance of this movement appears to have been precision of diagnosis (not unattended with pedantic minuteness), boldness of operative procedure, subdivision of practice into a number of specialities, but hardly a single addition to the stock of physiological or pathological ideas, or even to the traditional wisdom of the Hippocratic time. "The surgeons of the Alexandrian school were all distinguished by the nicety and complexity of their dressings and bandagings, of which they invented a great variety." Herophilus boldly used the knife even on internal organs such as the liver and spleen, which latter he regarded "as of little consequence in the animal economy." He treated retention of urine by a particular kind of catheter, which long bore his name. Lithotomy was much practised by a few specialists, and one of them (Ammonius) is said to have used an instrument for breaking the stone in the bladder into several pieces when it was too large to remove whole. A sinister story of the time is that concerning Antiochus, son of Alexander, king of Syria, who was done to death by the lithotomists when he was ten years old, under the pretence that he had stone in the bladder, the instigator of the crime being his guardian and supplanter Diodotus.

The treatise of Celsus *De re medica* (reign of Augustus) reflects the state of surgery in the ancient world for a period of several centuries: it is the best record of the Alexandrian practice itself, and it may be taken to stand for the Roman practice of the period following. Great jealousy of Greek medicine and surgery was expressed by many of the Romans of the republic, notably by Cato the Elder (234-149 B.C.), who himself practised on his estate according to the native traditions. His medical observations are given in *De re rustica*. In reducing dislocations he made use of the following incantation: "Huat hanat ista pista sista damiato damnaustra." The first Greek surgeon who established himself in Rome is said to have been Archagathus, whose fondness for the knife and cautery at length led to his expulsion by the populace. It was in the person of Asclepiades, the contemporary and friend of Cicero, that the Hellenic medical practice acquired a permanent footing in Rome. This eloquent and plausible Greek confined his practice mostly to medicine, but he is credited with practising the operation of tracheotomy. He is one of those whom Tertullian quotes as abandoning themselves to vivisections for the gratification of their curiosity: "Asclepiades capras suas quærat sine corde balantes et muscas suas abigat sine capite volantes" (*De anima*, 15). The next figure in the surgical history is Celsus, who devotes the 7th and 8th books of his *De re medica* exclusively to surgery. There is not much in these beyond the precepts of the Brahmanical śâstras and the maxims and rules of Greek surgery. Plastic operations for the restoration of the nose, lips, and ears are described at some length, as well as the treatment of hernia by taxis and operation; in the latter it was recommended to apply the actual cautery to the canal after the hernia had been returned. The celebrated description of lithotomy is that of the operation as practised long before in India and at Alexandria. The treatment of sinuses in various regions is dwelt upon, and in the case of sinuses of the thoracic wall

Cato Major.



resection of the rib is mentioned. Trephining has the same prominent place assigned to it as in the Greek surgery. The resources of contemporary surgery may be estimated by the fact that subcutaneous urethrotomy was practised when the urethra was blocked by a calculus. Amputation of an extremity is described in detail for the first time in surgical literature. Mention is made of a variety of ophthalmic operations, which were done by specialists after the Alexandrian fashion.

Galen's practice of surgery was mostly in the early part of his career (born 131 A.D.), and there is little of special surgical interest in his writings, great as their importance is for anatomy, physiology, and the general doctrines of disease. Among the operations credited to him are resection of a portion of the sternum for caries and ligature of the temporal artery. It may be assumed that surgical practice was in a flourishing condition all through the period of the empire from the accounts preserved by Oribasius of the great surgeons Antyllus, Leonides, Rufus, and Heliodorus. Antyllus (300) is claimed by Häser as one of the greatest of the world's surgeons; he had an operation for aneurism (tying the artery above and below the sac, and evacuating its contents), for cataract, for the cure of stammering; and he treated contractures by something like tenotomy. Rufus and Heliodorus are said to have practised torsion for the arrest of hæmorrhage; but in later periods both that and the ligature appear to have given way to the actual cautery. Häser speaks of the operation for scrotal hernia attributed to Heliodorus as "a brilliant example of the surgical skill during the empire." The same surgeon treated stricture of the urethra by internal section. Both Leonides and Antyllus removed glandular swellings of the neck (*strumæ*); the latter ligatured vessels before cutting them, and gives directions for avoiding the carotid artery and jugular vein. The well-known operation of Antyllus for aneurism has been mentioned before. Flap-amputations were practised by Leonides and Heliodorus. But perhaps the most striking illustration of the advanced surgery of the period is the freedom with which bones were resected, including the long bones, the lower jaw, and the upper jaw.

Byzantine. Whatever progress or decadence surgery may have experienced during the next three centuries is summed up in the authoritative treatise of Paulus of Ægina (650). Of his seven books the sixth is entirely devoted to operative surgery, and the fourth is largely occupied with surgical diseases. The importance of Paulus for surgical history during several centuries on each side of his own period will appear from the following remarks of Francis Adams in his translation and commentary (vol. ii. p. 247).

"This book (bk. vi.) contains the most complete system of operative surgery which has come down to us from ancient times. . . . Haly Abbas in the 9th book of his *Practica* copies almost everything from Paulus. Albucasis [Abulcasis] gives more original matter on surgery than any other Arabian author, and yet, as will be seen from our commentary, he is indebted for whole chapters to Paulus. In the *Continens* of Rhases, that precious repository of ancient opinions on medical subjects, if there be any surgical information not to be found in our author it is mostly derived from Antyllus and Archigenes. As to the other authorities, although we will occasionally have to explain their opinions upon particular subjects, no one has treated of surgery in a systematical manner; for even Avicenna, who treats so fully of everything else connected with medicine, is defective in his accounts of surgical operations; and the descriptions which he does give of them are almost all borrowed from our author. The accounts of fractures and dislocations given by Hippocrates and his commentator Galen may be pronounced almost complete; but the information which they supply upon most other surgical subjects is scanty."

It is obviously impossible in a brief space to convey any notion of the comprehensiveness of the surgery of Paulus; his sixth book, with the peculiarly valuable commentary of Adams, brings the whole surgery of the ancient world to a focus; and it should be referred to at first hand. Paulus himself is credited with the principle of local depletion as against general, with the lateral operation for stone instead of the mesial and with understanding the merits of a free external incision and a limited internal, with the diagnosis of aneurism by anastomosis, with an operation for aneurism like that of Antyllus, with amputation of the cancerous breast by crucial incision, and with the treatment of fractured patella.

The Arabians have hardly any greater merit in medicine than that of preserving intact the bequest of the ancient world. To surgery in particular their services are small, —first, because their religion proscribed the practice of anatomy, and secondly, because it was a characteristic of their race to accept with equanimity the sufferings that fell to them, and to decline the means of alleviation. The great names of the Arabian school, Avicenna and Averroes, are altogether unimportant for surgery. Their one distinctively surgical writer was Abulcasim (d. 1122), who is chiefly celebrated for his free use of the actual cautery and of caustics. He showed a good deal of character in declining to operate on goitre, in resorting to tracheotomy but sparingly, in refusing to meddle with cancer, and in evacuating large abscesses by degrees.

Mediæval. For the five hundred years following the work of Paulus of Ægina there is nothing to record but the names of a few practitioners at the court and of imitators or compilers. Meanwhile in western Europe (apart from the Saracen civilization) a medical school had gradually grown up at Salerno, which in the 10th century had already become famous. From it issued the *Regimen Salernitanum*, a work used by the laity for several centuries, and the *Compendium Salernitanum*, which circulated among the profession. The serious decline of the school dates from the founding of a university at Naples in 1224. In its best period princes and nobles resorted to it for treatment from all parts of Europe. The hôtel dieu of Lyons had been founded in 560, and that of Paris a century later. The school of Montpellier was founded in 1025, and became the rallying point of Arabian and Jewish learning. A good deal of the medical and surgical practice was in the hands of the religious orders, particularly of the Benedictines. The practice of surgery by the clergy was at length forbidden by the council of Tours (1163). The surgical writings of the time were mere reproductions of the classical or Arabian authors: "unus non dicit nisi quod alter." One of the first to go back to independent observation and reflexion was William of Saliceto, who belonged to the school of Bologna; his work (1275) advocates the use of the knife in many cases where the actual cautery was used by ancient prescription. A greater name in the history of mediæval surgery is that of his pupil Lanfranchi of Milan, who migrated (owing to political troubles) first to Lyons and then to Paris. He distinguished between arterial and venous hæmorrhage, and is said to have used the ligature for the former. Contemporary with him in France was Henri de Mondeville of the school of Montpellier, whose teaching is best known through that of his more famous pupil Guy de Chauliac; the *Chirurgie* of the latter bears the date of 1363, and marks the advance in precision which the revival of anatomy by Mondino had made possible. Eighteen years before Lanfranchi came to Paris a college of surgeons was founded there (1279) by Pitard, who had accompanied St Louis to Palestine as his surgeon. The college was under the protection of St Cosmas and St Damianus, two practitioners of medicine who suffered martyrdom in the reign of Diocletian, and it became known as the Collége de St Côme. From the time that Lanfranchi joined it it attracted many pupils. It maintained its independent existence for several centuries,

alongside the medical faculty of the university; the corporation of surgeons in other capitals, such as those of London and Edinburgh, were modelled upon it.

The 14th and 15th centuries are almost entirely without interest for surgical history. The dead level of tradition is broken first by two men of originality and genius, Paracelsus and Paré, and by the revival of anatomy at the hands of Vesalius and Fallopius, professors at Padua. Apart from the mystical form in which much of his teaching was cast, Paracelsus has great merits as a reformer of surgical practice. "The high value of his surgical writings," says Häser, "has been recognized at all times, even by his opponents." It is not, however, as an innovator in operative surgery but rather as a direct observer of natural processes that Paracelsus is distinguished. His description of "hospital gangrene," for example, is perfectly true to nature; his numerous observations on syphilis are also sound and sensible; and he was the first to point out the connexion between cretinism of the offspring and goitre of the parents. He gives most prominence to the healing of wounds. His special surgical treatises are *Die kleine Chirurgie* (1528) and *Die grosse Wund-Arzneï* (1536-37),—the latter being the best known of his works. Somewhat later in date, and of much greater concrete importance for surgery than Paracelsus, is Ambroise Paré (1517-1590). He began life as apprentice to a barber-surgeon in Paris and as a pupil at the hôtel dieu. His earliest opportunities were in military surgery during the campaign of Francis I. in Piedmont. Instead of treating gunshot wounds with hot oil, according to the practice of the day, he had the temerity to trust to a simple bandage; and from that beginning he proceeded to many other developments of rational surgery. In 1545 he published at Paris *La méthode de traicter les playes faictes par hacquebutes et aultres bastons à feu.* The same year he began to attend the lectures of Sylvius, the Paris teacher of anatomy, to whom he became prosector; and his next book was an *Anatomy* (1550). His most memorable service was to get the use of the ligature for large arteries generally adopted, a method of controlling the hæmorrhage which made amputation on a large scale possible for the first time in history. Like Paracelsus, he writes simply and to the point in the language of the people, while he is free from the encumbrance of mystical theories, which detract not a little from the merits of his fellow-reformer in Germany. It is only in his book on monsters, written towards the end of his career, that he shows himself to have been by no means free from superstition. Paré was adored by the army and greatly esteemed by successive French kings; but his innovations were opposed, as usual, by the faculty, and he had to justify the use of the ligature as well as he could by quotations from Galen and other ancients.

Surgery in the 16th century recovered much of the dexterity and resource that had distinguished it in the best periods of antiquity, while it underwent the developments opened up to it by new forms of wounds inflicted by new weapons of warfare. The use of the staff and other instruments of the "apparatus major" was the chief improvement in lithotomy. A "radical cure" of hernia by sutures superseded the old application of the actual cautery. The earlier modes of treating stricture of the urethra were tried; plastic operations were once more done with something like the skill of Brahmanical and classical times; and ophthalmic surgery was to some extent rescued from the hands of ignorant pretenders. It is noteworthy that even in the legitimate profession dexterous special operations were kept secret; thus the use of the "apparatus major" in lithotomy was handed down as a secret in the family of Laurence Colot, a contemporary of Paré's.

The 17th century was distinguished rather for the rapid progress of anatomy and physiology, for the Baconian and Cartesian philosophies, and the keen interest taken in complete systems of medicine, than for a high standard of surgical practice. The teaching of Paré that gunshot wounds were merely contused and not poisoned, and that simple treatment was the best for them, was enforced anew by Magati (1579-1647), Wiseman, and others. Trephining was freely resorted to, even for inveterate migraine; Philip William, prince of Orange, is said to have been trephined seventeen times. Flap-amputations, which had been practised in the best period of Roman surgery by Leonides and Heliodorus, were reintroduced by Lowdham, an Oxford surgeon, in 1679, and probably used by Wiseman, who was the first to practise the primary major amputations. Fabriz von Hilden (1560-1634) introduced a form of tourniquet, made by placing a piece of wood under the bandage encircling the limb; out of that there grew the block-tourniquet of Morel, first used at the siege of Besançon in 1674; and this, again, was superseded by Jean Louis Petit's screw-tourniquet in 1718. Strangulated hernia, which was for long avoided as a *noli me tangere*, became a subject of operation. Lithotomy by the lateral method came to great perfection in the hands of Jacques Beaulieu. To this century also belong the first indications (not to mention the Alexandrian practice of Ammonius) of crushing the stone in the bladder. The theory and practice of transfusion of blood occupied much attention, especially among the busy spirits of the Royal Society, such as Boyle, Lower, and others. The seat of cataract in the substance of the lens was first made out by two French surgeons, Quarré and Lasnier. Perhaps the most important figure in the surgical history of the century is Richard Wiseman, the father of English surgery. Wiseman took the Royalist side in the wars of the Commonwealth, and was surgeon to James I. and Charles I., and accompanied Charles II. in his exile in France and the Low Countries. After serving for a time in the Spanish fleet, he joined the Royalist cause in England and was taken prisoner at the battle of Worcester. At the Restoration he became serjeant-surgeon to Charles II., and held the same office under James II. His *Seven Chirurgical Treatises* were first published in 1676, and went through several editions; they relate to tumours, ulcers, diseases of the anus, king's evil (scrofula), wounds, fractures, luxations, and lues venerea. Wiseman was the first to advocate primary amputation (or operation before the onset of fever) in cases of gunshot wounds and other injuries of the limbs. He introduced also the practice of treating aneurisms by compression, gave an accurate account of fungus articulorum, and improved the operative procedure for hernia. Wise-man.

The 18th century marks the establishment of surgery on a broader basis than the skill of individual surgeons of the court and army, and on a more scientific basis than the rule of thumb of the multitude of barber-surgeons and other inferior orders of practitioners. In Paris the Collége de St Côme gave way to the Academy of Surgery in 1731, with Petit as director, to which was added at a later date the École Pratique de Chirurgie, with Chopart and Desault among its first professors. The Academy of Surgery set up a very high standard from the first, and exercised great exclusiveness in its publications and its honorary membership. In London and Edinburgh the development of surgery proceeded on less academical lines, and with greater scope for individual effort. Private dissecting rooms and anatomical theatres were started, of which perhaps the most notable was Dr William Hunter's school in Great Windmill Street, London, inasmuch as it was the first perch of his more famous brother John Hunter. In Edinburgh Alexander Monro, first of the name, became professor of anatomy to the company of surgeons in 1719,



transferring his title and services to the university the year after; as he was the first systematic teacher of medicine or surgery in Edinburgh, he is regarded as the founder of the famous medical school of that city. In both London and Edinburgh a company of barbers and surgeons had been in existence for many years before; but it was not until the association of these companies with the study of anatomy, comparative anatomy, physiology, and pathology that the surgical profession began to take rank with the older order of physicians. Hence the significance of the eulogy of a living surgeon on John Hunter: "more than any other man he helped to make us gentlemen" (*Hunterian Oration*, 1877). The state of surgery in Germany may be inferred from the fact that the teaching of it at the new university of Göttingen was for long in the hands of Haller, whose office was "professor of theoretical medicine." In the Prussian army it fell to the regimental surgeon to shave the officers. At Berlin a medico-chirurgical college was founded by surgeon-general Holtzendorff in 1714, to which was joined in 1726 a school of clinical surgery at the Charité. Military surgery was the original purpose of the school, which still exists, side by side with the surgical cliniques of the faculty, as the Friedrich Wilhelm's Institute. In Vienna, in like manner, a school for the training of army surgeons was founded in 1785,—Joseph's Academy or the Josephinum. The first systematic teaching of surgery in the United States was by Dr Shippen at Philadelphia, where the medical college towards the end of the century was largely officered by pupils of the Edinburgh school. Without attempting to enumerate the great names in surgery during the 18th century, it will be possible to introduce the more prominent of them in a brief sketch of the additions to the ideas and resources of surgery in that period. A great part of the advance was in surgical pathology, including Petit's observations on the formation of thrombi in severed vessels, Hunter's account of the reparative process, Benjamin Bell's classification of ulcers, the observations of Duhamel and others on the formation of callus and on bone-repair in general, Pott's distinction between spinal curvature from caries or abscess of the vertebræ and kyphosis from other causes, observations by various surgeons on chronic disease of the hip, knee, and other joints, and Cheselden's description of neuroma. Among the great improvements in surgical procedure we have Cheselden's operation of lithotomy (six deaths in eighty cases), Hawkins's cutting gorget for the same (1753), Hunter's operation (1785) for popliteal aneurism by tying the femoral artery in the canal of the triceps where its walls were sound ("excited the greatest wonder," Assalini), Petit's, Desault's, and Pott's treatment of fractures, Gimbernat's (Barcelona) operation for strangulated femoral hernia, Pott's bistoury for fistula, White's (Manchester) and Park's (Liverpool) excision of joints, Petit's invention of the screw-tourniquet, the same surgeon's operation for lacrymal fistula, Chopart's partial amputation of the foot, Desault's bandage for fractured clavicle, Bromfield's artery-hook, and Cheselden's operation of iridectomy. Other surgeons of great versatility and general merit were Sharp of London, Gooch of Norwich, Hey of Leeds, David and Le Cat of Rouen, Sabatier, La Faye, Ledran, Louis, Morand, and Percy of Paris, Bertrandi of Turin, Troja of Naples, Palleta of Milan, Schmucker of the Prussian army, August Richter of Göttingen, Siebold of Würzburg, Olof Acrel of Stockholm, and Callisen of Copenhagen.

Two things have given surgical knowledge and skill in the 19th century a character of scientific or positive cumulativeness and a wide diffusion through all ranks of the profession. The one is the founding of museums of anatomy and surgical pathology by the Hunters, Dupuytren, Cloquet, Blumenbach, Barclay, and a great number of more modern anatomists and surgeons; the other is the method of clinical teaching, exemplified in its highest form of constant reference to principles by Lawrence and Syme. In surgical procedure the discovery of the anæsthetic properties of ether, chloroform, methylene, &c., has been of incalculable service; while the conservative principle in operations upon diseased or injured parts and what may be called the hygienic idea (or, more narrowly, the antiseptic principle) in surgical dressings have been equally beneficial. The following are among the more important additions to the resources of the surgical art:—the thin thread ligature for arteries, introduced by Jones of Jersey (1805); the revival of torsion of arteries by Amussat (1829); the practice of drainage by Chassaignac (1859); aspiration by Pelletan and recent improvers; the plaster-of-Paris bandage or other immovable application for simple fractures, club-foot, &c. (an old Eastern practice recommended in Europe about 1814 by the English consul at Bassorah); the re-breaking of badly set fractures; galvano-caustics and écraseurs; the general introduction of resection of joints (Fergusson, Syme, and others); tenotomy by Delpech and Stromeyer (1831); operation for squint by Dieffenbach (1842); successful ligature of the external iliac for aneurism of the femoral by Abernethy (1806); ligature of the subclavian in the third portion by Astley Cooper (1806), and in its first portion by Colles; crushing of stone in the bladder by Gruithuisen of Munich (1819) and Civiale of Paris (1826); cure of ovarian dropsy by removing the cyst (since greatly perfected); discovery of the ophthalmoscope, and many improvements in ophthalmic surgery by Von Gräfe and others; application of the laryngoscope in operations on the larynx by Czermak (1860) and others; together with additions to the resources of aural surgery and dentistry. The great names in the surgery of the first half of the century besides those mentioned are:—Scarpa of Italy (1747-1832); Boyer (1757-1833), Larrey (1766-1842),—to whom Napoleon left a legacy of a hundred thousand francs, with the eulogy: "C'est l'homme le plus vertueux que j'aie connu,"—Roux (1780-1854), Lisfranc (1790-1847), Velpeau (1795-1868), Malgaigne (1806-1865), Nélaton (1807-1873),—all of the French school; of the British school, John Bell, Charles Bell, Allan Burns, Liston, Wardrop, Astley Cooper, Cline, Travers, Brodie, Stanley, and Guthrie; in the United States, Mott, Gross, and others; in Germany, Kern and Schuh of Vienna, Von Walther and Textor of Würzburg, Chelius, Hesselbach, and the two Langenbecks. In surgical pathology the discoveries and doctrines of the 19th century are greater in scientific value than those of any antecedent period; and it would be unprofitable to attempt any enumeration of them, or of their authors, in a brief space.

The authorities mostly used have been—Wise, *History of Medicine among the Asiatics*, 2 vols., London, 1868; *Paulus Ægineta*, translated with commentary on the knowledge of the Greeks, Romans, and Arabians, in medicine and surgery, by Francis Adams, 3 vols., London, 1844-47; Häser, *Gesch. d. Medicin*, 3d ed., vols. i. and ii., 1875-81. (C C.)

## Part II.—Practice of Surgery.

A great change has taken place in the practice of surgery since the publication (1860) of the article Surgery in vol. xx. of the 8th edition of the present work. This change is due in great part to the fact that the germ theory of disease has been accepted by the majority of surgical teachers and practitioners. Scientific men have demonstrated that the causation of many diseased conditions is closely connected with the presence in the diseased organ, tissue, or individual of living organisms, which have to a certain extent been classified, and are supposed to be forms