

THE HISTORY OF SURGERY FOR HIATAL HERNIA AND GASTROESOPHAGEAL REFLUX

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The surgical treatment of GERD is based on the concept of the bathing of the esophageal epithelium with gastric acid. This understanding is the culmination of both studies of anatomy, physiology, and pathology and radiography of the esophagus, and the clinical experience of treating patients. Each of these disciplines was an incomplete chapter awaiting the development of new technologies. A retrospective review of this progress is helpful in understanding the present state of the surgical treatment of GERD.

The understanding of the function of the esophagus from ancient times is evident from the construction of the word from the Greek as “*oisophagos*” (from “*oisein*” = carry and “*phagema*” = food). In Old English and Old French the Latin *gula* for throat became gullet and that word has been used interchangeably in the old medical literature [1]. The Oxford English Dictionary records the earliest English usage of Ysophagus as 1398 and in a 1541 surgical treatise by Guydon, he states “the Meri called Ysophagus is ye way of the mete and this Meri commeth out of the throte and thyrtem the mydryfe unto ye bely or stomacke.” The English continue to use oesophagus, probably to acknowledge the Greek origin of the word.

The oldest medical treatise to mention the gullet is the Edwin Smith Papyrus. This papyrus, one of the four principal medical papyri, deals almost exclusively with wounds or surgical conditions. Edwin Smith, an American Egyptologist, discovered this papyrus at Thebes in 1862. It was translated by Henry Breasted in 1930 and contains 48 surgical case histories classified by the organs affected and is organized from cephalad to caudad [2]. The papyrus ends abruptly at case 48 at the level of the chest. All the cases follow a formula where the “Title” names the condition, “The Examination” describes the findings, followed by the “Diagnosis”. All the cases are classified as an “illness

which I will treat, contend or not contend”, i.e., curable, possibly curable or incurable.

Case 28 has the title “Instructions concerning a wound in his throat”. The examination states “If thou examinest a man having a gaping wound of the throat, piercing through his gullet; if he drinks water he chokes and it comes out of the mouth of the wound; it is greatly inflamed, so that he develops fever from it; thou should draw together that wound with stitching.” Under diagnosis, “Thou should say concerning him ‘One having a wound in his throat, piercing thro to his gullet. An ailment with which I will contend.’” This last statement indicated that it was a possibly curable condition.

Although the physicians of antiquity such as Galen and Aulus Cornelius Celsus must have known something of the anatomy and the pathology of the esophagus, nothing is reported until the publication of the dissections of Andreus Vesalius. Vesalius of Brussels studied at Paris but was unsatisfied with his education and immigrated to Padua. A year after his arrival he was appointed Professor of Anatomy at Padua in 1542 at age 28. Woodblocks of his anatomical dissections were made by Jan Stephen Calcar, a countryman of Vesalius and a pupil of Titian. Although the blocks were carved in Italy, they were sent to Basel to be printed in 1543 by Johannes Oporinus [3]. The book was entitled *De Humani Corporis Fabrica (Libri Septum)* or the “structure of the human body in seven books.” In the fifth book (*Tabulae Libri Quinti: Organis Nutrioni Quae Cibo Potugu Fit . . .*) “Concerning the Organs Which Minister to Nutrition by Food and Drink,” both the anterior aspect of the entire stomach and esophagus together with the veins arteries and nerves inserted into the stomach, and the posterior aspect of the stomach and esophagus are illustrated [4].

Another 150 years passed before Anton Maria Valsalva published his treatise *De Aure Humana*

Tractatus, “Treatise on the Human Ear” in 1704 to describe the upper esophageal sphincter. In this book he described a new description of the soft palate and musculature of the pharynx. He was the first to delineate the cricopharyngeus muscle as a discrete muscle separated by the constrictors of the pharynx and lacking a median raphe [5].

The lower esophageal sphincter has been described as a ring of muscular fibers which act as a valve. This has been called the cardiac sphincter because of its proximity to the heart which lies just across the thickness of the diaphragm. A fold in the lining of the esophagus over the cardiac sphincter is sometimes called Braune’s valvule, after Christian Braune, a professor of surgery and anatomy at Leipzig who described it in 1875 [6].

In the age of GERD, the anatomical controversies have mostly involved the distal esophagus. Some questions are the presence or absence of a sphincter, the exact location of the esophago-gastric junction, and the structure of the phreno- esophageal membrane. Friedland, a radiologist, has researched these areas by reviewing the original sources [7]. Thomas Willis in the late 1600’s described the sling fibers of the stomach which cause a notch between the left lower esophagus and the stomach and in 1903 Wilhelm His, embryologist and professor of anatomy at Leipzig, called it the incisura cardiaca. In 1906, DJ Cunningham began calling it the angle of His. (The “bundle of His” in the heart was discovered by Wilhelm His Junior while a medical student.) [8]. The phrenoesophageal membrane attaches the esophagus to the diaphragm and was originally described by Galen. The British surgeon Allison emphasized the role of this membrane in preventing the formation of a hiatus hernia. In 1973, Eliska described four types of phreno- esophageal membrane classified by age into the fetal type, the juvenile type, the old age type and the transitional type. These different types are produced by the loss of elastic tissue and fatty infiltration of the membranes which allows for the development of a hiatus hernia [9].

Although, Ambroise Pare’ has been attributed as the first to describe a diaphragmatic hernia, his description was not of a hiatus hernia, but of two traumatic hernias of the diaphragm both discovered at autopsy [10]. The first case was that of a mason “who was wounded in the middle of the diaphragm in its nervous part, of which he died on the third

day. I opened the belly and could not find the stomach. This made me marvel greatly, thinking it a monstrous thing to be without a stomach. Then I considered diligently and realized that it must have entered the thorax even though the wound in the diaphragm was no larger than enough to admit the thumb. On opening the thorax I found the stomach filled with air and containing little fluid.”

The second case described an artillery captain who was shot through the chest, the wound healed externally but he continued to have a stomach disorder, “like a sort of colic so he could eat only sparingly. Eight months later he developed a severe colic like pain in the epigastrium . . . and died.” At autopsy “in the thorax was found a large part of the colon, filled with air; it had entered through a hole only large enough to admit the tip of the little finger, made through the diaphragm by the wound.”

When Giovanni Battista Morgagni was almost eighty years old he published a book “*De sedibus, et causis morborum per anatomen indagatis*” (The Origins and Causes of Disease Anatomically Investigated) in which he recorded the findings of 700 autopsies and linked them to the complaints of the patients and the symptoms of their diseases [11]. This marked the advent of anatomic pathology as a separate medical discipline. Morgagni described Pare’s case of the mason with the diaphragmatic hernia as well as other’s dissections. In Letter LIV Article 13, he first described a paraesophageal hernia. “But in the case of Schoberus we are not wanting in these particulars, as, without any wound, a very vehement cardialgia came on in the morning, at the break of day; attended by very frequent vomiting of an incredible amount of blackish matter, and straining to vomit, so that the young man died on the following night: and within his thorax was found, together with the omentum, and *intestine duodenum* . . . the stomach so distended with that matter, and with flatus, as to compress into a very narrow compass the heart and lungs; having been admitted into that cavity by the same foramen through which the gula is brought down, this foramen being greatly dilated and deprived of its tone.” These were considered pathologic curiosities observed at autopsy and no connection was made between the presence of a hernia and the possibility of acid reflux and/or esophageal disease.

Esophageal hiatus hernia was uncommonly described before the advent of radiographic techniques.

One reason was that the classic autopsy technique was to divide the esophagus just above the diaphragm and remove it along with the heart and lungs, thus losing its connections to the abdominal segment and with the stomach. Another was that at autopsy the muscles were relaxed and intra-abdominal pressure diminished and therefore the condition would be overlooked. It required the development of contrast radiography in the first decade of the twentieth century to identify hiatus hernia. This required examination in the recumbent and sometimes in the Trendelenburg position to demonstrate the condition. Once the study was standardized the relative frequent occurrence of hiatus hernia was recognized.

Although neither curiosity about or understanding of GERD were in evidence during the 1800's, there was in 1853 by Bowditch perhaps the first identification of what we now call hiatal hernia [12]. Bowditch reviewed the extant literature on both hiatal hernia and other types of diaphragmatic hernias and as well reported his observations and descriptions of his anatomic findings with these entities as encountered during performance of autopsies. Again, however, there was no attempt to connect these anatomic findings with the presence of either anatomic disease such as esophagitis or with premortem symptoms of esophageal disease.

There is no evidence that there was any connection made in the medical community between any type of post prandial symptoms to either the phenomenon of gastroesophageal reflux disease (GERD) or to hiatal hernia prior to the 19th century. In fact, in retrospect it is hard to imagine any physician having the acuity to connect gastric acid to esophageal disease or symptomatology prior to Beaumont's demonstration of the digestive and corrosive capability of gastric contents in 1833 [13]. Although, there is no evidence directly linking Beaumont's observations to subsequent understanding of acid reflux and its sequelae it seems likely that this evidence of the injurious efficacy of gastric contents would have informed subsequent speculations about the pathophysiology of esophageal injury and/or related symptoms.

In 1925, Friedenwald and Feldman did describe the typical symptoms of GERD, especially heartburn. They edged closer than their predecessors to recognizing the entity of GERD when they related these symptoms to the presence of an anatomic hia-

tal hernia. However, they stopped short of definitively associating the symptoms with the possibility of gastric acid reflux [14]. A year later, in 1926, Robbins and Jankelson actually demonstrated gastroesophageal reflux by radiographic techniques and observed that this produced epigastric and/or substernal discomfort in 90% of patients in which reflux occurred [14]. The stage was now set as the occurrence of reflux of gastric contents into the esophagus was documented and its association with symptoms demonstrated. This understanding could be linked to earlier observations as regards esophagitis and hiatal hernia.

In February 1929, Chevalier Jackson reported on "Peptic Ulcer of the Esophagus" and gave the incidence as eighty-eight out of more than 4000 cases of esophageal disease in 42 years of his experience and in speculating on the etiology included "retrograde flow of gastric juice" as a possible cause [15].

At the 85th Annual Session of the American Medical Association in Cleveland in June of 1934 Asher Winkelstein (1893–1972) presented a paper entitled "Peptic esophagitis: A new clinical entity." Dr. Winkelstein was the chief of Gastroenterology at Mount Sinai Hospital in New York and subsequently his paper was published in the *Journal of the American Medical Association* in March of 1935. Dr. Winkelstein's report consisted of five cases with biopsy proven esophagitis. Dr. Chevalier Jackson in discussing the paper remarked that "the chief reason, I think, why so little has been heard of peptic esophagitis is that so few esophagoscopies are done in patients with gastric symptoms" [16].

The ease of studying the distal esophagus and upper gastrointestinal tract was markedly advanced by the invention by Basil Hirschowitz of the fiberoptic endoscope. At the 1957 meeting of the American Gastroenterointestinal Endoscopy Society, the president of that society relinquished his presidential address so that Dr. Hirschowitz could present his first studies [9].

In 1906, perhaps the first true identification of GERD occurred. Tileston in 1906 collected and reported on 44 patients found to have pathologic esophagitis at the time of autopsy [17]. He went so far as to speculate that insufficiency of the cardia or the gastroesophageal junction would be a prerequisite to development of esophagitis. He did not however, use

the expression reflux or clearly attempt to connect this pathologic finding to premortem symptoms.

Although progress was made during the latter half of the 20th century in first identifying and subsequently elucidating the pathophysiology and pathogenesis of GERD, as recently as 1913 a review of one of the leading medical texts of the day, Garrison's *An Introduction to the History of Medicine* [18] failed to reveal any mention in either the text or index of any of the following terms: heartburn, gastroesophageal reflux, reflux, or hiatal hernia. This suggests that well into the 20th century there was no understanding of or even speculation about the possibility of acid reflux into the esophagus as a disease entity.

At about this same time, surgeons began to become at least indirectly involved in this area through interest in and repair of hiatal hernia. For example, though apparently not reported until Soutter in 1947 when he published the first review of the Massachusetts General Hospital cumulative surgical experience with hiatal hernia, the first elective repair of a hiatal hernia was performed at Massachusetts General Hospital in 1920 [13]. These operations were hernia repairs; justification for them was, as for any hernia, the perceived risks of incarceration and strangulation. GERD was not a consideration. In other words, operations for the repair of diaphragmatic hernia were based on anatomic rather than physiologic principles. Similarly, in 1928 Harrington reported 51 cases of diaphragmatic hernia seen at the Mayo Clinic since 1908, 27 of which were repaired surgically [19]. These two reports initiated and incited surgical interest in diaphragmatic hernias.

In the 1940's and 1950's, the contributions of Philip Allison in Great Britain were of major importance in furthering the understanding of the pathophysiology of GERD and hiatal hernia as well as the pursuit of their surgical treatment. His seminal report in 1951 was entitled "Reflux Esophagitis, Sliding Hiatal Hernia and the Anatomy of Repair" [20]. This article begins with a classic description of a 59 year old woman with heartburn and regurgitation. The second paragraph begins with the statement, "The symptoms are those of esophagitis from the reflux of gastric contents into the esophagus, due to incompetence of the gastroesophageal junction." With the minor cavil that we now are well aware that symptoms can occur with reflux without

anatomic esophagitis, this is a clear and unequivocal description of the pathophysiology of GERD. However, without the ability to distinguish hiatal hernia from intrinsic gastroesophageal incompetence as the important surgical consideration, Allison understandably focused on the hiatal hernia and the anatomy of hernia repair. The operation he performed was to reunite the two halves of the crus of the right diaphragm and to reattach the phreno- esophageal membrane to the undersurface of the diaphragm. Although this operation successfully repaired the esophageal sliding hernia, it did not prevent acid reflux. Consequently, while he made major contributions to the understanding of pathophysiology and began to address the challenge of surgical repair, his operation was not a successful one as patients retained their reflux symptoms despite surgical elimination of their hiatal hernia.

The next stage in the evolution of surgical correction of reflux esophagitis took two separate paths- one of serendipity and the other of trial and error and scientific study over a long period of time. Ronald Belsey began his series of observations at the Frenchay Hospital in Bristol. His examination of the seated, sedated patient with a rigid esophagoscope led him to observe a gaping cardia with gastric contents rising into the esophagus with deep inspiration. This observation of the gaping cardia suggested the operative goal of fixing the gastroesophageal junction 2-3 cm below the diaphragm. His Mark-I operation was essentially the same as the Allison approach. The Mark-II and Mark-III procedures were various degrees of fundoplication. These first 3 types of operations took place between 1949 and 1955 and about a third of the patients had poor results. He modified his operation based on long term outcomes and this experience culminated with the Mark-IV. This operation was based on his intuitive concepts derived from his personal experience. The operation was based on his belief in the importance of establishing an intra-abdominal segment of esophagus and creating a flap valve anti-reflux mechanism at the restored gastroesophageal junction and was performed through the left chest with a 270 degree fundoplication fixed to the undersurface of the diaphragm. Belsey's long term cumulative results were published after 20 years with over 1000 patients being treated and showed a better than 85% success rate [21]. It is remarkable to note that these results were obtained

on astute observations long before the availability of manometry, pH studies and flexible endoscopy. This landmark publication made several important contributions. Based upon the reported experience with 1,030 patients, the pathophysiology of GERD was discussed and analyzed. This report is important for emphasizing the conversion of surgical thinking from a focus on anatomy to an appreciation of physiology. Grades of esophagitis were defined and correlated with clinical outcomes, showing for the first time that the more diseased the esophagus the worse the surgical results and the more likely the need for reoperation. The evolution of the indications for operation was discussed and criticized, identifying the need to properly select patients to obtain satisfactory outcomes. Finally, the results of what Belsey termed his Mark-IV procedure were provided. This discussion emphasized the evolution of the operative technique based on careful follow-up of patients undergoing earlier modifications of the operation and of the delay in reporting on this operation until genuine long term follow-up, allowing certainty about long term results, had been obtained.

The serendipity path fell to Rudolph Nissen (1896–1981). Nissen was born in Niesse, Prussia, served and was wounded in WWI and was trained in medicine in a number of German universities. He was trained in Surgery by Ferdinand Sauerbruch in Munich and in Berlin. Sauerbruch was a protégé of Mickulcz who encouraged his work in chest surgery by the use of a pressure chamber until endotracheal anesthesia was developed. As a result Nissen was a competent thoracic surgeon who performed the first pneumonectomy. He resigned his position at the Charite in 1933 under pressure from the National Socialist Party. At about this time Ataturk was engineering a cultural revolution in Turkey and Sauerbruch arranged his appointment as Chief and Professor of Surgery at the University of Istanbul. In 1936 he was presented with a 28 year old male who had a distal esophageal ulcer penetrating into the pericardium. Nissen resected this area and reanastomosed the esophagus to the stomach using a Witzel tunneling technique. Fearing an anastomotic leak, he folded the anterior wall of the stomach over the gastroesophageal anastomosis as a fundoplication. He had the opportunity to follow up this patient and specifically noted the absence of esophagitis. During WW II Nissen was in Boston as a research fellow

under Churchill and in Brooklyn Jewish Hospital as chief of surgery and after the war was offered the position of Professor and Chair of Surgery in Basle, Switzerland. It was in December 1955 that he encountered a 49 year old female patient with a 3 year history of reflux esophagitis *without* a hiatal hernia. Based on his previous experience, using a transabdominal approach he mobilized the distal esophagus and wrapped the distal 6 cm of it with the gastric fundus (he called it a gastroplication) [22].

Although the operation proved to be effective, there were a number of complications including postoperative dysphagia, disruption of the wrap, inability to belch (“gas bloat syndrome”) and gastric motility problems. As a result a number of modifications have been proposed. The Rosetti-Nissen fundoplication uses the anterior wall for the total wrap. In 1977, Donahue and Bombeck emphasized the “short floppy cuff” [23]. This modification proposed complete mobilization of the fundus and GE junction, a wrap of short length and preservation of the vagus nerves. This reduced the incidence of dysphagia and gas bloat symptoms. Partial fundoplication wraps placed either anterior or posterior to the gastroesophageal junction, have been described such as the crurally fixed partial fundoplication of Toupet. There is also an anterior 180 degree fundoplication developed by Dor. A fundoplication described by Watson consists of full mobilization of the lower esophagus and gastroesophageal junction, crural repair, fixation of the esophagus to the crura and an anterior 180 degree Dor-type fundoplication. While retaining the eponym, both Nissen and other surgeons have modified his original operation to its present form. The hiatus is closed. A relatively short, no more than a three cm. wrap, of posterior to anterior fundus around the distal esophagus is constructed by passing the posterior fundus behind the esophagus and the suturing it to the anterior fundus.

The technique and application of both these operations have evolved over time. While the Belsey procedure is quite effective it is only occasionally performed at present because of the need for a painful thoracotomy. The Nissen procedure has achieved widespread utilization because it can be performed from either the abdomen or the chest, with good results, and can be accomplished laparoscopically, thus sparing the patient even a laparotomy.

Throughout the 1970's and 1980's both the gastroenterology and surgical communities exhibited increased interest in GERD. Multiple publications have advanced the understanding of pathophysiology and of treatment, both medical and surgical. Some operative techniques were established by the end of the 1980's as essential parts of a successful antireflux operation, most frequently a Nissen fundoplication, and some were more controversial. Securely established are the need: (1) to perform a sufficient mediastinal dissection to release the esophagus from tissue creating cephalad distraction, (2) to close the esophageal hiatus to prevent postoperative herniation, (3) to construct a relatively short (one to three cm) gastric wrap to balance control of reflux with the likelihood of dysphagia, and (4) to ensure a correct preoperative diagnosis with utilization of esophageal function tests when the clinical picture is ambiguous. Continuing to be debated are the need to divide the short gastric vessels, the benefits of performing the wrap with an esophageal dilator in place, the questions of identifying and treating the so-called short esophagus, and the need to modify the operation in the presence of impaired esophageal peristalsis.

The burgeoning field of laparoscopic surgery has transformed the field of antireflux surgery. Short and medium term followup of operated patients shows comparable surgical outcomes to those achieved with the open operation [24]. Because of the well documented benefits of the laparoscopic approach over an open operation, including but not limited to diminished postoperative pain, a shorter hospitalization and an attenuated inflammatory response, patient interest in laparoscopic antireflux surgery has been considerable. This increase in the number of patients seeking and actually undergoing antireflux surgery has likewise widened and stimulated the pool of both thoracic and general surgeons interested in this disease.

Increasingly sophisticated techniques of endoesophageal study are being utilized to analyze the function and dysfunction of the lower esophageal sphincter and the esophageal body. These investigations serve the need to appreciate, understand and have physiologic as well as anatomic information when planning and executing functional surgery. The modern battery of esophageal functional inves-

tigations are the descendants of earlier studies such as the Bernstein test, Skinner's Standard Acid Reflux Test, esophageal manometry and esophageal pH monitoring [25]. The current ability to detect and quantitate not only acid reflux, but also bile reflux, non specific liquid reflux and gas reflux have opened new doors into the understanding of esophageal function and dysfunction and will be effecting medical and surgical therapy in profound ways in subsequent years.

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