The Centenary of Lester Dragstedt—Fifty Years of Therapeutic Vagotomy

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Lester Reynolds Dragstedt was trained initially as a physiologist and subsequently became a surgeon. He achieved renown not only because of his intellectual and technical skills, but because he was able to utilize physiological principles to define the development of surgical procedures. A humble upbringing in Anaconda, Montana was followed by a scientific education in Chicago. His brief background in surgery was obtained during a two year period spent mostly in Vienna and Budapest. At the University of Chicago, he pioneered the development of therapeutic vagotomy in the treatment of peptic ulcer disease. His research interests were many and varied, ranging from the toxemia of intestinal obstruction to the quest for a pancreatic hormone which might regulate fat metabolism. After retiring as Chairman of Surgery at the University of Chicago, he assumed a research position in surgery at the University of Florida in Gainesville. Dragstedt was a creative scientist, a superlative clinical surgeon, and a teacher honored by his pupils. The example of his life confirms the benefit of scientific inquiry when applied to clinical and surgical practice.

INTRODUCTION

The centenary of the birth of Lester Reynolds Dragstedt on October 2, 1893, in Anaconda, Montana marks an epoch in American surgery. Dragstedt was the first individual trained as a scientist to become a surgeon. He established the doctrine of the surgeon/scientist that has become a cornerstone in the evolution of American academic surgery. It is not likely that any surgical contemporary made more lasting, or more important contributions to the physiological understanding of pancreatic function and gastric secretion. His written and oral presentations were models of lucidity and simplicity, and his personality that of “a man too nice to be a surgeon.” His clear separation of antral gastrin and vagal stimulation of gastric acid secretion by means of years of experimentation led him to laboratory and clinical demonstration of the value of vagal resection in the treatment of ulcers, which produced a major revolution in gastric surgery. January 14, 1993, marked the fiftieth anniversary of the first therapeutic vagotomy undertaken in the United States for peptic ulcer disease. The background of Dragstedt’s life and training, which culminated in his recognition of the physiological basis for this operation, are worthy of consideration.

FROM KUNGSBACKA TO ANACONDA, THE DRAGSTEDT FAMILY SAGA

In 1879, Carl Johan Dragstedt, Lester R. Dragstedt’s grandfather, decided to leave the difficult environment of the Kungsbacka area close to Gothenberg in Sweden to seek a

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better life in the New World. He took with him his eldest son, John Albert, and left behind his wife, Sofia, and two younger children, Ida and Charles. Like many thousands of other Swedish immigrants of the time, they proceeded by steamer to Hull, crossed England by train to Liverpool, and set out by boat to New York. The plan was to purchase land in the Midwest where substantial Swedish immigrant communities had already been established and then bring the rest of the family to America [1].

Unfortunately, in a quintessential New York experience, the elder Dragstedt lost all the money that he had derived from the sale of his farm in Sweden. He met an elegant and helpful Swedish person at Ellis Island who explained to him that Swedish money could not be utilized to buy land in the United States, and that it was necessary to convert such capital into American dollars. He helpfully offered to take on the conversion, but, sadly, failed to return with the proceeds! Thus, father and son were penniless in the United States within a short time after their arrival. As a result, a period of six years of itinerant labor followed to provide the funds to bring the rest of the family to the United States. At first, they worked as farm laborers on Long Island and thereafter as cod fisherman on the New Foundland banks. Subsequently, the father worked as a carpenter on the railroads in Texas and the son as a cowboy herding the cattle used to feed the railroad gangs. It was the practice of the railroad corporation to deduct fifty cents per month from each worker, in return for which they were given Texas land at ten cents an acre. Carl Johan recounts how, due to the kindness of his foreman, this tax was abrogated in his case, since it was known that he was saving to bring his family to America. Years later, the acreage that would have belonged to him became some of the major oil producing land of the country [2].

Father and son eventually made their way to the substantial Swedish farming community of Des Moines, Iowa. By this time, sufficient capital had accrued to bring Sofia and the two younger children to the United States. Economic times were difficult, and in search of work and fortune, the family first moved to Goldbutte and then to Anaconda, Montana where a huge copper mining industry had developed. Although the eldest son, John Albert, had initially worked in a distillery, his newly found wife, Carolyn Selene, disapproved of this position based on her strong Swedish Lutheran upbringing. As a result, John Albert became a blacksmith in the mining corporation before advancing to a position of administrative seniority within the company.

John Albert and Carrie Dragstedt had four children, of whom Lester Reynolds was the elder brother and Carl one year younger. Both demonstrated substantial academic vigor and in successive years were the valedictorians of the local high school. Lester was to become an internationally famous surgeon and scientist, whilst Carl attained widespread recognition as a physician and pharmacologist.

When Lester graduated at the head of his school class, it was uncertain as to whether he would go to the University of Chicago or the State University of Montana at Missoula. The final decision to attend the University of Chicago was dictated primarily by the friendship of the family with A.J. Carlson (Figure 1) who was, at that time, the Professor of Physiology at the University of Chicago. Carlson had initially met the Dragstedt family in 1899 when he had been sent to Anaconda, Montana, as a substitute Swedish Lutheran minister. Carlson came from the Bohuslan area of Sweden near Gothenburg and
immigrated to Chicago in 1896, where he worked for two years as a carpenter. He subsequently joined the Lutheran Augustana Academy in Rock Island, Illinois and demonstrated early evidence of intellectual vigor [3]. When transferred to Anaconda, Montana, he was virtually destitute and boarded with the Dragstedt family, where he became friendly with Charles Dragstedt, the younger brother of Lester's father, John Albert. Within a short time, it became apparent to Carlson that his future lay not in religion but in physiology. Charles Dragstedt was good enough to subsidize his scientific training at Stanford University, and within eight years, Carlson had become one of the most noted physiologists of the country. He subsequently became the Chairman of Physiology at the University of Chicago and held this position for thirty-six years.

**FROM SCIENCE TO SURGERY**

Dragstedt came to Chicago in 1911 and fell under the influence of Carlson. Carlson was a strict taskmaster and told Lester's father "send the boy to Chicago, they will find out in three months if he has any brains, and if does not, you can bring him back to Anaconda and put him to work in the copper smelter" [4]. By 1915, Dragstedt had received a Bachelor of Science Degree from the University of Chicago, and in 1916, a Master of Science Degree in Physiology. He then spent two years at the University of Iowa before returning as an Assistant Professor to the faculty of physiology in Chicago. Despite a two year military service interlude, his diligent work in both physiology and medicine enabled him to attain a Doctor of Philosophy Degree in Physiology in 1920, followed by an M.D. from Rush Medical College in 1921. In 1922 he married Gladys Shoesmith whom he initially met at Iowa City, where she had been a student of English.
They subsequently had four children, and Lester II is currently Chief of Surgery in Des Moines, Iowa.

By 1923, Dragstedt had become Professor and Chairman of the Department of Pharmacology and Physiology at Northwestern University in Chicago. Literally two years later in 1925, his career as a pure physiologist underwent a chimeric transformation when he accepted a position on the surgical faculty at the University of Chicago as an Associate Professor, an even more unique switch, given the fact that he had never even undergone an internship in clinical surgery. This decision was strongly influenced by Dallas Baldwin Phemister, who had just been appointed the first full-time professor and chairman of the newly formed University Department of Surgery.

What exactly motivated Dragstedt to switch from physiology to surgery remains unclear. The Dragstedt family records recount how their father, John Albert, was an extraordinarily technically adept individual, capable of repairing any device or devising any solution to a mechanical problem [1]. In the family, it was felt that Lester had always admired both the skill with which his father assumed these tasks and the delight that it provided both himself and the family. It is probable that Dragstedt might have done surgery initially, but Carlson was a powerful and influential mentor who moved him towards physiology. In addition, physiology provided the opportunity to work in an innovative and creative environment, whereas at that time, a surgical training in Chicago comprised an ill-defined and long apprenticeship to senior surgeons. An important figure in providing Dragstedt with a taste of surgery was James J. Moorhead who, as a colleague of Carlson, had been introduced to Dragstedt in the physiology laboratories [5]. Moorhead was a local Chicago surgeon who, apart from running a practice, enjoyed a prominent role in teaching experimental surgery to Carlson's scientific pupils. He taught Dragstedt the fundamentals of surgery and co-authored a number of early experimental surgical publications with him. Similarly, Phemister, who was a local surgeon in Chicago, taught Dragstedt at Rush as a medical student and had also become impressed by Dragstedt's research skills when his experimental work had been presented. Clearly sensing Dragstedt's interest in surgery, he had invited him to participate in the planning of the surgical laboratories for the new Department of Surgery at the University of Chicago.

Phemister, who exhibited a strong academic inclination, had been in practice prior to his acceptance of the offer of the Rockefeller Foundation to establish a novel Department of Surgery with a strong scientific basis in Chicago. His commitment to this premise was confirmed by his visits to a number of European countries, both to work and to observe the pre-clinical science departments of the eminent medical schools of the time. In a statement of considerable perspicacity, Phemister remarked to Dragstedt, "I am interested in teaching physiology to surgeons." Years later, in a letter to Owen Wangensteen, Dragstedt recorded this discussion: "Phemister prevailed upon me to join the Department of Surgery as an Assistant Professor of Surgery. He said that he thought it would be easier for a scientist to learn to be a surgeon, than a surgeon to learn to be a scientist" [6].

Thus, in 1925, Dragstedt, having at the early age of thirty years attained the chairmanship of a department of physiology and pharmacology, relinquished his position to embark upon a new career as a surgeon. At this stage, he had received an M.D. degree but had never undergone an internship in either medicine or surgery. He was thus appointed
a Rockefeller Foundation Fellow and sent to Europe to acquire two years of training in surgery and surgical pathology. His initial visit to the clinic of Hartmann in Paris was disappointing, and he moved onto DeQuervain's surgical clinic in Berne for three months. While in Berne, he met Leon Asher, the Professor of Physiology who had succeeded Kronecker (Figure 2). Asher had some twenty-five years previously befriended Harvey Cushing when he had worked with Theodore Kocher and Kronecker. During this time, he mostly performed thyroid surgery, but since he wished to focus primarily on abdominal work, he travelled next to Vienna. There he joined Jakob Erdheim, whom he reported to be one of the greatest teachers that he had ever met. He also spent some time as an assistant of Von Eiselsberg and attended courses with Chvostek, Sigmund Freud, and others. After six months in Vienna, he moved to Budapest to work with Eugen Polya. In order to obtain a position with Polya, he offered to pay $150 per month for the privilege. Polya readily acceded and hired Dragstedt as his first assistant. After watching Polya do a gastric resection for duodenal ulcer, Dragstedt was invited to do the next one:

I had done a lot of these in dogs but had never done a gastric resection in man. I did the resection in the way I customarily did in the dogs and he was apparently very pleased. I had been taught to close the duodenal stump by an ingenious method that I believe originated with Halstead. I had been taught this during my student period in the physiology laboratory of Carlson in Chicago by James J. Moorhead a local surgeon. Of course, I did not say anything to Polya about this work on dogs. He apparently thought I was a safe operator and told me to go ahead and do all the operating I wanted.
After three months with Polya, Dragstedt entered into a similar arrangement with Humer Hultl at the St. Rochus Hospital for a further three months [7].

UNIVERSITY OF CHICAGO

At the end of June 1926, Dragstedt returned to Chicago after having visited his mother's relatives in Tunbridge Wells in England. At this stage it was apparent that he had developed renal tuberculosis, and since conservative therapy had failed, he was referred by his younger brother, Carl to a urologist, Dr. Herman Kreschmer in Chicago. Kreschmer decided that the tuberculosis was unilateral and nephrectomy was therefore performed. Unfortunately, the renal pedicle was too short to ligate, and a vascular clamp was therefore left protruding from the abdominal wall overnight. Carl Dragstedt, Lester's younger brother, was delegated to spend the night watching him so that the clamp catches should not be jarred loose. The next morning, the clamp was released notch by notch without incident, and Lester made an uneventful recovery [8].

In 1927, Dragstedt assumed his responsibilities as an Associate Professor in Surgery (Figure 3), first at the Presbyterian Hospital in Chicago but shortly thereafter at the Albert Merrit Billings Hospital, which had just been completed. Initially, Dragstedt attempted to transfer most of his major cases to Phemister who declined. Dragstedt noted, "Phemister was always in the operating room next door so I was comforted by the thought that I could always call him if I should get into a tight spot." Dragstedt thereafter established a physiological surgical group within the Department of Surgery at the University of Chicago and matured into an eclectic scientist and exemplar of the classical, but uniquely
uncommon for his times, triple-threat academic surgeon. He was to distinguish himself as a researcher, clinical surgeon and a teacher, and each area of achievement would potentiate the other. In his 1953 Caldwell lecture, he summarized his philosophy of academic surgery stating, “the method of surgery is a valid and useful technique for the solution of problems of a more fundamental scientific nature” [9].

Dragstedt’s research activities were widespread. He investigated the bacteriology and systemic toxicity of intestinal obstruction [10], the genesis of parathyroid tetany [11], the existence of a putative fat burning hormone in the endocrine pancreas (lipocaic) [12] and the regulation of gastric secretion [13, 14]. In the latter area, he pioneered the evaluation of vagal function and antral influence on fundic acid secretion. His seminal work with isolated antral pouches and antral implants on the colon were fundamental in confirming the role of gastrin on acid secretion and the pH regulatory mechanism involved in gastrin release [15]. The success of his studies was to a large extent determined both by his scientific vigor and by his technical surgical training which enabled the development of reproducible and functional animal models for study. As a result of his secretory studies on the isolated stomach and his recognition of the predominant role of the vagus nerves he was able to develop the scientific basis for the introduction of therapeutic vagotomy [16].

EARLY HISTORY OF VAGOTOMY

Whilst the anatomic characteristics of the vagus nerve had been variously described by Marinus and Galen in the second century, little was known of its function [17]. Although the modern system of 12 cranial nerves was initially proposed in 1778, it had long been thought that there were only nine cranial nerves and the vagus was the eighth [18]. The name reflected its wandering course and, in the nineteenth century, it had been termed the pneumogastric nerve by French and Italian anatomists.

Benjamin Brodie, in 1814, was the first to demonstrate reduction of gastric secretion by vagal section and noted that cervical vagotomy in a dog prevented the mucous secretion of the stomach generated by insertion of arsenic into a wound in the thigh [19]. A. Phillip, in 1823, reported extensive experiments in rabbits in which, “cutting the eighth pair of nerves in the neck resulted in gastric retention of undigested food.” He concluded that the vagi controlled both secretion and emptying of the stomach. In addition, he reported that galvanic current applied to the distal vagus reversed the acute effect of vagotomy [20]. In the latter part of the nineteenth century, Ivan Pavlov had clearly identified the cephalic phase of gastric secretion, although he had incorrectly identified the distribution of the right vagus nerve to the greater curve of the stomach [21]. Heidenhain, in 1879, had constructed denervated pouches of canine stomachs, and Pavlov, with Khigine, produced vagally innervated pouches for experimental evaluation of the role of the vagus in secretion [22]. Similarly, scientists such as Karl von Rokitansky and Claude Bernard had contributed to an understanding of the vagal regulation of secretion. Rokitansky had in fact stated, “the proximate cause of duodenal ulcer may be looked for in diseased innervation of the stomach owing to a morbid condition of the vagus and to extreme acidification of the gastric juices” [23].

It seems likely, however, that the first vagal resection in humans was performed by Mathieu Jaboulay at the turn of the century. He excised both the vagal and celiac plexus by the intra-abdominal route to palliate the pain of tabes dorsalis [24]. His interest in this
area probably reflects his initial work on the use of sympathectomy to remove the pain of vascular ischemia. Several other European surgeons subsequently modified both the techniques and the indication for Jaboulay's abdominal vagotomy. In 1921, the French surgeon, Andre Latarjet, made a detailed study of the anatomy of the vagus nerves and applied his theory of complete anatomically based vagotomy to the treatment of dyspepsia [25]. Latarjet noted the post-vagotomy problem of gastric stasis and included a gastrojejunostomy as part of his procedure. Although much of the anatomy and physiology of surgical vagotomy was published by Latarjet and his predecessors, this work would lay dormant in the medical literature for many years. Vagotomy as a technique was held in low esteem in the 1920s and 1930s. The indications for the procedure varied from dyspepsia to gastric ptosis to unexplained abdominal pain and sundry symptomatology. Latarjet was, thus, never able to fully convince the medical establishment of the merits of his proposed operation, and it rested in fundamental disrepute prior to 1943, when Dragstedt performed his first human vagotomy.

To a certain extent this modest interest in vagotomy reflected the influence and visibility of the great gastric surgeons of the time. In 1905, Berkeley G.A. Moynihan had published his first book on the surgical treatment of gastric and duodenal ulcers, and William J. Mayo, in 1904, reported a series of 58 patients treated by gastrojejunostomy [26, 27]. Moynihan was the most enthusiastic advocate of surgery for the chronic duodenal ulcer "cases are within the experience of all in which prolonged medical treatment is powerless to ward off the recurrence of dyspepsia. I do not know of any operation in surgery which gives better results, which gives more complete satisfaction both to the patient and his surgeon than gastroenterostomy for chronic ulcer of the stomach." The late problems of gastroenterostomy (stomal ulcer) were initially felt related to surgical technique and only later ascribed to the genesis of the disease process. By 1920, John Finney [28] reported a 59 percent marginal ulcer rate after gastroenterostomy and noted the failure of the procedure to reduce acid secretion. The evolution of a series of short-circuiting operations (gastroduodenal anastomoses) did nothing to decrease recurrent ulceration rates, and it rapidly became apparent that a decrease in acidity was a requisite for successful surgery. Thus, by 1931, Hans Finsterer was already recommending two-thirds gastrectomies [29]. By the mid 1930s, gastrectomy was dominant in Europe, and by 1940, it represented the accepted method worldwide for surgical treatment of ulcer. An interesting variant of gastric resection was developed by Finsterer, who left a portion of the antrum (distal part of the stomach) in place when the chronically diseased duodenum was too difficult to close. He recognized the high rate of ulcer recurrence after this procedure and noted that excision of the remaining antrum cured the problem. In Vienna, Von Eiselberg also used this procedure with similar dismal results, and it awaited the experiments of Dragstedt to demonstrate that antral exclusion generated hypergastrinemia which resulted in excessive acid secretion and recurrent ulcer [30, 31].

In 1947, Sir Heneage Ogilvie addressed the centenary of the American Medical Association on a hundred years of gastric surgery [32]. He described radical gastrectomy, in experienced hands, as a satisfactory ulcer operation with a mortality of 2 percent, a cure rate of over 90 percent and a recurrence rate of approximately 1 percent. He delineated the current understanding of the physiology of the control of acid secretion and stated that
hormonic (sic) rather than vagal mechanisms were responsible. Although he described Dragstedt's pioneering work in dogs and the initial reports of supradiaphragmatic vagotomy in patients, he declared himself to be skeptical of the successful clinical results. "It is audacious to criticize the darling of the moment whether in films, sport or surgical technique. But it would be well before rushing into the operation wholesale, to ask whether it has drawbacks as well as advantages, whether it is indeed the answer to the gastric surgeons prayer?" In conclusion, he felt there was no reason to discontinue radical gastrectomy, since it had few negative effects and, in addition, had the advantage of removing most of the gastric vagal innervation. The operation of gastrectomy was finally abandoned because of its undesirable side effects, which its proponents, entranced by the low ulcer recurrence rate, had either minimalized or rationalized. Indeed, surgeons sought to overcome the irrational posture of treating a small ulcer in one organ by the removing seven eighths of its neighbor, by attempting to develop lesser surgical procedures [33].

**DRAGSTEDT'S OPERATION**

Despite numerous and detailed experiments in dogs, Dragstedt was reluctant to perform the operation on a human because, "we were in some doubt about the ability of human patients to tolerate the procedure. This was resolved for us when Dr. Phemister and Dr. Adams successfully removed the lower portion of the esophagus and upper portion of the stomach in a woman with carcinoma. The vagus nerves had to be sacrificed; it was interesting to observe that the patient regained her former weight and continued in good health" [6]. Even with this information Dragstedt was reluctant to proceed. Finally, on January 17, 1943, Dragstedt saw a thirty-five year old man with a symptomatic ulcer which had failed medical therapy and required multiple transfusions of blood. The intern, Edward R. Woodward, presented the patient to Dragstedt who, following the usual surgical practice of that time, suggested a subtotal gastrectomy. The patient demurred vigorously, "A subtotal gastrectomy! My father had that operation and he died, and my brother had that operation and he feels so awful he wishes he were dead. I am not going to have that operation" [18]. Woodward was instructed to sign the patient out against medical advice, but Dragstedt relented and went back to discuss other possibilities. He explained to the patient that he thought that the division of the vagus nerves would favorably influence the clinical course of his duodenal ulcer. On the following day, January 18, Dragstedt performed a bilateral vagotomy via a left thoracotomy with immediate resolution of the patient's symptoms [34]. Over the next eight days it was, however, possible to reproduce epigastric discomfort by infusing 0.1 N hydrochloric acid into the stomach. However, on the ninth day, the acid challenge failed to produce any symptoms, and it was felt that the ulcer had satisfactorily healed. By the end of 1943, Dragstedt had operated on six patients. This number increased to 16 in 1944, and 60 by 1945 [35].

Dragstedt believed that the efficacy of the vagotomies that he performed differed from the previous less consistent results obtained by other surgeons because his technique emphasized the need for complete vagotomy. This initially led him to utilize a transthoracic approach to secure complete nerve transection. However, as the series grew he noted increasing numbers of patients with post vagotomy "pyloric stenosis," which required a second abdominal operation for gastric drainage. Aware of the undesirability of performing two operations in the place of one, he began to perform abdominal vagotomy.
and simultaneous gastroenterostomy for patients with evidence of pre-operative pyloric stenosis [36]. Latarjet, like A. Exner before him, had reported delayed gastric emptying in vagotomised patients, which required the addition of a gastrojejunostomy. The recognition of this problem almost thirty years later by Lester Dragstedt would lead to a similar development of initially a gastrojejunostomy and then a pyloroplasty. Indeed, in many parts of the United States a combined operation of this type was called the Dragstedt operation. Subsequently, it was evident that the anatomic studies which he had developed now enabled him to perform a complete vagotomy transabdominually, and he began to routinely combine transabdominal vagotomy with a drainage procedure. The two vagal trunks could be sectioned above the most proximal of the gastric branches, and this procedure was termed transabdominal supradiaphragmatic section of the vagus nerves.

Although Kuttner, Borchers, and Podkinsky had attempted vagotomies on patients in the early years of the twentieth century their results were not consistent [37, 38, 39]. In some, symptoms were relieved; in others, ulcer persisted; yet in others, new complaints of gastric stasis and bowel disturbances were noted. Thus, in 1948, when Walter Alvarez reviewed almost two hundred reports of vagotomy, he concluded that it did not always protect against a peptic ulcer and that there seemed to be no answer as to whether it would prevent formation of a jejunal ulcer [40].

In 1925, E.D. McCrea of Manchester had published an extensive review of the anatomy, physiology and surgical treatment of vagi [41]. He argued that, “operative interference with the nerves of the stomach is both feasible and in certain instances justifiable.” He recognized, however, that the physiology of vagal function was in many instances not clear. McCrea claimed that the vagi were either augmenters or inhibitors of gastric function and suggested that this differential ability related to whether the stomach was either resting or in an active digestive phase. McCrea further suggested that the vagus nerve might be implicated as a cause or mitigator of peptic ulcer disease, but he was ambiguous and contradicted himself in relating these nerve lesions and their therapy to acid secretion and its clinical sequelae. However, statements such as “hyperchlorhydria is regarded as a precursor of gastric and duodenal ulcer” and “patients suffering from pain, hypertonus, hypermotility and vomiting and in whom no ulcer is present would benefit most from vagotomy” suggest that McCrea was a strong proponent of vagotomy. However, in comments later in the same article he equivocated, “whether nerve section has any real influence either on secretion or acidity is doubtful.” Thus, although his work was widely read and generally accepted it appears to have done little to promote the therapeutic use of vagotomy, and in fact, very few operations were performed upon the vagus nerve during the next two decades.

In the first half of the twentieth century, the standard ulcer operation was either a partial gastrectomy or a gastroenterostomy. When vagotomy was considered, it was performed in concert with partial gastrectomy. Eugene Klein in 1929 and Benjamin Berg in 1930, from the Mt. Sinai Hospital in New York, believed that denervation of the left vagus alone was sufficient to reduce the neural stimulus for gastric acidity [42, 43]. They felt that the efficacy of this procedure reflected its influence on, “the existence of a specific ulcer gastritis, the presence of free hydrochloric acid and the existence of a secondary infection in the stomach or duodenum usually with a green streptococcus.” Four
years later, in a paper co-authored by Philip Shapiro, Berg quite fundamentally restated his position, noting that “sub-total gastrectomy and double vagotomy in dogs induce only a temporary reduction in gastric acidity which is due principally to a transient decrease in the secretory activity of the fundic remnant. This is followed by the return of the acidity and secretory function” [44]. They felt that this observation from canine studies correlated with the failure of the operation to provide a satisfactory and reliable outcome in the patients whom they treated. Thus, vagotomy for the treatment of peptic ulcer disease was never popular with the surgical community of the early 1940s. Only New York and a few centers in Germany and Italy routinely advocated and performed the procedure. And even in these institutions, the indication for the operation in many instances was “gastric ptosis” rather than ulcer disease. Although, Woodward may have over stated his position, his point was well taken when he noted that vagotomy after the work of Latarjet “was not practiced for the next 20 years” [45]. Partial gastrectomy and gastroenterostomy in the hands of advocates such as Moynihan and Mayo prevailed as the standard operations for peptic ulcer disease.

By 1947, Dragstedt had performed more than 200 vagotomies based on his conviction that it reflected a sound physiologic basis and that clinical success was evident. About one third of the patients developed gastric stasis that required gastroenterostomy or a secondary procedure. The switch to the trans-abdominal route enabled both procedures to be performed simultaneously, and over the next decade, the technique of pyloroplasty was perfected and became the drainage method of choice. Later, as the role of the antrum in the physiology of gastric secretion was elucidated by Dragstedt and his colleagues, vagotomy combined with antrectomy became the procedure used most often to maximally reduce the secretion of gastric acid. Despite the clinical success of “the Dragstedt vagotomy” and the soundness of his physiological arguments favoring vagotomy for peptic ulcer disease, his medical and surgical colleagues in general resisted his method. A few surgeons, such as Keith Grimson and Ruffin from Duke University, Waltman Walters from Rochester, Minnesota and Francis Moore from the Massachusetts General Hospital, performed about 200 vagotomies, which were presented at the Central Surgical Association Meeting in Chicago in February, 1947 [46]. Their results were uniformly favorable. However, surgeons from the Mayo Clinic who had performed about 80 of these procedures which they termed “a gastric neurectomy,” observed that the results were inconstant, variable and in most cases unpredictable. They noted that the most significant complication encountered was that of gastric stasis and concluded that the operation had relatively limited application [47]. Francis Moore of Boston disagreed and claimed an 87 percent success rate, noting that the complication of gastrostasis was only temporary. He wrote, “many patients have thus been tided over a bout of motility symptoms and remain well subsequently. There is strong temptation to carry out gastroenterostomy under these circumstances; it is our conviction that it can be usually avoided” [48]. The surgeons from Duke University disagreed and felt that, “complete satisfaction occurred more frequently among patients with combined vagotomy and gastroenterostomy than among patients with vagotomy alone. Transthoracic vagotomy alone should not be used as a standard treatment of duodenal or gastric ulcer” [49].
In the United States, the argument then vacillated between the abdominal approach for vagotomy, the need for gastroenterostomy and the fact that gastric resection was a more dependable operation for cure of the disease. Overall, it was felt by many that vagotomy was a less hazardous and a simpler procedure which seemed to offer an approximately equal chance of good results. In 1952, A.V. Pollock of Leeds stated, "fashions in the treatment of chronic peptic ulceration come and go, and the surgical problem remains unsolved" [50]. In an attempt to establish a reasonable answer, the American Gastroenterological Association formed a national committee on peptic ulcer in 1952. They explained their mission as follows, "the need for evaluation of therapeutic procedures was considered urgent since in the absence of any permanent cure of this disease, new forms of treatment have come into general and protracted use often before their adequacy or inadequacy is determined. If such treatments involve surgery, irrevocable procedures have sometimes been used and later regretted." The committee in an interminable 200-page report concluded that gastroenterostomy was the operation of choice for peptic ulcer disease, and emphasized that, "it should not be concluded from this study that gastroenterostomy plus vagotomy is superior to gastroenterostomy alone" [51]. In 1952, Douglas A. Farmer and Reginald Smithwick of Boston University recommended in the New England Journal of Medicine that vagotomy be combined with hemi-gastrectomy for the treatment of duodenal ulcer disease. They noted that more than 80 percent of their patients suffered no serious side effects from the procedure, and that 93 percent of these patients had a gastric pH of 3.5 or greater after stimulation with either broth or injection with insulin. They concluded that "hemi gastrectomy combined with vagotomy has given the best results in our hands" [52]. In 1957, Charles Griffith and Henry N. Harkins published the theoretical basis for a more selective vagotomy in the hope that this would decrease gastric stasis and the gastrointestinal sequelae of vagotomy [53]. They further defined the vagal gastric anatomy and performed a partial vagotomy in ten dogs. This consisted of incising the branches of the nerves of Latarjet, which were thought to "supply clusters of parietal cells," and as a result, they concluded that the cephalic phase of gastric secretion would be eliminated and similarly no gastric stasis would be encountered. Unfortunately, ten years would elapse before the first selective vagotomy was performed upon a human. In 1967, Holle and Hart performed the first highly selective vagotomy but combined their procedure with a pyloroplasty [54]. Subsequently in 1969, David Johnston demonstrated that a drainage procedure was unnecessary and further confirmed the work of Bente M. Amdrup and his colleagues from Aarhus in Denmark [55, 56]. The efficacy of the procedure was further supported by the report in 1975 of only 17 deaths after more than 5000 highly selective vagotomies [53]. In addition, the report documented significant decrease in dumping, gastritis and duodenal reflux compared to the more traditional operations. Whilst the initial recurrence rates were reported at about five percent, not dissimilar to those noted after truncal vagotomy and drainage, subsequent authors began to report substantial increases in recurrence rates over time even after the learning curve for this procedure had been overcome [58]. Despite the development of more elegant techniques for "circumcising" the esophagus and delineating the criminal nerve of Grassi, it became apparent that the ulcer recurrence rates for this procedure were higher than initially suspected [59]. In particular, it seemed that the location of an ulcer in
the pyloric channel area predisposed to recurrence [60]. The subsequent development of techniques that involved either lesser curve superficial seromyotomy and a combination of a posterior truncal vagotomy with an anterior superficial seromyotomy received some modest support [61, 62]. The ability to leave the left anterior motor components of the nerve of Latarjet intact was predicated as sufficient to ensure normal gastric motility and emptying. Furthermore, the superficial seromyotomy was proposed as a far more rapid procedure than the relatively tedious and time consuming highly selective vagotomy (Figure 4).

CURRENT STATUS

As this debate continued to flourish, the appearance of the \( \text{H}_2 \) receptor antagonist class of drugs on the market changed the entire management strategy for peptic ulcer disease. This class of highly efficacious, safe and well-tolerated compounds resulted in a substantial decrease in the need for elective peptic ulcer surgery [6]. Furthermore, a number of epidemiological reports noted a significant waning in the incidence of peptic ulcer disease [64]. Over the next decade, the need for elective peptic ulcer surgery decreased at an exponential rate as early endoscopic diagnosis and appropriate acid inhibitory therapy were instituted. Vagotomy and gastric resection became procedures performed for the most under emergency conditions or in rare cases of intractability. A subsequent development in the mid-80s of the proton pump inhibitor class of drugs (capable of virtually obliterating all acid secretion) further decreased the need for surgical techniques of acid inhibition except under unusual circumstances [65]. The relatively small inhibition of acid secretion (25 percent - 40 percent) generated by vagotomy appeared almost inconsequential in the face of the 90 percent or greater inhibitory levels engendered by proton pump inhibition. Given the wide spread tolerability, safety and efficaciousness of this class of drugs, the consideration of a procedure which required invasion of the abdominal cavity under general anesthesia and denervation of significant parts of the stomach or the gut has seemed to many to constitute an unreasonable therapeutic approach. The further possibility that ulcers may in a large part reflect \textit{Helicobacter pylori} infection has further lessened the drive to perform irrevocable acid inhibitory surgery [66]. In more recent times, the development of laproscopic surgery has allowed for a less invasive method for severing the vagal nerves to the stomach [67]. Nevertheless, the procedure still requires general anesthesia, hospitalization and involves the disturbance of whatever other physiological functions are modulated by the vagi. It has been argued that long-term pharmacotherapeutic acid inhibition may be less cost-effective or tolerable than laproscopic vagotomy, but the data to support this claim are as yet minimal [68]. Furthermore, the likelihood of the development of more selective and specific pump inhibitors suggests that the efficacy of pharmacotherapy may be still further amplified. Opponents of long-term acid inhibition have argued that the sustained hypergastrinemia engendered by this therapy may well have serious consequences [69]. They have proposed that vagotomy might therefore be better employed in either the young or individuals with gastroesophageal reflux disease who might require life-long therapy. Thorough evaluation of the data collected from patients on proton pump inhibition over almost ten years has, however, demonstrated no adverse effect of hypergastrinemia other than enterochromaffin-like
cell (ECL) hyperplasia [70]. To date, no adverse effects or pathogenetic consequences of this condition have yet been observed. It is therefore likely that acid inhibition in the management of peptic ulcer disease will probably be best accomplished by the use of specific targeted pharmacotherapeutic probes that abrogate proton pump function or other components of the parietal cell secretory mechanism. Whilst there exists the possibility that there may be long-term consequences of potent and sustained acid inhibition they have not as yet been identified despite rigorous review over a decade. In contrast, the anesthetic and surgical risks of vagotomy combined with the consequences of the early and late morbidity of the procedure have been painstakingly identified and documented by numerous authors.

At this stage, it seems that the wandering nerve may have been removed from the surgical territory, except under emergent and unusual circumstances. It is of interest to note a historic and geographic parallel at this stage. The Kungsbacka area of Gothenberg
produced the Dragstedt family, and from nearby Bohuslan came the Carlson family. The gastric physiological interests of Carlson nurtured the young Dragstedt in his exploration of the vagus and subsequently the role of the antrum in acid regulation. Some 70 years later under the mentorship of the eminent Swedish physiologist Bore Uvnas, Lars Olbe would emerge as a physiologist, pharmacologist and surgeon to play a critical role in the evolution of the proton pump inhibitor class of drugs, once again in Gothenberg.

CONCLUSION

Lester Dragstedt was born in Anaconda, Montana, and rose to become the premier scientist and surgeon of the United States. He was widely recognized and honored throughout America and Europe for his contributions to science and surgery. His awards included the highest accolades of the American Gastroenterology Association, the American Surgical Association, the American Medical Association, the National Academy of Sciences and the Royal order of the North Star of Sweden (Figure 5). In 1948, he succeeded Dr. Phemister, who had first lured him from science into surgery, as Chairman of the Department of Surgery at the University of Chicago. As a member of the of the faculty for 32 years, he left an enduring example of scholastic and clinical vigor. He died on July 16, 1975, at his summer compound, Wabigama on Elk Lake in Michigan. One of the ultimate arbiters of success or failure in the United States, the obituary section of the New York Times, remembered him as having been the first person to separate Siamese twins and noted in passing that he had also developed a technique for sectioning the vagal nerves for the treatment of peptic ulcer disease. Similarly, 50 years after his first successful vagotomy in 1943, in his centenary year, it seems likely that the resurrection of vago-
tomy as a surgical procedure may have seen its day. Nevertheless, the example of Dragstedt as a creative scientist, a superlative clinical surgeon and teacher honored by his pupils will always remain as a model of the benefits of scientific inquiry when applied to clinical and surgical practice.

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