



History of Thyroid Surgery

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1.1 Introduction

“The extirpation of the thyroid gland for goiter typifies, perhaps better than any operation, the supreme triumph of the surgeon’s art”. With this sentence William Halsted opened his magnificent monograph *The operative story of goitre* in 1920. It is certainly the best way to begin a chapter on the history of thyroid surgery to focus on the importance and difficulties of surgery in this field [1].

Considering both the thyroid and parathyroid, their histories offer interesting contrasts: in thyroid surgery, surgeons started to operate to relieve symptoms resulting from anatomic problems such as dislocation and compression of adjacent structures and then the physiologists were stimulated to seek laboratory answers to the complications of thyroid surgery and to study thyroid function. For the parathyroids, first physiologists studied the gland’s hormonal function and its interaction with kidney and bone and then the surgeons started to operate on patients to relieve symptoms.

For thousands of years, goiter was considered a familiar, fatal and inoperable disease. Patients suffered from suffocation, difficulty in swallowing, heart failure and distressing disfigurement.

Also, if the first mention of goiters in China dated as far back as 2700 BC, apparently the first successful excision of a goiter was carried out only around 1000 AD by Albucasis (Abū al-Qāsim Khalaf al-Zahrāwī, 936–1013). Albucasis lived in Baghdad and undertook the operation with confidence following this experience: “A ‘homo ignarus’ had attempted a similar operation, and the patient having nearly bled to death from an injured artery. Albucasis knew very well how to control hemorrhage by ligature and the hot iron” [1].

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1.2 Anatomical Recognition of the Thyroid Gland

It is interesting to see that the anatomy of a normal thyroid gland was not known until the Renaissance. Leonardo da Vinci (1452–1519) made the first description of the normal thyroid and, in doing so, recognized it as an anatomical organ and not simply as a pathological aberration as believed for centuries. He drew the thyroid as a globular, bilobate structure, which he regarded as two glands, filling up empty spaces in the neck that separated the trachea from the clavicle, but his drawings were unknown for three centuries. Others pondered the function of the thyroid (to lubricate the neck, make it more aesthetically pleasing or, considering the gland a blood buffer, to protect the brain from sudden increases in blood flow from the heart).

In 1543 the anatomist Andreas Vesalius (Andreas van Wesel, 1514–1564) gave the first anatomic description and illustration of the gland. Working during the same period as Vesalius, Bartholomæus Eustachius (Bartolomeo Eustachi, 1520–1674), who also discovered the adrenals, more accurately described the thyroid as a single “glandula thyroidea” with an isthmus connecting its lobes, but his work was not published until the beginning of the eighteenth century [2].

The term “glandula thyroidæa” was established in 1656 by the anatomist Thomas Wharton (1614–1673) in his work *Adenographia: sive glandularum totius corporis description* (Adenography, or description of the glands of the entire body), even though he still regarded the thyroid gland as consisting of two distinct glands. The name was attributed to the gland owing to its close contiguity to the thyroid cartilage, the name of which dates back to ancient Greek medical literature: in fact, Greek anatomists called this cartilage θυρεοειδής (thyreoides) because of its shape, which evoked that of a shield, in Greek θυρεός (thyreos).

1.3 First Attempts in Thyroid Surgery

Early developments in thyroid surgery came from the school of Salerno in the twelfth and thirteenth centuries using setons, hot irons and caustic powders, often with fatal results.

Guilielmus Fabricius Hildanus (Wilhelm Fabry, 1560–1634) reported that in 1596 “an empiric [i.e., a quack] attempted to remove a goitre in the case of a 10-year-old girl. She died under the operation, and the surgeon was imprisoned” [1].

In 1791 Pierre-Joseph Desault (1738–1795) successfully excised the greater part (so it is said in the text) of an enlarged thyroid gland. Another operation, which Desault performed on a woman, was described in the *Dictionnaire des Sciences Médicales*: “After beginning the operation the hemorrhage was so severe that he abandoned the attempt and contented himself with tying up the piece of gland which had been cut”. The patient died subsequently of convulsions [2].

Technical surgical improvement did not occur until the middle of the nineteenth century. By the 1850s, the mortality rate after thyroid surgery was approximately 40%. The French Academy of Medicine condemned any type of operation on the thyroid gland and Robert Liston (1794–1847), who had done five thyroid

operations, wrote in 1846 that it was "... a proceeding by no means to be thought of" [3]. In the same period, Samuel D. Gross (1805–1884), a prominent American surgeon wrote: "Can the thyroid gland, when in a state of enlargement, be removed with a reasonable hope of saving the patient? Experience emphatically answers NO. If a surgeon should be so foolhardy as to undertake it, every step of the way will be environed with difficulty, every stroke of his knife will be followed by a torrent of blood, and lucky will it be for him if his victim lives long enough to enable him to finish his horrid butchery. No honest and sensible surgeon would never engage in it" [2, 3].

In the 1850s a variety of incisions, longitudinal, oblique, and occasionally Y shaped were done: bleeding was generally inadequately controlled. Typically, wounds were left open and dead spaces were either packed or left to fill with blood.

1.4 Progress in Thyroid Surgery

Even with pronouncements against thyroid surgery, progress in surgery and medicine developed dramatically in the second half of the nineteenth century. The findings of Paul Sick (1836–1900), Jacques-Louis Reverdin (1849–1908), Theodor Billroth (1829–1894), Theodor Kocher (1841–1917), Victor Horsley (1857–1916), William Halsted (1852–1922), George Murray (1865–1939), and others reported that the behavior of patients after thyroidectomy changed significantly and the operation was becoming safer.

In the meantime, the importance of the function of the thyroid was being discovered. Paul Sick reported that an energetic and happy 10-year-old boy became "quiet and dull" following removal of his thyroid gland by another surgeon in Stuttgart (Germany). In 1882, Reverdin described several patients who became feeble and anemic 2–3 months after removal of the thyroid gland. Two of these patients developed edema of the hands and face and took on a cretinoid appearance [4].

Anesthesia, antisepsis, and surgical hemostatic instrumentation were among the major innovations that provided the basis for a new, safer surgical approach.

The era of modern surgical anesthesia began with William Morton (1819–1868): he demonstrated the efficacy of ether at Massachusetts General Hospital in Boston in 1846. In 1849, in St Petersburg, Russia, Nikolaj Ivanovič Pirogov (1810–1881) performed the first thyroidectomy under general anesthesia.

The introduction of antisepsis by Joseph Lister (1827–1912) in 1867 was the second step in the surgical revolution, followed by the concept of intraoperative asepsis introduced by Gustav Neuber (1850–1932). He brought cap and gown into the operating theater. In 1886 Ernst von Bergmann (1836–1907) in Berlin introduced steam sterilization of surgical instruments.

Hemostasis was achieved by Thomas Spencer Wells (1818–1897): he devised a simple, self-retaining arterial forceps to reduce operative bleeding and, ultimately, mortality.

From 1850 to 1875 mortality from thyroid surgery was reduced by half thanks to better control of the patient's pain and motion and improved hemostasis, so

surgeons had more time to attend to the underlying anatomy for a more successful thyroidectomy with a safe, nonseptic postoperative course.

In this period, another important factor was the presence of very skilled surgeons [5, 6].

1.5 Billroth and Kocher

Theodor Billroth was appointed chair of surgery at Zurich University at the age of 31: there, in a fine new university hospital located in one of the world's most highly endemic goiter regions, he initiated a cautious program of surgical attack on large suffocating goiters but, during his first 6 years, he performed 20 thyroidectomies with a mortality of 40%. Billroth considered the results disastrous and he virtually abandoned the procedure for a decade. He resumed thyroid surgery in 1877 after the advent of antisepsis, achieving a mortality rate of 8%. The Billroth procedure involved division of the sternocleidomastoid muscle, and hemostasis achieved with ligation.

In 1860 Billroth founded (with B. Langenbeck and G. Gurlt) the world's oldest medical journal of surgery *Archiv für klinische Chirurgie* (now *Langenbeck's Archives of Surgery*). In 1863 he published his textbook *Die Allgemeine Chirurgische Pathologie und Therapie* (General surgical pathology and therapy). In 1867 he accepted the chair at Vienna.

He was the most experienced surgeon in the world at that time and many important surgeons (such as von Mikulicz, von Eiselberg, Wolfler) studied under him. He also performed the first successful laryngectomy and the first esophagectomy.

It is, however, Theodor Kocher who has been universally and deservedly acclaimed as "the father of thyroid surgery", standing alone in the annals of thyroid surgery.

Kocher, the second of six children of an engineer father and a Pietist mother, was born in Bern, Switzerland. After graduation in 1865 from the University of Bern, he spent a year visiting and studying at foreign clinics. He visited Glasgow, where he witnessed Lister's revolutionary antisepsis work; London, where he observed Spencer Wells paving the way for surgery in the abdominal cavity, previously avoided for fear of lethal infection; Paris, where he met Pasteur and Verneuil; Zurich, where he met with Billroth.

After graduation he became assistant in the Surgical Clinic of Bern University. In that period, he was induced to open a private practice because a marriage to a wealthy young woman demanded that he earn something himself: so he studied hemostasis privately in animals. In 1872 he succeeded his former chief in Bern, Albert Lucke, as professor of surgery and, despite attempts to persuade him to move to Prague, Vienna and Berlin, he remained in Bern until his death.

At the time of Kocher's appointment to Bern, goiters were endemic in Switzerland. He noted that up to 90% of school children were afflicted with goiter. He quickly acquired extensive experience in thyroid surgery, performing more than 5000 thyroidectomies over the course of his career. He was a meticulous surgeon who paid

careful attention to hemostasis, and introduced ligation of the inferior thyroid arteries, which reduced the risk of hemorrhage. His advocacy of the use of antisepsis was manifest in his mortality rates. He reported a reduction in mortality from 12.6% in the 1870s to 0.2% in 1898. In this period Bern became the world capital of goiter surgery.

In 1867 Kocher noted that one of his early patients, a 10-year-old girl, had developed infantile hypothyroidism with cretinoid features after thyroidectomy. In 1883 he presented his historic paper to the fifth German Surgical Congress, in which he described the adverse effects of total thyroidectomy (*cachexia strumipriva*).

William Halsted, who attended the clinics of Kocher and Billroth during the 2 years he toured Europe as a postgraduate student to learn the techniques of the major surgeons, made an interesting comparative observation: “Most of Kocher’s thyroidectomy patients developed myxedema postoperatively, but rarely tetany. The reverse was true of Billroth’s patients. The origin of this phenomenon lay in Kocher’s and Billroth’s different surgical techniques. Whereas Kocher was known for his bloodless operative field, attention to detail, and removal of most of the thyroid while preserving surrounding structures, Billroth was known for a more rapid approach, resulting in parathyroid injury and larger retained segments of thyroid” [5].

Halsted brought Kocher’s surgical philosophy back to the United States where at that time little thyroid surgery was done. Halsted helped to found the Johns Hopkins Hospital, where he was appointed the first professor of surgery. There he introduced residency training and trained many surgeons (including Harvey, Cushing, Horace, Crile, Lahey).

Returning to Kocher, he was awarded the 1909 Nobel Prize in Medicine for his contributions to physiology, pathology and surgery of the thyroid, and thus for initiating endocrinology. Three years later he donated his Nobel Prize money to his University for a Research Institute in Biology. Although Kocher’s most significant contributions lay in the area of the thyroid, he was a surgeon of great versatility and breadth of interests. His operation for hernia, carcinoma of the rectum, his method of mobilizing the duodenum to expose retroperitoneal spaces and his maneuver for reducing dislocation of the shoulder are well known and still bear his name. Many professional honors were conferred upon him: President of the German Society of Surgeons, Honorary Fellow of the Royal College of Surgeons, Honorary member of the American Surgical Society. His *Chirurgische Operationslehre* (Textbook of operative surgery) reached six editions and was translated into six languages.

Talking about Kocher’s life we can cite a curious detail: in 1913 Kocher performed successful thyroidectomy on Nadežda Konstantinovna Krupskaja, a Russian revolutionary affected by Graves’ disease with goiter and exophthalmos, wife of Lenin, head of the Bolshevik Party [7].

In conclusion, Kocher’s new operative style, based on the precise identification of anatomical structures, permitted the radical surgical removal of all diseased tissue with minimal morbidity and mortality. We might justifiably say that, by 1920, the principles of safe and efficient thyroid surgery had been established.

By 1938 Frank Lahey (1880–1953) advocated wider exposure for visualization of the inferior laryngeal nerve during thyroidectomy. With this technique he reported a rate of injury of 0.3%. Despite many papers on avoidance of recurrent laryngeal nerve injury, little attention was paid to the surgical importance of the external branch of the superior laryngeal nerve until 1935 when a world-famous soprano, Amelita Galli-Curci, underwent goiter surgery with resultant loss of upper vocal registry. The comment was: “The surprising voice is gone forever. The sad specter of a ghost replaces the velvety softness” [2].

After the Second World War progress included ventilation and antithyroid drugs. Ultrasound has refined our skills in clinical examination and computerized tomography scanning has refined our view of large intrathoracic goiter. Fine needle aspiration cytology, described by Nils Söderström in 1952, has been generally available since the 1970s.

1.6 Recent Advances

A better surgical view, thanks to the magnification offered by new instruments has made the surgical procedure safe and the patient’s recovery easier. Conventional open surgery has been the standard surgical technique for almost a century. This initially involved a 10 cm transverse midline neck incision which, over the years, was greatly reduced to a standard 3–6 cm incision with the use of magnifying glasses to offer a better tridimensional view. Undoubtedly this surgery provides excellent exposure but the risk of scar hypertrophy and the search for better cosmetic results have led to the development of minimally invasive techniques such as video-assisted, endoscopic, and robotic surgery [8–10].

Minimally invasive video-assisted thyroidectomy (MIVAT) is the most widely accepted endoscopic technique and was developed by Miccoli in Pisa (2000) and then Bellantone in Rome. The desire to avoid neck scarring has resulted in the development of robotic thyroid surgery (robot-assisted transaxillary thyroidectomy, RATT). This procedure was initially described by Kang in 2009. In Italy, the two centers with the largest experience are in Pisa and Modena. Additionally, this procedure is associated with a significant learning curve, longer operative times, greater invasiveness due to the dissection needed to approach the neck from the axilla, and higher costs. The only technique that allows a scarless thyroidectomy is the transoral endoscopic thyroidectomy with vestibular approach (TOETVA) performed by Richmond in 2011. Some concerns about this approach persist, however, and regard oncologic completeness and technical feasibility.

In conclusion, the words of Giddings in the *Journal of the Royal Society of Medicine* in 1996 are still very apt as authoritative advice on the diagnosis and management of thyroid conditions [3]:

Every patient undergoing thyroidectomy should be confident that:

- The resection has been planned in the light of an accurate preoperative diagnosis
- The principles of complete lobectomy, including the isthmus and pyramidal lobe, will be observed

- The recurrent laryngeal nerve, the external branch of the superior laryngeal nerve and the cutaneous branches of the cervical plexus will be preserved
- The parathyroid glands will be protected.

These four principles are necessary components of good quality surgery and are essential if general standards are to rise to those of the best surgeons. In any case, whenever a nonconventional approach to the thyroid gland is planned it is highly recommended that these procedures be centralized to high-volume centers with skilled endocrine surgeons.

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