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REVIEW ARTICLE

A Review on the History of 'Thyroid Surgery'

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Abstract The history of thyroid surgery is both interesting and illustrative. The ambitions of a thyroid surgeon have evolved along the length of time. The objective of this article is to give an idea about the evolution of thyroid surgery thus giving inspiration to future surgeons in their quest for a perfect technique, which would take into consideration disease elimination and maintenance of physiology and cosmesis. The history of thyroid surgery back to as early as 952 AD, when Albucasis first performed the surgery. Thereafter, the course of this surgery had its crests and troughs. At one point of time, surgeons refused to perform this surgery because of the complications. But later on, surgeons like Billroth and Kocher gave this procedure a new leash of life, after which this surgery became popular and underwent numerous modifications to where now it stands. History reveals that thyroid surgery has travelled a long path in time. From an operation which once was considered dreadful to the present times when techniques are being tried to make the incision as small as possible. The quest is still on to develop the perfect technique.

Keywords Thyroid surgery · History · Minimally invasive surgery

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Introduction

Thyroid surgery has had an illustrious past. Its probable beginning was with Albucasis when he recorded his experience of removal of a large goitre in 952 AD. Although there have been earlier reports of similar surgeries, their validity has not been warranted. Thereafter, it passed through a series of crests and troughs over the ages as its proponents and opponents held sway in the medical field over different periods of time.

At one point of history, thyroid surgery was considered such a dreaded operation with a definite grim outcome that surgeons were fearful in performing it at all. However, surgeons like Theodor Billroth and his pupil Theodor Kocher ventured into this surgical domain and mastered it, thereby popularising it and allaying all fears about a dreaded outcome. Thyroid surgery has travelled a long way since then, and now, attempts are being made to perform the surgery in a way so as to make it minimally invasive.

History of the Surgical Procedure

Around 2700 BC, 'goitre' was appreciated in China, and in as early as 1600 BC, the Chinese used burnt sponge and seaweed to treat goitres. Pliny the Elder noted goitre epidemics in the Alps and also mentioned the use of burnt seaweed in their treatment which supposedly they learnt from the Chinese. The Artharva Veda (2000 BC), an ancient Hindu collection of incantations, also contains exorcisms for goitre. It termed the swelling of the neck (goitre) as 'galaganda'.

The earliest anatomical picture of the thyroid gland was made by Leonardo da Vinci in 1511 during his anatomical studies in Florence. The exact function of the gland was not known to him, and he presumed that its purpose was to fill in

the interval produced by a deficit of muscles, in so doing holding the trachea away from the sternum [1].

Exophthalmic goitre was first described by Caleb Hiltier Parry of Bath in 1768 in his write-up in 'Enlargement of the Thyroid Gland in Connection with Enlargement or Palpitation of the Heart' [2]. This subject was then further scrutinised by Robert James Graves and Carl Adolf von Basedow who published their observations independently in 1835 and 1840, respectively. Their publications dealt with the association of goitre, exophthalmos, palpitation, irritability, weight loss, wild hunger, hyperactivity, warmth and sweating [3, 4].

One of thyroid surgery's earliest references comes from the seventh century when a classical Byzantine doctor, Paul of Aegina, described struma and its operation, but it is not certain whether what was struma according to him was actually a goitre of the present day [5]. The earliest distinct reference of a successful attempt at surgical treatment of goitre is present in the medical writings ('Al Tasrif') by the Moorish physician Ali Ibn Abbas or Albucasis in about 952 AD. His experience is recorded as the removal of a large goitre under sedation with opium with the use of simple ligatures along with hot cautery irons as the patient sat with a bag tied around his neck to collect the blood from the wound [6].

The Salerno school was a leading surgical centre in between the ninth and the thirteenth century AD. In 1170, a prominent surgeon, Roger Frugardii, performed a thyroidectomy using setons, hot irons, ligaments and caustic powders [7]. Frugardii wrote 'Practica chirurgiae' which became a principle of surgery in the thirteenth and fourteenth centuries. It had special importance in the schools of Bologna and Montpellier where surgery had an important place because of Ronaldo of Parma and Wilhelm von Congenis [8].

When the church started to control University Legislation, progress started to wane. The church discouraged medical activity, especially surgery, amongst educated people and clerics. Libraries shunned books on surgical works and faculties stopped educating surgeons, as in the Montpellier school in 1230. An expression was coined by the church 'Ecclesia abhorret e sanguine' meaning 'The Church bewares of blood'. Doctors started to avoid taking up surgery fearing a loss of position and rank. Thus, surgery was disjointed from medicine, and it began to be controlled by uneducated people, the so-called barbers. They set broken bones, drained abscesses and did blood lettings which were a part of treatment in those times [8].

In the late Middle Ages, surgery was revived with the efforts of Guy de Chauliac and others like Henry de Mondeville or Guido and Bonetus Lanfranchi. They used the teachings of Albucasis and Roger Frugardii, but there were no references to the thyroid surgeries performed by them.

The period of Renaissance saw the emergence of a great surgeon Ambrois Parre, but his contribution to the field of thyroid surgery was not very significant [8]. In 1791, Pierre Joseph Desault achieved a landmark in thyroid surgery by performing the first partial thyroidectomy [9]. Surgeons like Dupuytren in 1808, William Blizard in 1811 or Henry Earle in 1823 followed him closely. In between 1842 and 1859, Heusser is said to have performed 35 thyroidectomies with only one death. Victor von Bruns of Tubigen, in between 1851 and 1876, was the first surgeon to have separated the isthmus from the gland and performed 28 thyroidectomies with six deaths.

However, Halsted in his 'The operative history of goitre' scrutinised procedures done before 1850 and analysed them to be associated with 40 % mortality [9]. The high mortality was mainly due to haemorrhage, asphyxia due to tracheal compression, hospital gangrene and air embolism. These drawbacks made even the most skilled jittery, and they avoided operating on goitres. In 1846, Robert Liston called thyroid surgery 'a proceeding by no means to be thought of' after performing five thyroidectomies [11]. Two years later, Samuel Gross wrote: "Can the thyroid in the state of enlargement be removed? Emphatically, experience answers no. Should the surgeon be so foolhardy to undertake it....every stroke of the knife will be followed by a torrent of blood and lucky it would be for him if his victim lived long enough for him to finish his horrid butchery. No honest and sensible surgeon would ever engage in it."[12] The French Academy of Medicine also banned thyroid operations in 1850 due to the high mortality associated with them.

Thyroid surgery started coming out of its doldrums in the middle of the nineteenth century. This was due to the concerted improvement in anaesthesia, infection prophylaxis and better haemostasis. Oliver Wendell Holmes coined the term 'anaesthesia'. Crawford W Long of Georgia used sulphuric ether as the anaesthetic agent for the first time in 1842 and in 1846; WTG Morton demonstrated the use of ether anaesthesia in Massachusetts General Hospital. Three years later, Nikolai Piringoff performed a successful thyroidectomy using ether anaesthesia in St. Petersburg [12].

Surgery progressed further with newer methods of infection prophylaxis, such as the use of carbolic acid in antisepsis by Joseph Lister of Glasgow in 1867 [13]. The introduction of steam sterilisation of instruments by Ernst von Bergmann in 1886 [14] and intraoperative antisepsis with a cap and gown by Gustav Neubar in 1883 [15] reduced the incidence of infection significantly in the postoperative period.

In 1874, Spencer Wells and Jules Pear reached a landmark in surgery by introducing the first effective haemostatic forceps. With all these advances, the surgical stage was well set for the advent of the most skilled surgeons of the nineteenth century. Theodor Billroth performed 36 thyroidectomies experiencing 16 deaths, in Zurich and Vienna [16]. With the use of newer methods of antisepsis and haemostasis in between 1877 to 1881, Billroth performed 48 thyroidectomies and was able to decrease the mortality to 8.3 %. The Swedish

surgeon, John Berg, in his comment about Billroth said "His entire attitude, like his speech, bore witness to a scientific genius to one of Europe's admittedly best and most trusted surgeons. While it may be said that he (Billroth) was aware of his superior gift, I saw no sign of haughtiness and often admired his tolerance towards the younger trainees" [5].

Theodor Kocher, a pupil of Billroth, carried forward the baton of thyroid surgery from his teacher. In 1872, Kocher was appointed to the chair of surgery in Berne. He became a professor of surgery at the age of 31. During his first 10 years in Berne, he had performed 101 thyroidectomies, experiencing a mortality of 2.4 %. By 1895, the mortality rate improved to about 1 %. He operated initially through an oblique incision along the anterior border of sternomastoid or by a vertical midline incision. He suggested a more cautious resection and a more precise technique by extracapsular dissection.

In 1909, Kocher was awarded the Nobel Prize for the work done by him on thyroid surgery. At the age of 76, in 1917, he presented the results of his entire work at the Swiss Surgical Congress, weeks before his demise. His presentation revealed his enormous amount of work, about 500 thyroid surgeries performed by him with a mortality rate of 0.5 % [16].

The side effect of total thyroidectomy in the form of cretinoid changes was first observed by Kocher, and he called this 'cachexia strumi priva'. He observed that the patients would become sluggish, cold, fat and sometimes mentally deranged. In 1877, William Ord named this disorder 'myxedema' [17]. After this discovery Kocher stated: "In technical terms, we have certainly learned to master the operation for goitre. We can deal with bleeding and prevent loss of speech. Billroth's tetany is so unusual that it has not made us change our methods. But something else happened… Removal of the thyroid gland has deprived my patients of what gives then human value. I have doomed people with goitre, otherwise healthy, to a vegetative existence. Many of them I have turned to cretins, saved for a life not worth living…"[5]. His thoughts were imparted in a German Surgical Congress in Berlin and written in a report on the results of total thyroidectomies in 1883, which was published in the 'Archiv für Klinische Chirurgie' [18]. He promised not to remove a thyroid gland completely and advised to perform lobectomies. One of his famous rules reads: "A surgeon is a doctor who can operate and who knows when not to" [5].

What is really interesting is the fact that Billroth had limited experience with myxedema after total thyroidectomy. He was plagued by another disorder following surgery, which is tetany. Kocher on the other hand seldom witnessed it. Halsted who had the rare opportunity of watching both the surgeons presumed that the difference of outcome was the result of their difference in temperaments.

"The explanation probably lies in the operative methods of the two illustrious surgeons. Kocher, neat and precise, operating in a relatively bloodless manner, scrupulously removed the entire thyroid gland, doing little damage outside the capsule. Billroth, operating more rapidly, and as I recall his manner, with less regard for tissues and less concern for haemorrhage, might easily have removed the parathyroids or at least interfered with their blood supply, and have left remnants of thyroid" [10].

In 1891, Gley opined that post-thyroidectomy tetany is caused either by removal of the parathyroid glands or interference of the blood supply to these glands. In 1896, Vassale and Generalim demonstrated that loss of parathyroid function may cause tetany in animals [19]. This gave an opportunity to the surgeons to further develop techniques to preserve the glands. Billroth's pupils, Anton Wolfer and Jan Mikulicz Radecki, were the first to look for a solution to this problem. Anton Wolfer, the then chair of surgery of Graz, in 1886, described tetany in detail. Miculicz, the chair of surgery of Kraków, in 1882, devised a new approach to thyroidectomy. He suggested that with the preservation of the posterior aspects of both the lobes, tetany could be prevented.

The parathyroid blood supply was published in 1907 by Halsted and Evans. They opined that 'ultra-ligation' of the thyroid arteries was to be practised, which was ligation distal to the points of origin of the parathyroid artery branches. They suggested avoiding inferior thyroid artery ligation [20].

Another serious complication after total thyroidectomy was the laryngeal nerve injury. Mikulicz Radecki was particularly interested in preventing this complication. His new technique of preservation of the posterior aspect of the lobes additionally took care of the recurrent laryngeal nerves and preservation of its function. It may be presumed that a significant number of recurrent laryngeal nerve injuries were not diagnosed till the introduction of mirror examination of the larynx, the credit of which goes to the Spanish singer Manuel Garcia.

On his discovery, Manual Garcia had stated "I had often thought of using a mirror to observe the larynx from within while singing, but I had always considered it impossible. In September 1854, on a visit to Paris, I decided to see whether it could be done. I went to the famous instrument-maker Charrier and asked if he had a thin mirror with a long shaft that could be used to inspect the throat. He had a small tooth-mirror, sent to the London exhibition in 1851, which nobody wanted. I bought it and took it to my sister's, with another little pocket-mirror, impatient to begin my experiment. I warmed the mirror in hot water, dried it carefully, and placed it against the tongue. When I cast in light with the pocket-mirror against it, I saw the larynx wide open before me!"[5].

Until the case of the lead opera singer Amelita Galli-Curci, little attention was paid to the superior laryngeal nerves and their function. She was operated for goitre in 1936 by Arnold Kegel and G. Raphael Dunleavy. Several months after recovery, the singer returned to the stage but her career was short-lived. She failed in her upper range and could not sustain the notes with apparent breathlessness during her performance.

The complication that happened to Amelita Galli-Curci can now be recognised to be an injury to the external branch of the superior laryngeal nerve, which resulted in cricothyroid muscle dysfunction which, in turn, resulted in its inability to sustain maintenance of tone of the vocal cords [5].

All these years, thyroidectomies were being performed on non-toxic goitres as toxic ones were considered poor candidates for surgery. Thus, toxic goitres posed a new challenge for the surgeons. In 1884, Ludwig Rehn of Frankfurt-am-Main reported three cases where goitres were operated upon to relieve impending obstruction but incidentally they got cured from the toxic symptoms [21].

Toxic thyroidectomies were performed by surgeons like Theodor Kocher, Frank Hartley, Charles Mayo, Thomas Peel Dunhill and George Washington Crile. To provide greater safety, Kocher practised initial ligation of the thyroid arteries [11]. Hartley was a pioneer in removing the second lobe partially in a select number of patients [22]. Mayo practised unilateral or bilateral pole ligation prior to partial thyroidectomy in patients with severe thyrotoxicosis [23]. A second lobectomy was suggested by Dunhill in patients with thyrotoxicosis who failed to respond to their initial procedure. The basis of Graves' disease was not known till 1886 when P.J. Moebius suggested that the cause was disordered function of the thyroid gland itself. From a surgical viewpoint, however, this did not make much of a difference.

Although it had been known for some time that seaweed kelp reduced goitre size, it was not until 1811 that Bernard Courtois discovered iodine in burnt seaweed, which fostered the idea that this was the active ingredient in the treatments that were being successfully prescribed for goitre. Ten years later, Coindet was the first to recommend iodine in the preoperative treatment of goitre to decrease vascularity and consequently lessen the operative risk. This was endorsed further by Marine in 1907, who proposed that iodine was necessary for normal function of the thyroid gland, and in 1911, iodine was recommended as the therapy for Graves' disease which happened to be a landmark in the treatment of toxic goitres [24].

In 1923, Plummer published results of the 600 thyrotoxic patients that he had operated upon after using Lugol's iodine preoperatively. He demonstrated that the operative mortality rate dropped from 4 to 1 % by using Lugol's iodine [25].

Further progress in the management of toxic goitre happened with the introduction of radioactive iodine and its incorporation in therapeutics in 1942 by Means, Evans and Hertz. A year later, in 1943, came thiouracil, introduced by Edwin Bennet Astwood. Beta blockers (propranolol), developed about 20 years later, were inducted into the armamentarium for treatment of toxic goitres in 1965. The incorporation of these drugs contributed significantly to the perioperative management of toxic goitre, the group of treatment: drugs, radioiodine and surgery, still followed as the basis of treatment for thyrotoxicosis.

With the development of radiological procedures like ultrasound and computerised tomography scanning, the diagnosis has become even more precise. The introduction of fine needle aspiration cytology (FNAC) in 1952, as described by Soderstorm, further improved the diagnosis of goitre [14].

Along with advances in other disciplines of medical science, viz., anaesthesia, physiology and radiology, surgical treatment of thyroid diseases improved significantly. The procedure became safer with introduction of devices like the nerve monitor for electro-identification of the recurrent laryngeal nerve intraoperatively. The transplantation of accidentally removed parathyroid glands also gave a new hope in total thyroidectomy surgeries.

Apart from making the surgery safe and effective, the quest started for newer techniques of performing the procedure to achieve cosmetically better results and surpassing its other drawbacks.

Minimal access thyroid surgery (MITS) is a recent addition to the surgical techniques of thyroid surgery. Minimal access surgery is well accepted in other surgical specialties, but in head and neck surgery, its acceptance has been rather slow [26]. Garner et al., in 1996, generated much interest in this field after he reported feasibility of endoscopic approach to the parathyroid glands [27]. His focus shifted to thyroid surgery as well to the quest for less invasive techniques and better aesthetic outcome. The concept attracted the attention of patients who appreciated the prospect of a better cosmetic outcome, less hospital stay and less postoperative pain.

Over a short period of time, a number of techniques simultaneously started being called as minimally invasive thyroid surgery. These can be classified as pure endoscopic techniques, video-assisted techniques and minimally invasive open surgery.

Pure endoscopic technique also differed in terms of the different routes being used to approach the thyroid compartment with or without carbon dioxide gas insufflation—the routes of access being lateral neck [28], axilla [29], anterior chest [30] and breast [31]. In all the routes, usage of a 30° endoscope is common. Minimally invasive video-assisted thyroidectomy (MIVAT) was introduced and popularised by an Italian team (Miccoli et al.) in the 1990s. It is the most widely used method. In this method, a 1.5-cm incision is made in the cervical skin crease, and it is through this incision that the excised part is delivered after video-assisted excision of the gland. 'Small incision thyroidectomy' is a minimally invasive open surgical technique which does not require specialised instruments [32]. It differs from the conventional surgery only in terms of its length of incision, but with advantages galore which includes decreased tissue trauma, less hospital stay, better cosmesis, less postoperative pain and increased postoperative comfort. However, it has its disadvantages too—longer surgical time, steep learning curve and the inflated expenses of the surgery.

Till 2002, thyroid malignancies were considered unsuitable for endoscopic surgeries, but then, Miccoli et al. [33] reported his series of endoscopic surgery done in papillary thyroid cancer patients. They found MITS to be as effective as conventional surgery in carefully selected cases of papillary thyroid carcinoma, as there was no significant difference in between the two groups in terms of iodine (I^{131}) uptake or circulating thyroglobulin (Tg) levels. Although there is not any specific criteria for selection of cases, there seems to be a consensus in terms of patient selection for MITS, in terms of size of the tumour (<35 mm in case of benign ones and <20 mm in case of malignant thyroid nodule/gland), with no history of any previous surgery or irradiation, no sub-sternal or extrathyroid spread in cases of papillary carcinoma.

Conclusion

Thyroid surgery has indeed travelled a long and arduous path through the ages. From an operation which was once considered predestined for failure and even death to the present times when techniques are being tried to make the incision as small as possible, this abridged sketch of the history of thyroid surgery reflects how apparently insurmountable barriers were traversed by brave pioneers of surgery and how they advanced the surgical treatment of the thyroid from the dark ages and ushered in the modern era.

Conflict of interest I, Dr. Saurav Sarkar, the corresponding author of the article: A Review on the History of 'Thyroid Surgery' on behalf of all my co-authors, do hereby state that there are no potential conflicts of interest that are directly or indirectly related to the research and write-up of this article.

Thank you
Dr. Saurav Sarkar

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