



## Evolution of Surgery in Papillary Thyroid Carcinoma

Sergio F. Zúñiga P.<sup>1\*</sup>, Andy Camila Gómez B.<sup>2</sup>

<sup>1</sup>Professor Head and Neck Surgery, Head and Neck Surgery Department, National University of Colombia

<sup>2</sup>General Doctor, Head and Neck Surgery Department, National University of Colombia

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\*Corresponding author: Dr. Sergio F. Zúñiga P., Professor Head and Neck Surgery, Head and Neck Surgery Department, National University of Colombia, Phone No. : (+57)310 248 1939, Email: [szunigap@unal.edu.co](mailto:szunigap@unal.edu.co)

### Abstract

Papillary Thyroid Cancer is currently one of the most common cancers in the world. Therefore, we believe that it is important to be aware of the evolution of this surgery that every surgeon faces and has faced.

The thyroid gland has been the subject of health problems and has attracted the attention of many individuals, from emperors to modern specialized Doctors (thyroidologists). Sheng Nun, the second Chinese emperor (2838 - 2898 B.C.), made the first reference to goiter, attributing it to mountain waters and its treatment with algae. Abulcasis, 952 A.C., performed the first thyroidectomy and is credited with the use of catgut and fine-needle aspiration biopsy (FNAB). The poor outcomes at the time led to thyroidectomy to be considered a dangerous treatment, mortality exceeding 41%, due to bleeding and infection. With the advances in anesthesia, asepsis, antiseptics, and technology, current morbidity and mortality rates are acceptable.

We wonder what the most significant advancements have been, if there is a cure for this cancer what the ideal surgery is and if we are heading in the right direction. We provide a brief description of the evolution of papillary thyroid carcinoma surgery, highlighting successes, uncertainties, and outcomes.

We conclude that there has not been a precise preoperative assessment or universal standardization of risk factors. There is better technology low morbidity, trend towards cosmetic

improvement, but, surgical times and costs have increased, seemingly without reduced mortality. There appears to be an increase in mortality due to a higher incidence of advanced Papillary Thyroid Cancer.

### Keywords

History of Thyroid Surgery Evolution, Technology, Minimally invasive surgery, Morbidity and Thyroidectomy, Mortality and Thyroidectomy.

### Abbreviations

- FNAB: Fine Needle Aspiration Biopsy
- B.C.: Before Christ
- A.C.: After Christ
- A.T.A.: American Thyroid Association
- CA: Cancer

### Introduction

Thyroid disease has caught the attention of humanity since 2000 B.C... Since then, it has been a subject of study, aiming to understand the potential causes that lead to functional and structural issues in this marvelous and small organ, weighing merely 20 grams, but with systemic repercussions. The genesis of benign and malignant tumors, their optimal treatment, cure, and prevention remain mysterious.

We take a brief look at different aspects of the history and embark on a journey from ancient times to the present, showcasing the evolution and progress in Thyroidectomy which has evolved from a highly dangerous procedure to a much safer process with low morbidity and mortality in modern times.

We briefly explore the global contexts of different eras in which Thyroid surgical advancements came through, the key figures who pioneered them, the challenges they faced and are currently facing, and the fundamental concepts underpinning current types of Thyroidectomy. The worldwide increase in early diagnosis of Papillary Cancer and the advancement of surgical technology have led to the proliferation of various surgical approaches, aiming to achieve the same oncological outcomes as traditional surgery but emphasizing on aesthetics and avoidance of neck scarring, which has increased costs and surgical times.

But what have we achieved in cancer control? Here, alarms are raised because, to date, there is no universal standardization of the various prognostic factor systems available worldwide, nor their universal applicability. Similarly, we have not been able to define the most suitable type of surgery to cure patients affected by Papillary Cancer.

In conclusion, we pose the question: What, then, is the future of Papillary Cancer?

## Ancient History Up To 1970

Thyroid gland diseases fall into two categories:

- a) Functional - known as hyper or hypothyroidism.
- b) Structural - referred to as nodules, which can be either benign or malignant.

The condition known as goiter was identified in ancient times, as documented by the Chinese Emperor Shen Nung (2838 - 2898 B.C.), often called "The Farmer" for his knowledge and teachings on plants and agriculture. This ailment was seemingly common in that era and attributed by the emperor to volcanic waters. His knowledge led him to conclude that seaweed was the treatment for this condition in his "Treatise on Waters and Herbs." (1) This treatment was also practiced in India with Ayurvedic medicine and by the Roman engineer, military man, and architect Vitruvius Pollio in the 1st century B.C..

In 85 B.C., the Chinese physician Tshui Chin-thi differentiated for the first time between solid neck tumors, which were incurable (malignant), and mobile and curable (benign) ones. (2)

Interest in the Thyroid gland led anatomists to draw Thyroid diagrams in 1490 during the Renaissance at the Padua School. Leonardo da Vinci published the first anatomical drawing of the Thyroid in 1511. (3) Vesalio in 1543, in his book "De Humani Corporis," described it as two Thyroid glands. (4) Numerous examples of goiter and Thyroid masses

can be found in art, such as the works of Francesco Alberto in 1694, Fermo Stella's "The Passion of Christ," Caravaggio's "Holofernes and Judith," Velázquez's "Christ after Flagellation," and Dante Gabriel Rossetti's "La Bionda del Balcone" in 1868, among many others.

Abul Casis, an Andalusian physician and scientist (936 - 1013 A.C.), described Thyroidectomy for the first time with success under sedation in 952 A.C. He also created metal instruments for cauterizing blood vessels and is credited with the use of catgut for internal tissue sutures. (3, 5) The School of Salerno was a leading surgical center between the 9th and 13th centuries A.C... In 1170, the surgeon Roger Frugardii, a physician from Salerno, Italy, performed a successful Thyroidectomy and wrote the book "Practica chirurgiae," which served as a surgical reference in the 13th and 14th centuries. (6)

The first description of goiter in Colombia was in 1625 by Fray Pedro Simón, who attributed it to the waters, calling it "neck mumps." (7)

Thyroid surgery has gone through different stages, evolving from risky procedures to the current safe and efficient surgery of the present. Below, we will see a summary of these stages especially dedicated to the surgery of papillary thyroid carcinoma.

In 1739, Lorenz Heister (1683 - 1758), a medical professor of anatomy and surgery, published the book "Chirurgie," in which he described the removal of the Thyroid gland for the first time and recognized that goiters could turn malignant. (8)

Thyroid surgery was exceptionally rare, dangerous, and considered high risk. Suitable anesthesia techniques did not exist, and knowledge of Thyroid anatomy and physiology was limited. Mortality was mainly due to bleeding, infection, asphyxiation, air embolism, and hypothyroidism, occurring in 40% of patients until 1850. (9) In that year, The French National Academy of Medicine banned Thyroid operations due to the high mortality associated with them. (3, 5, 10) In Britain, Thyroid surgery was regarded as a "proceeding by no means to be thought of," in Europe as "foolhardy," and in America as "horrid butchery."

To avoid this morbidity and mortality, non-surgical treatments were preferred, such as the application of burned sponges, ingestion of significant doses of iodine 3 - 4 times a day, topical use of iodine, and, in cases of tracheal compression symptoms, the introduction of needles with setons or lints at the root of the tumor, which would necrotize and fall off. (11)

However, advancements such as the following led to better results with reduced infection and lower mortality:

- a. Hemostatic forceps, Charriere (1820) in Paris.

- b. In 1.842, sulfuric ether was used as an anesthetic for the first time by Crawford W. Long and W.T.G Morton in 1846 at Massachusetts General Hospital. (12)
- c. Ignaz Semmelweis, a Hungarian surgeon, discovered handwashing in the mid - 1.840's as a way to prevent maternal deaths due to puerperal infections.

As a consequence of opposing the prevailing medical practices of his time, Dr. Semmelweis was dismissed from the hospital where he was employed. He subsequently fell into a deep depression and struggled with alcoholism. His behavior alarmed his wife and relatives, who feared he had lost his sanity. In 1.865, he was committed to a psychiatric hospital, where he passed away just two weeks after admission due to septic shock, following a severe beating by one of the hospital guards. This attack left him with multiple wounds on his body. (13, 13a.) An unjust ending for a visionary physician, as his discovery marked a significant milestone in the history of medicine, particularly in the prevention of infections. His discovery was perfected with the use of sterile rubber gloves introduced by Halsted.

In 1850, the French surgeon Armand Trousseau highlighted the importance of removing the Thyroid gland to treat goiters, although he acknowledged the significant risks of the surgery. Trousseau was one of the early proponents of ligating the Thyroid vessels to reduce the risk of bleeding during surgery. (15)

In 1853, Charles Emile Troisier, a student of Trousseau, performed a partial Thyroidectomy on a 40-year-old woman with a goiter. Although the patient survived the surgery, it was highly complicated, and Troisier concluded that Thyroidectomy should be avoided whenever possible. (16)

Surgery progressed further with newer methods of infection prophylaxis, like the use of carbolic acid in antisepsis by Joseph Lister of Glasgow in 1867. (14)

With these advances, several renowned surgeons such as Just Lucas-Championnière (1843 - 1913) in France, Richard von Volkman (1830 - 1889) in Germany, Theodor Billroth (1829 - 1894) in Austria, Timothy Holmes (1825 - 1907) in England, began performing Thyroid surgeries. However, Christian Albert Theodor Billroth, a German physician and surgeon, significantly reduced the mortality rate of Thyroidectomy to 8.3%. (3)

Emil Theodor Kocher (1841 - 1917) a Swiss surgeon and Billroth's student, made great strides in Thyroidectomy techniques. In 1895, he reduced mortality to around 1%. His incisions were initially oblique along the anterior border of the sternocleidomastoid muscle and later vertical. He perfected the technique of Thyroidectomy, designed instruments as Kocher forceps, and, in 1909, received the Nobel Prize in Medicine for his studies on Thyroid pathophysiology. In 1917, he presented statistics on 5.000 Thyroidectomies with a mortality rate of 0.5%. (17)

Kocher operated slower than Billroth, and his Thyroid dissection was intracapsular, making the surgery less bloody and with a lower risk of hypoparathyroidism.

Emil Theodor Kocher, along with Frank Lahey, Theodor Billroth, William Halsted, Charles Mayo, George Crile, and Thomas Dunhill, is considered one of the "Big Seven" for their contributions to the progress of safer Thyroidectomies. (18) Since then, Thyroidectomy began to yield better results with lower morbidity and mortality.

The first publication of a Thyroidectomy performed in Colombia was in 1.888 by Dr. José María Samper Ortega. The article, entitled "Operation of a Thyroid tumor," was published in the Colombian medical journal "El Monitor Médico." The article described the case of a 40-year-old woman who suffered from a Thyroid tumor. The surgery was successful, and the patient recovered without complications. Dr. Samper's article was a milestone in the history of Colombian medicine and helped establish Thyroid surgery as standard medical practice in the country. (19)

The years between 1.920 and 1.950 marked the second stage of Thyroidectomy evolution, coinciding with global events like World Wars I and II, the atomic bomb, the use of neck radiation for benign conditions like juvenile acne, tuberculous lymphadenopathy, hypertrophy of tonsils and adenoids, and low iodine intake. (20) It was during this period that research began regarding the behavior of Thyroid nodules, commonly referred to as goiters despite the presence of cervical lymphadenopathy that indicated them as metastatic benign goiters. (21)

Identification of Thyroid hormone - Advances in Thyroid biochemistry occurred in the early 20th century. In 1914, Edward Calvin Kendall isolated thyroxine, the primary hormone produced by the Thyroid. This allowed for Thyroid hormone supplementation in patients who had undergone Thyroidectomy (23), eliminating the strumipriva cachexia suffered by total Thyroidectomy patients.

During this period, it was also demonstrated that radiation induced Thyroid Cancer in animals (24), and significant knowledge was established, such as histological tumor types and the probable sites of disease extension: "papillary carcinoma metastasizes to the lymph nodes and lungs, as does follicular carcinoma to the lungs and bones." These data have remained essential for over 50 years. (22)

Diagnosis was primarily clinical, based on the growth and evolution of the tumor over time, the hardness of Thyroid tissue upon palpation, compressive symptoms, the presence of cervical lymphadenopathy, and biopsy by freezing when a diagnostic doubt arose. (25, 26)

In 1.926, Dr. Hyes Martin introduced Fine Needle Aspiration Biopsy (FNAB) as a non-invasive diagnostic method for Thyroid nodules with an effectiveness of 60% -

80%. However, it did not gain popularity because there were concerns that this method might disseminate tumor cells along the needle's path. (27)

The term "Thyroid Carcinoma" began to generalize. In 1.938, Schlesinger et al. published a study on the frequency of Thyroid nodules. They performed 2.185 autopsies on patients who died of causes other than Thyroid diseases at three hospitals in New York, examined 1,371 Thyroids and found 112 Thyroid nodules (8.2%) larger than 1 cm. Of these, 5.3% were in men and 11.6% in women. Among the 1.371 Thyroids, 0.4% were malignant, but of the 112 Thyroids with nodules, 4.5% were malignant. (28) This was the first study of its kind and laid the foundation for what is now known as active surveillance for papillary carcinoma.

There was a proliferation of histological classifications for this condition, and it was recognized that there were two forms of less aggressive tumors, classified as follicular and papillary. Tumors classified as having a more benign course were in Group I, while those in Group III were the most aggressive, with Group II in between. Their clinical behavior could lead to reclassification into any of these groups, but the disease's generally indolent behavior in most cases was acknowledged. (22)

At the time, there was debate regarding the possibility of operating any nodule larger than 1 cm, especially in people over 50 years old and specifically women, as a prophylaxis for Thyroid Cancer.

In 1941, Dr. Saúl Hertz was the first to use radioactive iodine for the treatment of Thyroid disease. This was a significant advancement that provided doctors with a new way to treat Thyroid conditions without surgery. (29, 30)

Indications for Thyroidectomy in Colombia at the time included symptomatic compression and/or partial or total paralysis of the cervical nerves, with an even stronger recommendation if one considered that 6 - 10% of pre-existing goiters could evolve into hyperthyroidism or malignancy, and high-dose iodine treatment was contraindicated in these cases. (31)

Before the 1950's, total Thyroidectomy was the standard operation for most Thyroid conditions. However, in the 1.950's, Thyroid lobectomy (removal of part of the gland) became more popular, as it was considered a safer and more effective option for some patients. (32) For advanced and/or aggressive cases, management was done through radiotherapy, constituting 15% - 20% of cases. It was also demonstrated that low-risk cases had a high probability of cure. (25, 26)

The surgical technique for cancer included resection of the underlying platysma, the homolateral internal jugular vein, the sternocleidomastoid muscle bilaterally, the infrahyoid muscles, removal of the posterior part of the gland, which might include the parathyroids, the recurrent laryngeal nerve, fragments of the esophagus or trachea if involved, and

adjacent lymph nodes. It was suggested to preserve the contralateral Thyroid lobe. (33)

The 5-year life expectancy for papillary carcinoma ranged from 50% to 80%, and radiotherapy was the adjuvant treatment for increased survival, despite its effectiveness not being well-established since it was considered a non-radio-sensitive tumor.

In 1949, Trunnel enthroned the role of  $I_{131}$ , especially indicated for the management of metastases with a 46% uptake. (34) In the 1950's and 1960's, total Thyroidectomy started to be recognized as the most effective treatment for Thyroid Cancer, associated with lower recurrence rates. (35) Morbidity remained relatively low, with a 5% incidence of recurrent laryngeal nerve injury and a permanent hypoparathyroidism rate of 11.4%. (36)

The patients who overwent a complete tumoral resection, classified as a stage I or II did not receive postsurgical radiotherapy, unless the tumor was poorly differentiated. Radiotherapy was the treatment of choice in stages III and IV. (37)

In the 1960's, there were early attempts to use ultrasound, although it did not gain much acceptance initially, but it would gain more relevance later. (38) In the 1970's, doctors used TSH suppression therapy to treat Thyroid nodules, based on the principle that TSH suppression with high doses of Thyroid hormone could reduce the size of these nodules. (39) However, they failed to prove this hypothesis.

Advancements in intra-operative monitoring of the recurrent laryngeal nerves during Thyroid surgery contributed to a reduced frequency of vocal cord paralysis as a complication, Shedd & Burget (1.966) and Shedd & Durham (1.966). During this time, indirect laryngoscopy before Thyroid surgery became a standard preoperative study. (40)

## 1970'S TO 2000'S

The period from 1970 to 1999 was characterized by the search for prognostic factors in order to adapt treatments to the risk of mortality in these patients. An increase in cases of Thyroid Cancer was reported, attributed to the nuclear disaster at Chernobyl in Russia on April 26, 1986, but efforts were made to increase iodine intake in the population. Additionally, a reduction in cases of anaplastic carcinoma was observed. There was a greater understanding of prognostic factors, leading to the individualization of patient follow-up based on these factors. Another significant advancement during this time was the discovery of Thyroglobulin (Tg) in 1982 and recombinant TSH (rhTSH) for follow-up and tracking with  $I_{131}$  in 1999. (41, 42)

Starting in the 1980's, the introduction of ultrasound further improved doctors' ability to diagnose and treat Thyroid diseases. Ultrasound provided detailed images of the Thyroid

and allowed doctors to perform guided biopsies of nodules. (43, 44)

However, not all physicians agreed on the application of these advances in patient care. There were dissenting voices that expressed, "Needle biopsy cannot be considered a substitute for open biopsy, and it is suggested that fine needle aspiration biopsy should not be used in Thyroid nodule investigations. Fine needle aspiration biopsy should be abandoned." (45)

In the pursuit of individualizing treatments, elaborating on risk factors and subsequently offering the most appropriate treatments, the American Head and Neck Society established "The Hyes Martin Lecture" in honor of one of the most prominent Head and Neck Surgeons in history. The most distinguished physicians in this field are designated to deliver this lecture at the society's annual meeting.

In 1976, Dr. Edgar L. Frazell presented the lecture "Management of Cancer of the Thyroid," and some key conclusions can be highlighted:

- Almost all aspects of Thyroid Cancer management are debatable.
- Uniformity of management is unlikely in the foreseeable future.
- Should total Thyroidectomy be the procedure of choice, even though the mortality is very low in low-risk patients?
- Surgery should be individualized.
- There is an overreliance on statistics to make treatment decisions (46).

These concepts still prevail today, and these questions remain unanswered (Personal opinion).

A variety of risk factors emerged, with prominent ones including EORTC, AMES Lahey Clinic, AGES Mayo Clinic, MACIS Mayo Clinic, TNM, OSU, and NTCTCS. These systems categorized patients into high and low mortality risk, determining who would be candidates for total or subtotal Thyroidectomy, whether additional treatments with  $I_{131}$  and/or TSH suppression were needed, and the intensity of follow-up based on this categorization.

Cervical lymph node dissection also evolved in the 19th century. The presence of lymph node metastases implied a poor prognosis and incurability. Attempts were made to remove these nodes along with the primary tumor to improve the survival of these patients, but lymph node dissection was almost never complete.

- In 1.880, Halsted devised the Halsted incision, which is a Y-shaped incision to dissect structures from the mastoid to the medial clavicle.
- In 1.888, the Polish surgeon Jawdýnski successfully performed a neck intervention using a technique similar to the one described 17 years later by G. Crile, the en bloc lymph node dissection. The en bloc

dissection became popular and was perfected by H. Martin and Conley, who did not advocate preserving structures like the spinal nerve or performing prophylactic or elective dissections.

However, Dr. Oswaldo Suarez, an Otolaryngologist from Córdoba, Argentina, presented his work on modified neck dissection in 1.963, which preserved the spinal nerve, the sternocleidomastoid muscle, and the internal jugular vein, avoiding the morbidity of radical dissection and the resulting cosmetic deformity. Bocca, Pignataro, and in Europe, Gavilán C., a Spanish Otolaryngologist, followed Dr. Suarez, pioneering this and other neck surgeries. (47, 48)

In Thyroid cases, Noguchi (Japan) demonstrated that the incidence of cervical lymph node metastases was 88.2% when elective neck dissection was performed, corroborated by Meissner at 65% and Attie at 68%. He recommended this type of surgery for patients with metastatic neck disease and/or prophylactically for patients with nodules larger than 1.5 cm. (49)

This led to extensive debates and differing opinions regarding total Thyroidectomy, with arguments both for and against total Thyroidectomy and neck dissections, depending on the application of risk factors, with valid arguments on both sides.

In 1977, Dr. Ernest Mazzaferri, an American endocrinologist at Ohio University, published an innovative research paper which demonstrated after following more than 576 patients for 10 years, that total or near-total Thyroidectomy +  $I_{131}$  + TSH suppression levels of 0.1 uUI/ml in patients with tumors larger than 1.5 cm resulted in higher survival rates. Recurrence was at 14.5%, with mortality below 1%. He implied that recurrence in cervical lymph nodes did not imply higher mortality, and the "berry picking" technique produced similar results to complete lymph node dissections. It was also suggested that radiotherapy should not be used as an adjuvant treatment. (50)

Thus, even with various risk factors and different opinions on surgical management, it was demonstrated that recurrences in low-risk cases were at 5%, and around 40% for high-risk patients, with mortality at 2% over 10 years for low-risk patients and 30% to 46% for high-risk patients, depending on the sources consulted. It was noted that recurrences occurred in 85% in the neck, and mortality depended on age, being 0.1% for those under 20 years and around 47% for those over 75 years.

Questions intensified regarding total Thyroidectomy in low-risk cases, which subsequently brought a lifelong medication, Thyroid suppression, and potential long-term effects as well as  $I_{131}$  ablation. The main idea was to avoid over-treatment. This included the discussion of whether central mediastinal lymph node dissection (CLND) should be performed routinely or not. (51)

In Latin America, Zúñiga S. F. and Sanabria A. published the first experience of routine central neck dissection in 266 patients, concluding that prophylactic central neck dissection did not show any advantage in the rate of neck recurrence in patients with N0 clinical stage disease. (52)

### Stage from 2,000 to the Present Day

The American Thyroid Association (A.T.A.) has made a significant contribution to the evolution of papillary Thyroid carcinoma treatment by making a considerable effort to gather the best available evidence and establish a consensus on management that offers results based on the best scientific evidence.

In 2002, Miccoli et al. modified minimally invasive surgery, reducing the cervical incision to a length of 20 - 25 mm and performed a Thyroidectomy with minimal scarring on the neck assisted by endoscopy, which was coined MIVAT (Minimally Invasive Video- Assisted Thyroidectomy). (61)

In 2006, the A.T.A. published guidelines with surgical recommendations, emphasizing the importance of removing the entire primary tumor, disease extending beyond the Thyroid capsule, and involved cervical lymph nodes, reducing morbidity and mortality from local recurrences in residual nodes, allowing a more precise disease classification, follow-up, and facilitating complementary treatments. It was stated that total or near-total Thyroidectomy, along with bilateral central lymph node dissection, is the preferred surgical treatment for improved survival and reduced lymph node recurrence. Lateral neck dissection is only performed with a confirmed diagnosis of metastasis and includes levels II to V. (53)

In 2009, the A.T.A. issued new updated guidelines due to the increase in well- differentiated Thyroid Cancer cases. Since 2006, considerable advancements were made in diagnosis and treatment, including findings on ultrasound guiding fine-needle aspiration biopsies and the use of molecular markers in indeterminate cytologies.

Total or near-total Thyroidectomy is recommended for tumors larger than 1 cm, while lobectomy is advised for tumors smaller than this size. Central lymph node dissection is recommended for treatment when there are clinically suspicious lymph nodes in T3 and T4 tumors but is not indicated as a prophylactic measure. (54) It's worth noting that meta- analyses show a higher probability of recurrence when this dissection is not performed. (55)

The advent of minimally invasive surgery, with less morbidity, improved cosmetic outcomes, and better postoperative recovery, led the Surgery Department in the Nippon Medical School to start implementing this video-assisted neck surgery technique. This initiated the field of "minimally invasive" Thyroidectomies. (56)

Until this point, with open surgical techniques, the 10 and 20 year overall survival rates were 90% and 76%, respectively. Specific survival was 95% and 90%, local recurrence was 8.2%, distant metastasis was 5.5% (57), global hypocalcemia was 7% - 51%, and permanent hypocalcemia was 1.5% - 4%. (58) The rate of recurrent laryngeal nerve injury was 1% - 6%. (59)

Upon the extraordinary increase in the frequency of papillary Thyroid carcinoma, as well as the advancements in diagnosis and treatment which generated world-wide clinical controversies, the ATA once again took center stage and published updated guidelines in 2015, aiming to provide the most current evidence to the medical community. These guidelines included recommendations for fine-needle aspiration biopsies (FNAB), management of indeterminate cytologies using molecular tests. Reassurance of surgical treatment goals for patients with medium and low-risk tumors 1 - 4 cm in size were made. Prophylactic central lymph node dissection for T3 and T4 tumors, patients with lateral cervical lymph node metastasis, or high-risk tumors. The guidelines also introduced a dynamic risk recurrence classification system, categorizing patients as high, medium, or low risk, allowing for selective I<sub>131</sub> treatment and evaluating response to treatments based on biochemical, structural, or combined criteria. Additionally, patients with medium and high risk were reclassified one year after treatment. (60)

In summary, the 20th century brought technological advances and better results, including improvements in surgical technology such as endoscopic instruments, fine suturing, and dissection techniques according to the approach that reduced complications and improved patient postoperative experiences.

The 21st century marked the digital age, characterized by the globalization of information, homogenization, and democratization of ideas, with advances disseminated worldwide almost instantly, and increased interconnectedness.

Advancements in Thyroid carcinoma surgery aimed to reduce surgical morbidity and achieve safer surgery while decreasing cancer-related mortality through timely diagnosis. These include:

- The widespread use of neck ultrasound and FNAB for the detection of smaller carcinomas, (62) the introduction of TIRADS to estimate nodule malignancy risk based on ultrasound.
- The Bethesda System predicting malignancy chances for biopsies and the suggested management.
- The use of bipolar and ultrasonic energy to reduce bleeding during and after the surgery as well as surgical time. (63)
- Intraoperative monitoring of the recurrent laryngeal nerve.

The advent of minimally invasive video-assisted Thyroid surgery (MIVAT) resulted in improved cosmetic outcomes,

reduced postoperative pain, and safer procedures. With the intention of avoiding neck scarring, different research groups started implementing non cervical approaches such as: transmammary, transaxillary, behind-the-ear and combinations: transaxillary and transmammary, bilateral transaxillary using endoscopy. The drawback is that this approaches leave scarring in different areas, and its surgical approach didn't match the "minimally invasive" concept. The tracts needed to get to the Thyroid bed are wide distanced, and the risk of injury to an anatomical structure is considerable. For the first time in 2009, an article on the use of robotic assisted surgery is published by the Dr. Sang-Wook Kang and cols. From the Surgery Department at the Yonsei University College of Medicine in Seoul, Korea. From October 4, 2007 through March 14, 2008, 100 patients with papillary Thyroid Cancer underwent robot assisted endoscopic Thyroid surgery using a gasless transaxillary approach. (64) Not satisfied by this, and motivated by critiques made on the body scarring produced by this type of approach, Dr. Witzel et. Al from the Surgery Department, Paracelsus Medical Private University in Salzburg, Austria, published the first transoral sub lingual Thyroidectomy (TOVAT), performed in human and pig corpses with a simple, easy to follow technique, which propitiated its usage as it avoided neck scarring. (65) Thus, on March 18, 2009, Thomas Wilhelm and Andreas Metzger from the Department of Otolaryngology, Head, Neck and Facial Plastic Surgery in Borna, Germany, performed a TOVAT right hemithyroidectomy on a 53 year old male. The surgery was successful, (66) however, this approach implied issues specially related to sloughing of the skin in the neck, which lead to the vestibular approach (TOETVA). In Thailand, 2016, Dr. Angkoon Anuwong M.D., General Surgeon at the Police General Hospital publishes the first 60 cases intervened with this technique, which has had a wide acceptance and is performed by trained surgeons world-wide. (67)

Comparing the results obtained, traditional open surgery shows a definitive recurrent laryngeal nerve injury of 0.64% - 1.3% and definitive hypocalcemia of 0.5% - 5%. On the other hand, the results of minimally invasive approach reported: definitive laryngeal recurrent nerve injury of 0% - 6.3% and definitive hypocalcemia of 0% - 6.7%. The statistics don't differ by a significant amount, however, the increase in costs and surgical time don't benefit the latest technologies. (68)

The global increase in the diagnosis of Thyroid Papillary Cancer, specially Micropapillary Cancer makes the actual situation even more complex. Different approaches have been proposed, for instance, in 1993 Dr. Miyahuchi and Hito in Kobe, Japan decided not to intervene 340 patients with papillary Thyroid carcinoma that was less than 1cm, only those with a growth bigger than 1.2 cm or those who developed cervical lymph node metastasis. 15.9% of the patients were intervened in a 10-year span with no mortality and very low morbidity compared with immediate surgical intervention. (69) These results create the dilemma of intervening or not micropapillary Thyroid carcinomas.

However, alternative non-surgical approaches, like radiofrequency ablation (RFA), have emerged for low-risk Thyroid microcarcinoma patients. A review study on RFA with 1389 patients and 1422 tumors showed complete nodule disappearance in a range of 33.7% to 100%, with longer follow-ups indicating tumor disappearance frequencies of 56% - 100%. (70)

Changes introduced in the 8th edition of the AJCC TNM system reclassified cases from Stage III to Stages II and I, raised the age indicating a poor prognosis to 55 years, and emphasized recurrence over mortality. This has created inconsistencies when compared with the MACIS (Metastasis, Age, Completeness of resection, Invasion, Size) system, making it difficult to determine the results concerning mortality in Papillary Thyroid Cancer patients. (71)

Despite improved technology and new approaches to enhance cosmetic outcomes and maintain low morbidity, similar to traditional techniques, we question whether technological advances have had an actual impact on reducing cancer-related mortality, if they are accessible in lower-income countries, and if most surgeons have access to them.

Moreover, an evaluative and comparative study performed in Mexico in order to determine the applicability of the prognostic factors systems issued in the U.S. Europe and Asia in the Latin American population which established that the heterogeneity between this population groups didn't allow their unification in the determination of the risk between high and low risk patients, concluding it is not viable to adapt in this region.(72) Comparing the A.T.A. and ETA guidelines no conclusion was able to be drawn in the type of surgery recommended on low risk patients. (73)

Last, but not least, in a research developed by Dr. Kitahara C. from the Radiation Epidemiology Branch, Division of Cancer Epidemiology and Genetics, of The National Cancer Institute, Bethesda, Maryland towards the tendency and mortality of Thyroid Cancer in the U.S. between 1974 and 2013 in 77,276 patients demonstrated an increase in Thyroid Cancer of 3% per year, with an increase in the incidence and mortality rate of 2.9% annually, especially for advanced states of Papillary Cancer. (74) It seems like a paradox of microcarcinoma detection, no surgery and increase of bigger tumours. (Personal opinion)

What is the message for the future? It's essential to continue researching genetic and epigenetic factors, environmental influences, and radiation exposure to better understand the genesis of Papillary Thyroid Carcinoma and ultimately prevent and provide appropriate curative treatments. Besides, there is a need to tailor treatment for Papillary Thyroid Cancer patients with the help of tools such as the Dr. Ashok Shaha risk score. (75)

## Conclusions

- Thyroidectomy is a safe procedure when performed by experienced surgeons.
- There has been significant progress in the early detection of Thyroid Cancer.
- Preoperative assessment remains challenging for determining personalized surgical treatment.
- The debate about the appropriate surgical treatment for papillary carcinoma persists.
- There is no standardization of risk factors.
- Technological advances have improved surgical techniques and cosmetic outcomes.
- There is an increase in the expense and surgical time.
- There is a trend toward not operating on microcarcinomas, using alternative ablative treatments, such as radiofrequency ablation (RFA), even though RFA is still experimental.
- There is an increase in the frequency of advanced Thyroid Cancer, with rising mortality.
- Is the new technology likely to make it more difficult for lower-income countries and surgeons to access it?

Paraphrasing Albert Einstein in 1950: This is an era of increase in multiple resources as well as an increase in ill-advised goals.

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