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Modified Neck Dissection in Treatment of Thyroid Cancer: A Safe Procedure

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Abstract—*Differentiated carcinoma of the thyroid metastasizes early and frequently to cervical lymph nodes. Radical neck dissection performed electively or therapeutically results in high cure rates. Modified neck dissection consisting of a single transverse incision, resection of the jugular chain of nodes and those in the posterior triangle of the neck with preservation of the sternomastoid muscle, the spinal accessory nerve and the submandibular salivary gland provides a cosmetic, functional result with minimal morbidity. In a series of 313 neck dissections for thyroid carcinoma, only three patients with papillary or follicular carcinoma, which was resectable, treated by thryoidectomy and modified neck dissection died of disease.*

INTRODUCTION

NECK DISSECTION plays an important part in the treatment of differentiated carcinoma of the thyroid. When nodal metastasis is present the performance of an adequate resection of the lymph nodes increases the prospects of prolonged disease-free survival. The operation has been modified and can be done with excellent cosmetic and functional results and with minimal morbidity and mortality.

METHODS AND MATERIALS

In a 35 year period (1952–1986) the author operated on 874 patients for thyroid carcinoma. Of these, 828 were differentiated tumors (703 papillary, 90 follicular, 17 medullary and 18 Hurthle cell cancers). There were 15 lymphomas, 28 cases of anaplastic cancer and three had metastatic lesions in the thyroid gland. Three hundred and thirteen of these patients had neck dissections in addition to thyroidectomy. In six additional patients metastatic nodes were locally excised. The number of patients in whom neck dissections were performed in each 5 year period is shown in Fig. 1.

My technique of radical neck dissection gradually evolved during the past 35 years. In the first few cases the standard radical neck dissection was performed through two transverse incisions. In 1957 I started to perform the procedure through a single transverse incision [1]. The operative technique was gradually modified over the years; the current approach is to resect the jugular chain of lymph nodes, the contents of the posterior cervical triangle and the median nodes along the trachea with preservation of the submandibular gland, the sternomastoid muscle, the spinal accessory nerve and the sensory branches of the cervical plexus.

In the 313 cases of neck dissection, there were 207 females and 106 males (2 : 1 ratio). The ages ranged from 6 to 86, with a peak incidence between 20 and 40. The mean age was 38.

Neck dissections were done in 158 patients with palpable nodes in the lateral neck. In four patients nodes became palpable after an interval of 4 months to 3 years following thyroidectomy. In 20 patients bilateral neck dissections were performed, 10 in one-stage and 10 with an interval of 3 months to 4 years between the operations. Of the 313 neck dissections, 155 were done electively (i.e. no palpable nodes). In this group there were 110 with positive nodes (71%) (Table 1). The age incidence of patients with involved nodes is shown in Fig. 2.

The largest number of neck dissections were done for papillary carcinoma—287, of which 155 were elective and 132 therapeutic. There were nine neck dissections done for follicular carcinoma, 11 for medullary carcinoma, five for anaplastic and giant cell cancer and one for a Hurthle cell carcinoma (Table 2).

RESULTS

In a personal series of 313 modified neck dissections for carcinoma of the thyroid there were no post-operative mortalities, no wound infections, one instance of post-operative hemorrhage requiring re-operation, no chyle leaks, no cases of pneumothorax

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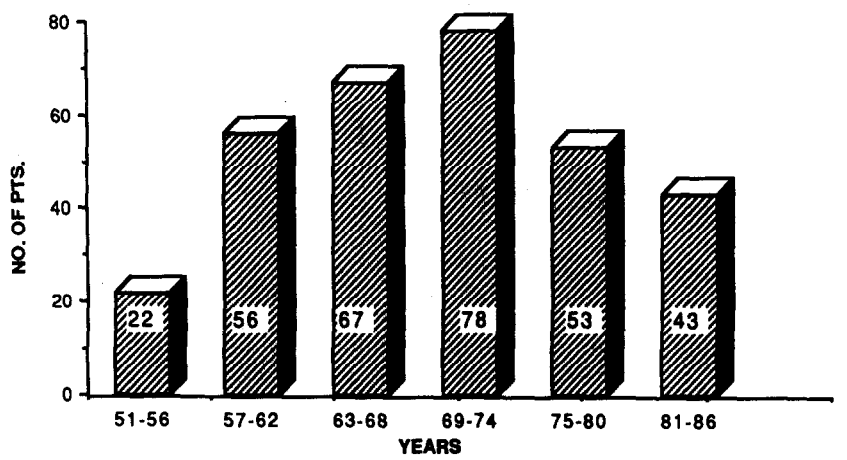

Fig. 1. Number of neck dissections performed by 5-year periods.

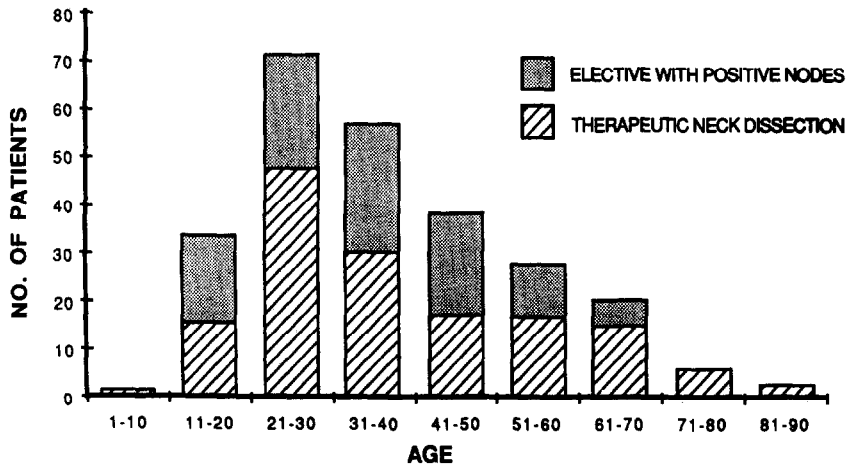

Fig. 2. Age incidence of positive node involvement in patients having neck dissections.

Table 1. Neck dissections in thyroid cancer 1952–1986

Therapeutic neck dissection			158
Primary and nodes palpable		92	
Primary not palpable—nodes palpable		42	
Bilateral neck dissection		20	
Neck dissection after an interval		4	
Elective neck dissection			155
Positive nodes		110 (71%)	
Jugular nodes only	35		
Jugular and paratracheal nodes	59		
Paratracheal nodes only	16		
Negative nodes		45 (29%)	
		Total	313

Table 2. Pathology in neck dissections for thyroid cancer

Papillary	287
Follicular	9
Medullary	11
Anaplastic	5
Hurthle cell	1
Total	313

and no wound dehiscence. In 20 patients, bilateral neck dissections were performed, 10 as one-stage procedures. In three patients both internal jugular veins were resected; only one of these patients developed significant facial edema which resolved completely after about 2 years.

Of the 313 patients in the series 24 died of unrelated causes. Seventeen patients died of thyroid carcinoma: five of these had anaplastic lesions at the time of surgery and survived less than 6 months; in two fatal cases the neck dissection was done for medullary cancer; there was one death in a patient with follicular carcinoma who had lung metastasis at the time of operation. Nine of the fatalities were in patients with papillary carcinoma: three of these had bilateral neck dissections for nodal disease that was massive and bilateral; of the other six, two were treated for recurrent disease after failure of surgery done elsewhere—the other four fatal outcomes were in patients presenting with extensive local disease

Table 3. Results of neck dissections in thyroid cancer

Died of other causes	24
Died of disease	17
Lost to follow up after 10 years +	13
Living with disease	5
Free of disease 1–32 years	254
Total	313

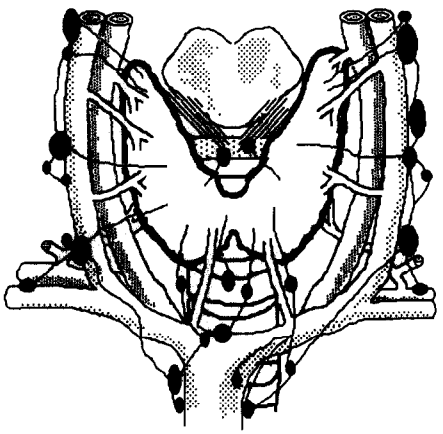

Fig. 3. Lymphatics of the thyroid gland (computer drawing by Dr. Attie).

which could not be completely resected, who died 4 months to 2 years post-operatively of uncontrolled disease in the thyroid region. Thirteen patients were alive and free of disease when last seen and lost to follow up before 10 years. Three patients with medullary cancer are living with metastatic disease. Two patients treated for papillary cancer are alive with local recurrent disease 9 and 26 years after their initial surgery. The remaining 258 patients are living and well from 1 to 32 years (Table 3).

DISCUSSION

Anatomy of lymphatics of the thyroid

The lymphatic drainage of the thyroid gland is very rich and generally runs in superior, lateral and inferior directions, following the branches of the superior thyroid vessels, the inferior thyroid artery and the inferior and middle thyroid veins (Fig. 3).

The superior pathways drain the upper pole regions as well as the medial aspects of the lobes adjacent to the isthmus and the pyramidal lobe when present. These terminate in precricoid and upper and middle jugular lymph nodes. The lateral lymphatic pathways follow the middle thyroid veins to drain into the nodes in the middle and lower jugular chain. The inferior pathways drain into either the pre- and paratracheal nodes or the lower jugular nodes.

Less commonly lymphatic drainage may pass into retropharyngeal nodes, the nodes in the superior mediastinum in the region of the thymus, and in rare instances the submandibular lymph nodes.

Table 4. Involved nodes in thyroid cancer

Positive nodes in 329 neck dissections	268
Paratracheal nodes positive—no RND	89
Jugular nodes locally excised	6
Total	363

There is a rich intraglandular lymphatic network with free communication between the two lobes. Lymph drainage from one thyroid lobe to nodes on the opposite side of the neck is not infrequent.

Pathology of lymph node metastasis in thyroid carcinoma

Metastases to regional lymph nodes occur often and early in differentiated thyroid cancer. In our series of 828 differentiated thyroid cancers operated upon, the lymph nodes were involved in 363 cases (44%) (Table 4). Nodal involvement is most common in the papillary carcinomas—up to 80% of adults and children with papillary cancer have positive nodes at some time during their course; nodal metastasis also occurs in medullary, follicular and Hurthle cell cancers. The pathological types of thyroid cancer in which neck dissections were performed are shown in Table 2.

The smallest tumor may give rise to numerous lateral and/or paratracheal nodes. On the other hand, a tumor may attain a large size, be present for many years and directly invade neighboring structures without nodal involvement. The patterns of nodal metastasis are unpredictable and may be independent of either the size or location of the primary.

An enlarged node may be the first clinical manifestation of thyroid carcinoma the primary tumor being non-palpable and extremely small. This condition was known for many years as 'lateral aberrant thyroid carcinoma'. I have operated on 42 such patients where the primary tumor was not palpable; in all these cases the primary lesion was found in the thyroid gland. In some cases the involved lymph nodes may remain apparently unchanged for many years without treatment; we have seen some that only enlarged after as long as 30 years in dormancy. The metastatic node may be cystic and diagnosed clinically as a branchial cyst.

At times, there may be one node invaded and simple removal of the node resulted in long disease-free survival (I have operated on three such cases with follow up without recurrence after 8, 20 and 30 years). This phenomenon explains the success of the node-plucking method advocated by Crile [2]. However, Crile admitted that one of his patients needed as many as 22 procedures to become disease-free.

Nodes involved by thyroid cancer are usually

discrete and mobile for many years without extracapsular invasion. The lateral nodes often reach large size without invasion of the jugular vein, sternomastoid muscle or the tenth and eleventh cranial nerves. In my experience the paratracheal nodes have a greater tendency to invade neighboring structures than do the jugular nodes. Thus there may be early invasion of the recurrent laryngeal nerves, trachea, cricoid cartilage or esophagus.

In contrast to other head and neck cancers, carcinoma of the thyroid rarely involves nodes in the submaxillary triangle. I have only seen it in one patient, an 18-year-old with massive bilateral nodal involvement. Frazell and Foote [3] noted only one instance of submandibular node involvement in 67 patients having elective neck dissections. Haagensen *et al.* [4] report submandibular involvement in four of 111 patients having neck dissections; all four had massive nodal invasion.

The total number of nodes removed during neck dissections and the percentage involved by tumor varies. Haagensen *et al.* [4] cleared 111 radical neck specimens and counted a total of 5118 nodes, an average of 48 nodes per neck; 778 of these proved to be positive (15%).

Rarely, papillary thyroid cancer will spread via the blood stream without involvement of lymph nodes. It is not known whether the disease will metastasize to distant sites from lymph nodes containing tumor.

Neck dissection in the treatment of thyroid cancer

The first radical neck dissection performed by Crile [5] was for treatment of thyroid cancer. During the early part of the century the trend was to perform more radical operations for cancer. The general belief was that resection of the primary tumor, the regional lymph nodes and the intervening tissues *en bloc* constituted a 'cancer operation' and enhanced chances for a cure. Such operations as radical mastectomy, the combined operation for oropharyngeal cancer (commando operation), and resection of melanoma with the regional nodes and intervening tissues became standard procedures. Subsequently, it was noted that resection of the primary lesion and the appropriate lymphadenectomy performed in discontinuity or at separate sittings with no attempt to resect the intervening tissues did not seem to alter the survival or recurrence rates.

The standard radical neck dissection consisted of removal of the contents of the posterior triangle of the neck, the jugular chain of lymph nodes with sacrifice of the vein, resection of the contents of the submandibular triangle including the nodes along the mandible, the nodes in the tail of the parotid plus the nodes along the spinal accessory nerve. The operation included sacrifice of the sternomastoid muscle, the eleventh nerve and the cervical plexus except for the phrenic nerve. The so-called standard radical neck dissection was applied to all types of cancers of the head and neck, such as carcinoma of the mouth, pharynx, larynx, thyroid gland, salivary glands and skin of the face and neck (including melanoma). The same operation was performed whether or not there were clinically involved nodes, and whether it was done in continuity with the primary or as an isolated procedure.

In order to gain access to all parts of the neck numerous incisions were devised (Fig. 4). The earliest modifications were to utilize cosmetic and more functional incisions while removing essentially the same amount of tissue. Most surgeons today use only transverse incisions.

Gradually, it became apparent that variations were necessary in order to tailor the operation to different tumors. In most cancers, unless there was massive involvement of the lymph nodes, the spinal accessory nerve could be preserved. In rare instances a short segment of the nerve may have to be resected; a direct anastomosis or nerve grafting can be performed. The nodes within the submandibular triangle need not be removed in thyroid cancer since they are rarely involved. The sternomastoid muscle is almost never invaded in thyroid cancer, even with extensive nodal disease. By dissecting the sternomastoid free in its entire length and dissecting beneath it, a complete neck dissection can be performed without sacrificing the muscle (Fig. 5). Some surgeons divide and re-suture the muscle, but we have not found this necessary.

The internal jugular vein may or may not be resected in the modified neck dissection. In most cases I prefer to sacrifice the jugular vein in a unilateral neck dissection. The reason for this is that often the nodes are closely adherent to the vein and may lie behind it. Sometimes there is metastasis to a node deep behind the lower end of the vein which in some cases is not seen until after the vein is divided. There are three situations in which an attempt should be made to preserve the internal jugular vein: (1) when performing a second side neck dissection; (2) if the internal jugular vein is very large (often compensatory for a small vein on the opposite side); (3) in patients with short, thick necks. In the operation performed for thyroid cancer, the thyroid veins, the anterior and external jugular veins and the transverse cervical veins are resected. Removal of both internal jugular veins in these patients reduces the collateral blood supply to the vertebrals and small muscular vessels which are often not sufficient. In such instances there is often massive edema of the face and neck ('moon-face'), marked congestion of the remaining vessels and sometimes increased cerebrospinal fluid pressure.

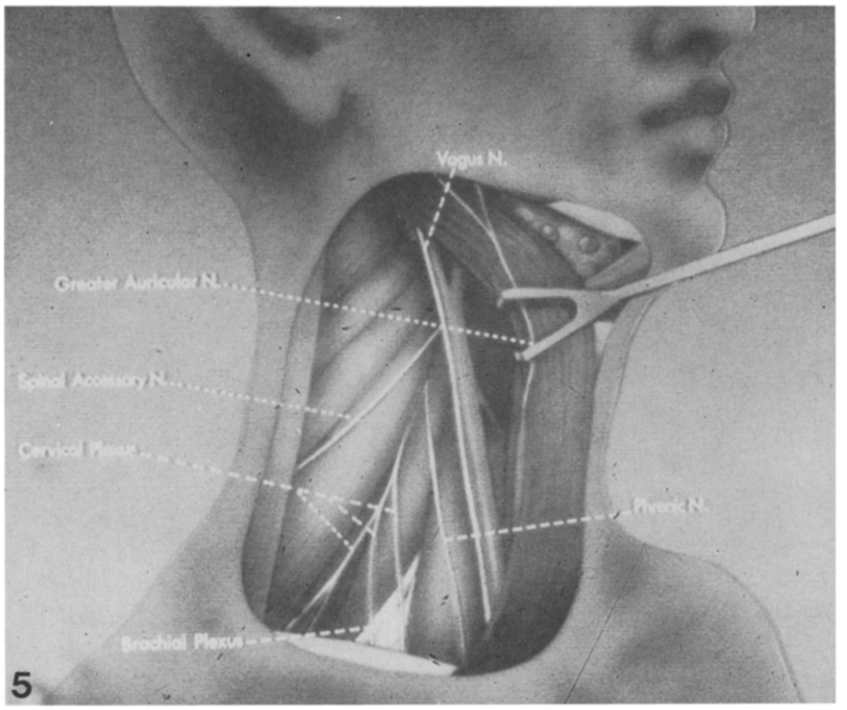

Fig. 5. Retraction of sternomastoid muscle permitting a 'complete' neck dissection without sacrificing the muscle.

Fig. 6. Appearance of wound at completion of modified neck dissection with preservation of sternomastoid muscle, spinal accessory nerve and cervical plexus.

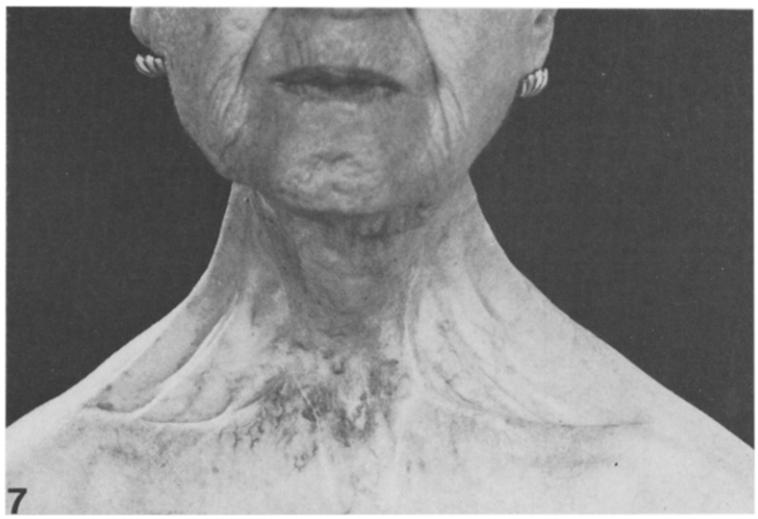

Fig. 7. Scarring, deformity, edema and venous congestion resulting from bilateral radical neck dissection utilizing double-Y incisions and sacrificing both internal jugular veins, sternomastoid muscles and spinal accessory nerves.

Fig. 8. Appearance of patient following modified neck dissection through single transverse incision (1 week postoperatively).

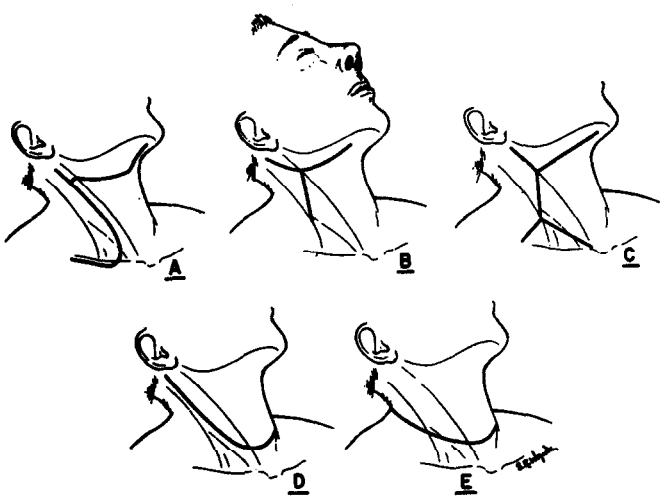

Fig. 4. Incisions used in radical neck dissections. A. Semken incision. B. Brown and McDowell incision. C. Martin incision. D. Eckert and Byars incision. E. Attie incision (described herein). (from Surgery 1957, **41**, 492–502).

In selected cases (early or elective neck dissections) I have been able to preserve most of the sensory branches of the cervical plexus. This includes the greater auricular and the supraclavicular branches; only the transverse cervical branch is sacrificed (Fig. 6).

In summary, the modified radical neck dissection for thyroid carcinoma consists of resection of the pre- and paratracheal nodes, the entire jugular chain with or without sacrifice of the vein, the contents of the posterior triangle of the neck and removal of the anterior mediastinal nodes via the cervical incision. The sternomastoid muscle, the spinal accessory nerve, the submandibular triangle contents and often the cervical plexus branches are preserved. The entire procedure is performed through a single tranverse incision parallel to the clavicle. The result is a cosmetic and functional neck dissection leaving no defect or disability.

When involved lymph nodes in the mediastinum beyond the reach of the neck incision are encountered at operation or seen in C.A.T. or M.R.I. scans they are resected through a sternotomy either at the same or a subsequent procedure.

In an experimental study in dogs, Dayal and DeSilva [6] compared the lymph node yield in a standard neck dissection with that in a 'functional' one (sparing the sternomastoid, the internal jugular vein and the spinal accessory nerve). They found that the mean number of nodes removed in the two procedures was identical. The clinical experience of most authors has been that the modified neck dissection is as effective as the standard operation in long-term survival and in preventing recurrence [7, 8].

Influence of lymph node involvement on prognosis

The involvement of lymph nodes in papillary cancer of the thyroid does not necessarily increase the risk of distant metastasis. Thus, it differs from other head and neck cancers, where the disease progresses from local involvement to node metastasis when larger and to distant metastasis when neglected. Follicular carcinoma will often spread to bone or lung without first (or ever) invading lymph nodes. On rare occasions, papillary cancer will spread via the blood stream in the absence of nodal involvement.

The relationship of nodal involvement with differentiated thyroid cancer to prognosis is debatable. Cady [9] studied 792 patients with differentiated thyroid cancer. His study suggested that patients with involved nodes had a better survival than those with negative nodes and survival was proportional to the number of nodes involved. The number of metastatic nodes was inversely proportional to age. In a subsequent paper from the Lahey Clinic [10] it was reported that involvement of lymph nodes increased recurrence rates but did not affect survival. Like other authors, they found no difference in survival between patients treated by standard neck dissection and those having modified dissections.

Other authors reported worse prognosis in patients with nodal involvement when compared to those without nodes. Harwood [11] compared the survival of 50 patients who had negative nodes with 50 who had positive nodes in differentiated thyroid cancer. Twenty-four per cent of patients with nodal involvement at initial examination died of thyroid cancer, whereas only 8% of those without nodes died of the disease. They demonstrated that nodal disease had an adverse effect on prognosis, especially in older patients (41% of patients over 40 with involved nodes died of thyroid carcinoma). Mackenzie [12] reported a higher incidence of recur-

Table 5. Positive nodes in elective neck dissections

Author	No. of cases	Percentage
Jude	52	21
Block	26	31
McGoven	16	43
Frazell	67	61
Attie	155	71
Noguchi	33	82

rence in patients with nodal involvement treated by limited node excision (36%) than those having radical neck dissection (9%). In both groups, however, recurrences were successfully treated. Mazzaferri *et al.* [13] reviewed a series of 576 papillary thyroid cancers treated surgically. Of these, 46% had involvement of regional lymph nodes; 233 (40%) of the patients had some form of neck dissection. In their series, there was a slight increase in recurrence and fatality rate in the group having lymph node metastasis, the type and extent of the neck dissection performed did not seem to affect prognosis. McGregor *et al.* [14] reported on 77 patients with well-differentiated thyroid cancer and proven lymph node metastasis. Of 33 patients with limited nodal involvement (less than 10 nodes) 26 had less than a modified neck dissection; 35% recurred and two died of disease. Of 44 patients with extensive nodal involvement (more than 10 nodes), 24 had limited neck dissections; 50% recurred and six died of disease.

Indications for neck dissection in thyroid carcinoma

There is general agreement that when lymph node metastasis is clinically evident, some form of radical neck dissection is indicated. As stated above, our preference is for a modified neck dissection which is cosmetic and functional. A large percentage of patients with papillary cancer of the thyroid have lymph node involvement at some time during the course of their disease. The incidence of lymph node metastasis in clinically negative necks has been variously reported. Many surgeons have advocated and performed elective neck dissections [15] in patients with unilateral, invasive papillary cancers 2 cm or greater is size. The incidence of positive nodes ranged from 21 to 82% (Table 5).

Patients with papillary thyroid cancer in whom no elective neck dissection was performed developed nodes at a later time in 7–15% of cases [16–18]. Postponement of the neck dissection until nodes became palpable or when histologically proven did not seem to affect prognosis. Consequently, since 1983 I have not routinely performed elective neck dissections. Following the suggestion of Rosen and Maitland [19], I expose the jugular chain during thyroidectomy for thyroid cancer and biopsy any enlarged or suspicious nodes on the side of the tumor. If the nodes are positive, a modified neck dissection is done at a later time.

The extent of the neck dissection varies to some degree depending on the extent of disease. If the involved nodes are small or moderate in size and show no extracapsular invasion the operation described above, preserving the muscle, eleventh nerve and sensory nerves is performed. In rare cases with extensive disease and invasion beyond the nodes the involved structures are sacrificed.

Essentially the same operation is utilized in the treatment of papillary, follicular and Hurthle cell cancers that spread to lymph nodes. In medullary carcinoma, however, the tumor is more aggressive and the standard neck dissection may be required. In MEN II cases with tumours of significant size elective neck dissection may be indicated.

Because of the unpredictable pattern of dissemination in papillary cancer, the finding of positive nodes in the paratracheal, pretracheal or precricoid areas is not an indication for lateral neck dissection even though jugular nodes are more likely to contain tumor in these patients. In my series, there were 75 patients with positive paratracheal node involvement who had elective neck dissections; in 59 cases the jugular nodes were also involved while in 16 patients the jugular nodes were negative. An additional 84 patients had positive paratracheal or Delphian nodes and did not have a lateral node dissection. None of these subsequently developed clinical nodes in the jugular chain in a one to 34 year follow-up.

Risks and complications of radical neck dissection

In the early part of the century radical neck dissection was only occasionally performed with reported mortality rates varying from 10 to 14% [20]. The causes of death were listed as pneumonia, hemorrhage and uremia. As the procedure became more widely used and practiced by surgeons limiting their practices to the surgery of the head and neck the safety of the procedure became established. Martin *et al.* in 1951 [21] reported on 100 radical neck dissections performed for various diseases with no post-operative mortality. They stated that mortality from neck dissection should not exceed 1–2%. From 1952 to 1986 I have performed 313 radical or modified radical neck dissections for thyroid carcinoma without mortality.

Many complications have been reported following radical neck dissection. These can be divided into those due to the operative procedure *per se* and those that represent sequelae resulting from deliberate sacrifice of anatomical structures.

The type of incision used has caused some problems. Vertical incisions or extensions may cause contractures or form keloids and restrict neck

motion, aside from aesthetic objections. Multiple incisions or those having angles or trifurcate portions may dehisce or necrose due to poor blood supply; such wounds, aside from prolonged morbidity, may jeopardize exposed carotid arteries. Use of transverse incisions, and preferably the single transverse incision [1] avoids these complications.

Meticulous hemostasis will avoid post-operative hemorrhage. Serous collections are common following neck dissections; suction under the flaps for a few days minimizes the problem. Infection post-operatively is rare unless openings are made into the trachea, larynx or esophagus. In such cases antibiotics, temporary tracheostomy and naso-gastric feedings are used.

Structures encountered during the procedure may be sacrificed if invaded by tumor. The only consequence of trauma to the vagus nerve on one side of the neck is hoarseness due to vocal cord paralysis. Bilateral vagal injury, however, is more serious; in addition to bilateral cord injury, cardiac and gastro-intestinal problems may result. Division of the sympathetic trunk causes Horner's syndrome. Phrenic nerve injury causes elevation of the diaphragm on that side. Laceration of the carotid artery can usually be repaired—ligation of the internal or common carotid artery can result in hemiparesis or death.

Injury to the thoracic duct if unrecognized during the operation may lead to chylous collections in the wound, chylous fistula or chylothorax. Although the chyle leak will usually close spontaneously it may persist for many months, leading to severe dehydration and inanition due to loss of nutrients. Chylothorax can lead to pulmonary and mediastinal complications. Re-operation and ligature of the thoracic duct or occlusion by suture will relieve the condition.

Unilateral or bilateral pneumothorax has been described following radical neck dissection. Bowden [22] reviewed a series of 18 cases with two deaths. In only one patient was the pneumothorax due to trauma to the apex of the pleura protruding into the neck wound; in the other patients the probable cause was exposure of the superior mediastinum during a period of respiratory tract obstruction with an increased inspiratory effort. If recognized and treated early (aspiration or under-water drainage of the pleural cavity) there are no after effects.

Simultaneous (and rarely, non-synchronous) bilateral radical neck dissection with sacrifice of both internal jugular veins may lead to serious consequences. Insufficient venous drainage of the head and neck may lead to marked edema and cyanosis causing great discomfort, unsightly swelling and respiratory distress due to laryngeal edema (Fig. 7). Increased cerebro-spinal fluid pressure may lead to lethargy, unusual behavior and coma. Decreased visual acuity and even sudden permanent blindness [23] have been reported. Staging the two neck dissections reduces the risk. Preferably, at least one of the internal jugular veins should be preserved. Tracheostomy may be needed in bilateral operations. Elevation of the head to improve drainage, cortisone to reduce edema and spinal tap if rise in CSF occurs are important therapeutic measures.

Standard radical neck dissection included resection of the spinal accessory nerve. This led to loss of trapezius function and often resulted in serious cosmetic and functional sequelae. There were varying degrees of shoulder drop, loss of abduction of the upper extremity, and in severe cases, we have seen dislocation of the sternoclavicular joints and in one instance fracture of the clavicle. The marked asymmetry is aggravated by the defect resulting from resection or atrophy of the sternomastoid muscle. To avoid these objectionable sequelae we advocate and perform a modified neck dissection in which the muscle and the nerve are preserved intact.

The cosmetic transverse incision and the preservation of the sternomastoid muscle and the eleventh nerve produce a very acceptable result, appearing hardly worse than a thyroidectomy (Fig. 8). Many patients complain of numbness due to loss of the cervical plexus branches, especially in the ear lobule from sacrifice of the greater auricular nerve. During the past four years I have successfully preserved the cervical plexus branches, especially in patients with limited lymph node involvement.

SUMMARY AND CONCLUSIONS

1. Lymphatic drainage of the thyroid gland is rich going into paratracheal, mediastinal, jugular and supraclavicular nodes.
2. Lymphatic spread of thyroid carcinoma is unpredictable, occurs early in differentiated cancer and may be present for long periods without affecting prognosis.
3. The preferred treatment of proven metastatic thyroid cancer in lymph nodes is modified neck dissection.
4. Modified neck dissection is a safe procedure.
5. In a series of 313 neck dissections performed for carcinoma of the thyroid, only three patients with papillary or follicular carcinoma of the thyroid which was resectable, not previously operated upon and treated by thyroidectomy and modified neck dissection died of the disease.

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