Hypothesis: Reoperation benefits patients with locoregional, persistent, or recurrent medullary thyroid cancer (MTC). Currently available localizing studies have limited utility for detecting all foci of residual MTC.

Design: A retrospective study with a mean follow-up time of 7.5 years (median, 13 years; range, 2.2-29 years).

Setting: A tertiary referral medical center.

Patients: Thirty-three patients who underwent 46 reoperations for locoregional residual MTC.

Results: Sixty-four percent of residual MTC was located in the lateral cervical nodes, 22% in the central cervical nodes or thyroid bed, and 14% in the anterior mediastinum (197 of 1128 nodes resected were positive for MTC). After reoperation, basal calcitonin levels were undetectable in 2 patients, reduced by greater than 50% in 10 patients, and either increased or were not reduced by greater than 50% in the remaining patients. On reoperation, one patient had a thoracic duct injury that required reexploration and ligation. Patients who had a greater than 50% decrease in calcitonin levels after reoperation were less likely to develop distant metastases compared with patients who did not have a greater than 50% decrease (P<.05). The sensitivities of magnetic resonance imaging (n=31), computed tomographic scan (n=16), ultrasound (n=9), and dimercaptosuccinic acid scan (n=3) were 91%, 86%, 88%, and 100%, respectively.

Conclusions: Although reoperation in patients with residual MTC rarely results in biochemical cure, cervical reexploration is safe and in selected patients may limit MTC progression. Lateral cervical node dissection could be beneficial at the time of initial surgical treatment because of the high frequency of residual MTC in the lateral cervical nodes. Noninvasive imaging studies were helpful but far from perfect for guiding the reexploration for locoregional residual MTC.

Arch Surg. 2000;135:895-901
PATIENTS AND METHODS

Between 1971 and 1998, 33 patients underwent locoregional reoperation for persistent or recurrent MTC at the University of California, San Francisco (UCSF) hospitals. Persistent MTC refers to patients who had an elevated postoperative plasma calcitonin level. Recurrent MTC was defined as new evidence of locoregional or distant MTC in which the basal postoperative plasma calcitonin level was normal after initial surgical resection for at least 6 months. Residual MTC in this report refers to either persistent or recurrent MTC.

Medical records, including operative notes, pathology reports, and localizing imaging study results were reviewed. Follow-up information was obtained from clinic visits and through the UCSF Cancer Registry. On follow-up and prior to undergoing locoregional reexploration for residual MTC, all patients had preoperative chest radiographs and most patients routinely had a computed tomographic (CT) scan or magnetic resonance imaging (MRI) of the chest to identify MTC lung metastasis. Furthermore, patients with residual MTC had a preoperative abdominal CT scan to detect liver metastasis as well as measurements of liver function tests in some patients. In patients with symptoms suggesting bony metastasis or patients with highly elevated plasma calcitonin, a bone scan was done. The type of MTC was classified into 4 groups: sporadic MTC, familial non-MEN MTC, MEN 2A or MEN 2B, as previously described. Within 4 months after reoperation, all patients had at least their basal plasma calcitonin level measured, and some had stimulated plasma calcitonin level measurement(s). Patients with elevated postoperative calcitonin levels were considered to have residual MTC. During the study period, different biochemical assays for calcitonin measurement were used. Therefore, the percent reduction of plasma calcitonin after reoperation was used (percent calcitonin reduction = [1 − basal postoperative calcitonin level / basal preoperative calcitonin level] × 100%).

A similar technique of cervical lymphadenectomy as described by Tissel et al., Dralle et al. and Moley et al. was used, although we prefer to preserve normal parathyroid glands in situ rather than autotransplanting them. Central neck node clearance consisted of the removal of lymphatic and fibrofatty tissue from the carotid sheath (laterally) and hyoid bone (superiorly) to the clavicle (inferiorly), removing upper mediastinal tissue through a cervical incision. Modified radical neck dissection (functional) with or without mediastinal lymphadenectomy refers to resection of tissue from the hyoid bone (superiorly), the trapezius muscle (laterally) to the clavicle, and anterior mediastinum (inferiorly). Patients who had residual MTC in the deep anterior mediastinum identified by localizing studies had a median sternotomy performed in addition to cervical reexploration.

The accuracy of the localizing studies were determined by comparing the results of the imaging study with those of the pathologic examination of the resected specimen. Because all of the patients had MTC, the specificity of the localizing studies is undefined (ie, no true-negative results). We evaluated the influence of several clinical and pathologic factors on the outcome of reoperation for residual MTC. The Student t test was used for continuous variables, and the Fisher exact and \( \chi^2 \) tests were used for categorical data.

RESULTS

Thirty-three patients underwent a total of 46 locoregional reoperations for persistent (n = 29) or recurrent (n = 4) MTC. The indications for reoperation in patients with residual MTC were (1) increasing hypercalcitoninemia (59%); (2) local symptoms (28%); and (3) pal-
After initial surgical treatment, residual MTC, manifested by elevated plasma calcitonin levels (basal or stimulated), is unfortunately common in patients with clinically evident MTC and remains a frustrating clinical dilemma. All of these patients should undergo an extensive workup for metastatic MTC. It remains unclear whether patients with biochemical evidence of residual MTC should be closely observed until MTC is identified by various localizing studies, or whether an aggressive surgical approach consisting of locoregional removal of all lymphatic and soft tissue should be done in the central, ipsilateral, or both lateral neck compartments.4,13-15 Although to our knowledge there have been no prospective studies comparing observation with reoperation, several investigators have documented that both approaches are reasonable. Van Heerden et al16 documented that patients who had apparently curative surgical treatment with residual MTC and no identifiable MTC may enjoy a long survival time. In contrast, others have reported that reoperative meticulous “microdissection” may lead to biochemical normalization in about a third of patients with occult residual MTC.13-15 Our study offers a longer follow-up time than previous studies evaluating results of reoperation for residual MTC.13-15 We believe that a longer follow-up time is imperative to evaluate the benefit of reoperation because MTC is generally a slow-growing tumor, and residual MTC may occur later. Our surgical approach in patients with residual MTC has been to first determine if an adequate initial surgical resection was done (ie, at least a total or near-total thyroidectomy with bilateral central neck node clearance).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Persistent MTC</th>
<th>Recurrent MTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, M/F</td>
<td>17/12</td>
<td>4/0</td>
</tr>
<tr>
<td>Average age, y</td>
<td>38.7</td>
<td>56</td>
</tr>
<tr>
<td>Sex, M/F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average age, y</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMMENT**

**Clinical and Pathologic Characteristics of Patients Undergoing Reoperation for Persistent and Recurrent MTC**

- **MTC** indicates medullary thyroid cancer. Values represent number of patients unless otherwise indicated.
- **Symptomatic** refers to patients who had a cervical mass, or complained of neck pain, dysphagia, and hoarseness attributable to locoregional residual MTC.
- **Palliative** refers to patients who had local symptoms from locoregional residual MTC in the setting of known MTC distant metastases.

<table>
<thead>
<tr>
<th>Type of MTC</th>
<th>Persistent MTC</th>
<th>Recurrent MTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sporadic</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td>Familial</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>MEN 2A</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>MEN 2B</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indications for reoperation</th>
<th>Persistent MTC</th>
<th>Recurrent MTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypercalcitoninemia</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Symptomatic†</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Palliative‡</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TNM stage</th>
<th>Persistent MTC</th>
<th>Recurrent MTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>III</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lymph node metastasis</th>
<th>Persistent MTC</th>
<th>Recurrent MTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distant metastasis</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dead/alive</th>
<th>Persistent MTC</th>
<th>Recurrent MTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/25</td>
<td></td>
<td>0/4</td>
</tr>
</tbody>
</table>

Additional tables and data are provided in the original document.
In patients who had lesser procedures, we have performed locoregional reoperation removing any remaining thyroid tissue as well as cervical and upper mediastinal lymph nodes. If the initial surgical treatment was at least a total or near-total thyroidectomy with central neck node clearance, the following were indications for reoperation: (1) increasing plasma calcitonin levels with or without residual MTC localized by imaging studies, or (2) the presence of symptomatic locoregional residual MTC with or without metastatic MTC.

The normalization of calcitonin levels after locoregional reoperation in our study was lower (10.5% of asymptomatic patients with hypercalcitoninemia) than that reported by other investigators, but our study had a longer follow-up time.11-13 This emphasizes that a long follow-up time is necessary before patients can be assured of being “cured” of MTC after reoperation for residual MTC.10 Interestingly, patients with residual MTC who had a greater than 50% reduction in the plasma basal calcitonin levels after reoperation were less likely to develop distant metastases. Although this may reflect a selection bias, there was no statistically significant difference in the absolute calcitonin levels before reoperation, stage of MTC, or length of follow-up time. This suggests that reoperation in patients with locoregional residual MTC may limit MTC progression. Furthermore, we found that reoperation for symptomatic locoregional residual MTC was effective in relieving symptoms, and may potentially prevent later airway compromise and death by suffocation in these patients. The former is consistent with the findings of other investigators who evaluated reoperation for residual MTC in palliating symptomatic metastatic MTC.17

Complication rates from locoregional reoperation for residual MTC have been reported to range from 5% to 14% and have mainly consisted of recurrent laryngeal nerve injury, hypoparathyroidism, and thoracic duct injury.15-17 Our complication rate was lower than that of most reports. This would suggest that the benefit of reoperation for residual MTC outweighs the low risk of reoperative morbidity and mortality. Such low morbidity and mortality rates have been observed by experienced surgeons. Therefore, these patients should be referred to institutions experienced with reoperative thyroid surgery.

We and other investigators have documented that the initial extent of thyroidectomy is an important factor in the risk of residual MTC and the prognosis of patients with MTC.11,18,19 Compared with lesser procedures, total thyroidectomy and central neck node dissection is associated with a lower risk of residual MTC, improved survival, and the need for fewer reoperations.11 Cervical node dissection, therefore, has a therapeutic role for MTC and allows for more than just accurate staging of MTC. Some patients, however, continue to be treated with inadequate initial surgical resections. Even when total thyroidectomy with central neck node clearance is used, a higher than acceptable rate of residual MTC has been observed.11 The extent of MTC lymph node involvement at the time of resection cannot be reliably determined intraoperatively to guide the optimal extent of cervical node dissection required. This is best exemplified in a study by Moley and DeBenedetti,10 who reported a sensitivity of 64% and specificity of 71% for an experienced surgeon to accurately identify MTC lymph node metastases. Furthermore, even small primary MTC foci are associated with up to 80% ipsilateral cervical node and 44% contralateral node MTC metastases.10 On reoperation, we similarly found residual MTC in the lateral cervical node compartments in 70% of patients, suggesting that these patients should perhaps have had an initial lateral neck dissection. By doing so, reoperative neck node dissection could be avoided, reducing the morbidity of reoperation. In patients diagnosed at a young age by genetic screening, lateral cervical node clearance may be unnecessary because cervical node MTC metastasis occurs infrequently (8.6%) in patients undergoing prophylactic surgical treatment.19

The accuracy of localizing imaging studies for locoregional residual MTC depends on (1) the size and site of residual MTC, (2) the experience of the radiologist in interpreting the imaging study, (3) technical imaging factors, and (4) the confirmation of imaging results by pathologic examination. Localization study results have been reported without uniform confirmation of the presence of MTC and have made the interpretation of the accuracy of several imaging modalities difficult. In our study, all of the localizing study results were confirmed by pathologic examination of the specimens removed. The high sensitivity of plasma calcitonin level, especially stimulated calcitonin level, for detecting residual occult MTC makes it difficult to detect foci of residual MTC by using standard imaging studies and these may not be detectable until these patients are observed for a longer period.20 Although selective venous catheterization with measurement of a calcitonin (basal or stimulated) gradient has been reported to have a high sensitivity, especially for liver metastasis, residual MTC can only be localized to a region.21 Furthermore, this technique is invasive, expensive, technically challenging, and not widely available. Only a limited number of investigators have evaluated MRI for locoregional MTC.21 Medullary thyroid cancer foci enhance on MRI T2-weighted imaging and areas of fibrosis may be distinguished from MTC. Although MRI may identify suspicious lesions, it is not highly specific (false-positive rate of 16% in our study). However, it is not associated with any radiation exposure to the patient and is especially helpful for detecting residual MTC in the mediastinum. Van Heerden et al10 have advocated high-resolution ultrasound scanning for identifying residual MTC in the neck, whereas other investigators have reported more limited success.22-24 Ultrasound scanning is relatively inexpensive, and a fine-needle aspiration biopsy can be done on suspicious lesions to confirm residual MTC. On the other hand, ultrasound is not useful for detecting mediastinal residual MTC and would have missed 14% of the residual MTC found in the mediastinum. Overall there was no significant difference in the sensitivities of MRI, CT scan, and ultrasound scanning for locoregional residual MTC. Computed tomographic scan images may be difficult to interpret because of surgical clip artifacts from prior surgery. We have had limited experience with technetium Tc 99m DMSA scintigraphy scanning and variable sensitivities (ranging from 0%-100%) have been reported.25 The potential advantage of technetium Tc 99m DMSA
scintigraphy and other radionuclide scanning methods is that they allow whole-body scanning and therefore may detect sites of distant MTC metastases. In a recent study by Conti et al.,26 positron emission tomography imaging correctly identified residual MTC in all 6 patients with hypercalcitoninemia. Unfortunately, only in 2 patients who had surgical resection were the positron emission tomography results confirmed. Our problem with all currently available localizing studies is that they often fail to correctly diagnose involved locoregional nodes when they are smaller than 1 cm. It seems that to achieve biochemical cure of patients with nodal MTC metastases they must be small, few, and without extranodal invasion.15,27,28

Tung et al.29 have reported that routine diagnostic laparoscopy identified 8 of 41 liver metastases from MTC not detected by standard imaging studies, probably due to the miliary nature of MTC liver metastases. We have not performed routine laparoscopy before reoperation for locoregional MTC. This technique might have identified liver metastases in the 2 patients who later developed liver metastases. However, we do not believe that routine diagnostic laparoscopy to detect liver metastasis is necessary to select patients for reoperation. This is because reoperation for residual locoregional MTC can lead to symptomatic relief even in patients with widely metastatic MTC and decreases the risk of death from locoregional MTC causing airway obstruction or invasion into the great vessels.17

In summary, locoregional reoperation for residual MTC rarely results in long-term biochemical cure, but seems to limit MTC progression. Prophylactic lateral cervical node clearance at the time of initial surgical resection for patients with MTC may reduce the high frequency of residual MTC and avoid the need for reoperation. Noninvasive imaging studies are helpful in detecting residual MTC but are not sensitive or accurate enough to be used to guide the extent of resection required on reoperation for residual MTC.

Presented at the 71st Annual Session of the Pacific Coast Surgical Association, San Francisco, Calif, February 21, 2000.

Philip H. G. Ituarte, MPH, PhD, provided assistance with statistics.

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REFERENCES


DISCUSSION

Nis Schmidt, MD, Vancouver, British Columbia: I prepared some overheads just to help us focus on the contents of this paper. It is a privilege and a pleasure to be invited by Dr Clark and his group to respond to this paper on medullary cancer of
the thyroid gland. Medullary cancer of the thyroid is an infrequent malignant disease of the thyroid, as we have heard. Only in a very specialized and focused practice of surgery such as that of Dr Clark and his group would one accumulate a large experience with this endocrine tumor of APUD tissue origin. Fortunately, medullary cancer continues to produce calcitonin and, in the presence of neoplasia, this is fortuitous for identifying genetically determined disease in infants to residual recurrent or metastatic disease in the adult. This is not the occasion to present another paper on this phenomenon. We are here to consider medullary cancer and how one attempts to localize and treat with curative intent.

Dr Kebebew presented the paper clearly and succinctly. Thirty-three patients studied retrospectively had a total of 46 procedures to attempt further surgical eradication of recurrent disease evidenced by rising or high calcitonin levels after initial surgical management or increasing local symptoms. Initial surgical management of medullary cancer of the thyroid is a real issue. Initial diagnosis of medullary cancer should be highly accurate if ABC (ie, aspiration, biopsy, cytology) is practiced on thyroid nodules and calcitonin levels are measured preoperatively. Depending on the referral pattern of practice, all thyroid lumps should have a cytologic diagnosis before going to the operating room. If not definitive, at least there should be some opinion as to the histologic diagnosis. The basic operation then for medullary cancer should be a total thyroidectomy with central clearing and ipsilateral or bilateral dissection for grossly evident disease or nodal enlargement. My own experience with this disease has taught me this. I stress this basic procedure in my practice and in my teaching. I have seen medullary cancer (nonpalpable in the thyroid and nonpalpable in nodes) present in the soft tissue around the thyroid without any evidence of disease in nodes histologically, so it is a vexatious disease that can spread surreptitiously around the area as we have seen from the contents of this paper.

Unfortunately, even this infrequently results in the return of serum calcitonin levels to normal. Hence the dilemma: when is enough surgery enough? In the situation of palpable or symptomatic recurrence of medullary cancer or in follow-up, if serum calcitonin levels remain high or increase, the future for the patient is distinctly worrisome. There is a mortality to this disease. There is also severe morbidity of locoregional recurrence with tracheal, vascular, neurologic, even bony invasion, in addition to the morbidity of difficult reoperative neck procedures.

Localization studies in this situation are not reassuring. As we have heard, none of the noninvasive modalities, including x-rays and ultrasounds and the like, are particularly definitive. Invasive venous sampling is imprecise and the literature is full of series of localization studies comparing without conclusion one modality with the other. Chemotherapy and radiation if used in the treatment by isotope or external means are disappointing, and, if done to the maximum, usually preclude any further local therapy or surgery. Does one then embark on radical reoperation in all cases of high serum calcitonin? Obviously not.

What is still needed is a better localization test, which, if done early, could sort out medullary cancer of the thyroid that is confined to the gland or that is locoregional at the outset and deserves early aggressive therapy. If it is already shown to be systemic and beyond more surgical effort, we might be operating in the neck for a disease that is really systemic from the start or is both local and systemic. A decision has to be made as to the effectiveness of further surgery the first, second, or third time around.

In the last 5 years, increasing publications, interest, and availability and experience are accumulating with positron emission tomography. It may be key for the future to use a fluorinated glucose molecule, increased cellular enzyme activity, and increased cellular membrane transport of glucose, allowing the FDG or 2-fluoro-2-deoxyglucose molecule to be trapped inside the cell. This, when labeled with a positron-emitting fluorine 18 molecule, is accumulated and will provide a unique biochemical scan and whole-body image.

Once again the study may be limited, the surgery may be limited, but with this new technology that is expensive but becoming more available, our surgical science may in fact win the day. So, thank you for the opportunity of responding to this paper.

I have a couple of questions. It is so critical as to how the first operation is done on these patients. How does one try to educate other surgeons who may be tackling some of these tumors? Secondly, do you have any experience as yet with the PET scanning?

Claude H. Organ, Jr, MD, Oakland, Calif: A lot of these endocrine lesions we are curing biochemically, but the patients are continuing to be symptomatic. We have bounced around the concept of lateral aberrant thyroid tissue and benign metastasizing goiter; however, I want to call the Association’s attention to the fact that calcitonin liberated by C cells comes from lateral anlages (the ultimobranchial body or the fourth pharyngeal pouch). It is a lateral anlage and where medullary cancer is concerned, we have to be very careful about what we are looking at. Two questions: (1) Please define recurrent as opposed to persistent disease. (2) Can I conclude from your manuscript that these metastases are not functioning metastases?

Theodore X. O’Connell, MD, Los Angeles, Calif: I have 2 questions for the authors. First, although I do believe that these extensive node dissections probably control local disease and I agree with the authors, there is no data in the paper that proves it because there is no comparative treatment or treatment group. The second question is, since the biochemical cure is so low, even with these extensive neck dissections, do they have any experience with any adjuvant therapy such as external beam radiation to see if there is increased biochemical cure with adjuvant therapies?

Lawrence A. Danto, MD, Stockton, Calif: I also thought this was an excellent presentation and discussion by Dr Schmidt. Sentinel node identification and biopsy is a vexing disease as has been pointed out. Early operation for cure is very important. What is the role of sentinel node identification?

David R. Byrd, MD, Seattle, Wash: The key to the surgical management of this disease seems to be with the first operation. I think many of us have struggled with the extent of lymphadenectomy at the first operation. Would the authors comment on (1) any imaging at the initial diagnosis to help guide the extent of lymphadenectomy, and (2) could one use postoperative basal and/or stimulated calcitonin levels (since it has such a short half life) after total thyroidectomy and central neck dissection to guide surgical management of the ipsilateral and/or contralateral neck nodes?

John T. Vetto, MD, Portland, Ore: I have 1 technical question. The authors advocate what is almost a complete dissection: removing memorial levels 2, 3, and 4, which they call “central,” and 5, which is actually posterior (they call it “lateral” in the paper). Do the authors remove level 1 as well, or do they find that these nodes are almost never involved? Those are the submandibular nodes. Also, do they spare normal structures? In other words, are they performing selective dissections, complete dissections, or modified complete dissections?

Dr Duh: Dr Schmidt, thank you very much for your comments. You asked about PET scans. We have limited experience with PET scans. Recently we have had a few patients who have had PET scans, and they seemed to be useful. I believe you also find PET scans to be a relatively sensitive test. Unfor-
Fortunately, although tumors were found by PET scanning and were removed, the calcitonin levels remained elevated.

Dr Organ, we use 6 months to define recurrent vs persistent disease. Disease is present if there are clinical signs of disease or if serum calcitonin is elevated. We routinely observe these patients for their serum calcitonin and CEA levels.

Whether all of the tumors are functioning or not is a good question. We believe that almost all of the tumors that we find are functioning. A common clinical dilemma is having an elevated basal or stimulated serum calcitonin level and not being able to find the disease.

Dr O’Connell, regarding the rationale for the extensive surgical treatment and whether there are other therapies, there are no other effective therapies available besides surgery. Although we are aggressive surgically, we have not been as aggressive as some of our German colleagues who routinely do the compartment dissection including a mediastinal cleanout during the first operation. Surgeons who perform extensive microdissection, including mediastinal cleanout, report a lower level of calcitonin when a more extensive operation is done. We do not yet know whether such aggressive surgery prolongs patient survival.

Dr Danto, we do not have any experience with sentinel nodes for medullary thyroid cancer, although we have considered this approach for low-risk patients. It is common for medullary cancer to metastasize to the lymph nodes very early, but it is difficult to predict which lymph nodes are involved. The rule of thumb for patients with a clinically obvious nodule and medullary thyroid cancer is that two-thirds have positive central nodes, two-thirds have positive ipsilateral lateral nodes, one third have positive contralateral nodes, and one third have positive mediastinal nodes. Since the nodal involvement is difficult to predict, identifying sentinel node may be a good idea. Patients with occult tumors measuring 1 cm are less likely to have involved nodes.

Dr Byrd, regarding preoperative imaging studies prior to the first operation, we have become more aggressive in doing prophylactic neck dissections. Imaging studies such as ultrasoundography may be useful for locally invasive tumors in planning the operation. At operation, we routinely perform a total thyroidectomy, central neck clearance, and an ipsilateral lateral neck dissection for almost all patients with a palpable medullary thyroid cancer that is larger than 1 cm. We usually use size of tumor to determine the extent of initial operation.

Dr Vetto, we do not routinely do a level I dissection.

**ARCHIVES OF INTERNAL MEDICINE**

Predictors of Recurrence After Deep Vein Thrombosis and Pulmonary Embolism: A Population-Based Cohort Study

John A. Heit, MD; David N. Mohr, MD; Marc D. Silverstein, MD; Tanya M. Petterson, MS; W. Michael O’Fallon, PhD; L. Joseph Melton III, MD

**Background:** The appropriate duration of oral anticoagulation after a first episode of venous thromboembolism (VTE) is uncertain and depends upon VTE recurrence rates.

**Objective:** To estimate VTE recurrence rates and determine predictors of recurrence.

**Methods:** Patients in Olmsted County, Minnesota, with a first lifetime deep vein thrombosis or pulmonary embolism diagnosed during the 25-year period from 1966 through 1990 (N = 1719) were followed forward in time through their complete medical records in the community for first VTE recurrence.

**Results:** Four hundred four patients developed recurrent VTE during 10 198 person-years of follow-up. The overall (probable/delinite) cumulative percentages of VTE recurrence at 7, 30, and 180 days and 1 and 10 years were 1.6% (0.2%), 5.2% (1.4%), 10.1% (4.1%), 12.9% (3.6%), and 30.4% (17.6%), respectively. The risk of recurrence was greatest in the first 6 to 12 months after the initial event but never fell to zero. Independent predictors of first overall VTE recurrence included increasing age and body mass index, neurologic disease with paresis, malignant neoplasm, and neurosurgery during the period from 1966 through 1980. Independent predictors of first probable/definite recurrence included diagnostic certainty of the incident event and neurologic disease in patients with hospital-acquired VTE. Recurrence risk was increased by malignant neoplasm but varied with concomitant chemotherapy, patient age and sex, and study year.

**Conclusions:** Venous thromboembolism recurs frequently, especially within the first 6 to 12 months, and continues to recur for at least 10 years after the initial VTE. Patients with VTE with neurologic disease and paresis or with malignant neoplasm are at increased risk for recurrence, while VTE patients with transient or reversible risk factors are at less risk. (2000;160:761-768)

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