Endosonography in the localization of parathyroid tumors: A preliminary study

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A preoperative transesophageal exploration of the parathyroids by endosonography was performed on 23 patients with primary hyperparathyroidism. The system used was a 7.5 MHz transducer mounted on the tip of an endoscope with an external diameter of 13 mm. The field of visualization was 360 degrees. A retrograde exploration was done moving up from the aortic arch to the upper esophageal sphincter. All patients underwent surgery afterward, and adenomas were found. In 12 cases the adenoma was visualized. All 12 adenomas were posteriorly located on the right side (four cases) and left side (eight cases) of the esophagus. Nine of these 12 tumors were on the posterior face of the thyroid lobes, with six tumors in the middle one third of the thyroid lobe and three in the lower one third of the thyroid lobe. The other three tumors were located below the lower pole of the thyroid lobes in the upper posterior mediastinum. Mean tumor weight was 1165 mg. Of the 11 tumors that could not be visualized, eight tumors were anteriorly located; three of these tumors were on the anterior and lateral surface of the lower pole of the thyroid, and five were in the thyrothymic tracts. The remaining three tumors were located on the back of the thyroid lobes; two of these tumors were at the upper esophageal sphincter, and one was on the side of the pharynx. Mean tumor size was 1334 mg. Localization of parathyroid tumors by endosonography appears possible but only if lesions are located posteriorly, close to the esophagus. Endosonography is not indicated below routine cervical exploration for primary or secondary hyperparathyroidism. As in other such studies, endosonography could be useful in cases of persistent or recurrent hyperparathyroidism. (SURGERY 1990;108:1021-5.)

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DETECTION OF PARATHYROID TUMORS by ultrasonography is a relatively recent development. Ultrasonography was proposed by Edis and Evans\(^1\) in 1979, and intraoperative ultrasonography was proposed by Sigel et al.\(^2\) in 1981. Currently ultrasonography is the only preoperative localizing procedure that is recommended before initial surgery is undertaken because it is simple, noninvasive, and inexpensive and may shorten operating time. Intraoperative ultrasonography has been proposed for patients with persistent or recurrent hyperparathyroidism.\(^3\)

Endoluminal ultrasonography or endosonography is an older method. Wild and Reid\(^4\) first used it transrectally to study the prostate in 1956. With technologic advances in the performance and size of transducers, endosonography is being performed more and more frequently in urology, gynecology, and, more recently, in gastroenterology.\(^5\)

The idea of investigating the parathyroids by way of the esophagus is not new since barium swallow and cine-esophagography were among the first imaging techniques to be attempted. Endosonography can visualize not only the esophageal wall but also immediately adjacent structures. Imaging of parathyroid tumors close to the esophagus at the cervical or mediastinal levels is thus, in theory, a possible application.

In this study we describe our results with endosonography in 23 patients who underwent exploratory neck surgery for primary hyperparathyroidism. The aim of this pilot study was twofold: (1) to determine whether

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parathyroid tumors could be detected by endosonography and, if so, to determine under what conditions and (2) to define the potential indications for this method.

MATERIAL AND METHODS

From January to December 1988, 64 patients were operated on for hyperparathyroidism. Before surgery, 23 patients with untreated primary hyperparathyroidism consented to undergo transeophageal exploration of parathyroids by endosonography. The patients included eight men and 15 women whose ages ranged from 37 to 70 years (mean age, 53 years). Diagnosis was confirmed in all patients by serum calcium, phosphorus, and parathyroid hormone levels and by 24-hour urinary calcium measurement.

All patients had already undergone ultrasonography as part of the preoperative work-up, but not at the same institution. Some patients had also undergone other localization procedures (computed tomography scan, eight patients; combined thallium-technetium scan, nine patients).

The system used was a 7.5 MHz transducer mounted on the tip of an endoscope (EU-M2; Olympus Corp., Lake Success, N.Y.) with an external diameter of 13 mm. The field of visualization was 360 degrees. Ultrasound was transmitted to the wall of the esophagus by a water-filled balloon placed around the transducer. After light sedation and topical pharyngeal anesthesia, the patient was placed in strict dorsal decubitus position.

RESULTS

All patients underwent successful parathyroid operations, with elimination of disease. Each patient had one parathyroid adenoma. Final pathologic diagnosis was considered as adenoma if at least two normal glands were confirmed by biopsy during the surgical procedure. No complications occurred in this series. Surgical outcome was defined as successful if serum calcium levels and parathyroid hormone levels were normal 1 year after operation.

After they were removed all adenomas were measured and weighed, and their locations were carefully recorded on a drawing kept in the patients' files. In 12 patients (52%) endosonography enabled visualization of the adenoma (Fig. 1). Parathyroid adenomas appeared as hypoechoic lesions (Figs. 2 and 3). All 12 tumors were posteriorly located on the right side (four tumors) and left side (eight tumors) of the esophagus. Nine of these 12 tumors were on the posterior face of the thyroid lobes; six tumors were in the middle third of the thyroid lobes, and three tumors were in the lower third of the thyroid lobes. The other three tumors were located below the lower pole of the thyroid lobes in the upper posterior mediastinum. Mean tumor weight was 1165 mg.

In 11 patients (48%) endosonography failed to visu-
alize the adenoma (Fig. 1). Eight of these tumors were anteriorly located; three tumors were on the anterolateral surface of the lower pole of the thyroid, and five tumors were in the thyrothymic tracts. The remaining three tumors were located on the back of the thyroid lobes; two of these were at the upper esophageal sphincter, and one was on the side of the pharynx. Mean tumor weight was 1334 mg.

**DISCUSSION**

Use of endosonography to investigate parathyroid tumors is currently hampered by technical limitations. The first problem stems from the presence of air pockets between the balloon and the esophageal wall. These pockets interfere with transmission of ultrasound waves and reduce the quality of imaging. The balloon must be filled with enough water that it presses tightly against the wall. But at the level of the upper esophageal sphincter the full balloon triggers the gag reflex, which renders examination very difficult. Another problem is the trachea. This air-filled organ constitutes a veritable acoustic barrier that prevents imaging of the anterior cervical region and mediastinal region. Finally, with current 7.5 MHz transducers the maximum range of visualization does not exceed 50 mm. Thus, with current endosonography technology we can visualize only parathyroid tumors located in the lower posterior cervical and upper posterior mediastinal regions. These limits were confirmed in our study since 12 of 15 posteriorly located adenomas were visualized (Fig. 1). Nine of these tumors were on the posterior face of the thyroid lobes; six tumors were in the middle one third of the thyroid lobe, and three tumors were in the lower one third of the thyroid lobe. The other three tumors were in the upper posterior mediastinum. The three posterior tumors that were not visualized were superiorly located; two of these were in the posterior region of the upper one third of the thyroid lobe, and one was against the wall of the pharynx. None of the eight anteriorly located adenomas was visualized. Three of these tumors were in the anterior region of the lower poles of the thyroid lobes, and five were in the thyrothymic tracts or the upper poles of the thymus (Fig. 1).

Major studies of normal anatomy of parathyroid glands showed that 77% to 81% of upper parathyroids are posteriorly located and are theoretically accessible to endosonography imaging. In addition, with enlargement an adenoma may be displaced from its normal anatomic site. This is particularly true for enlarging upper parathyroids, which have a tendency to shift posteriorly and descend into the upper posterior mediastinum. According to Thompson, 40% of adenomas arising in superior glands are in a paraesophageal or retroesophageal position in contrast with the 1% to 4% reported incidence of normal superior glands in these locations. In this study, 11 of the 14 adenomas that developed from upper parathyroids were clearly detected by endosonography. The other three adenomas, although posterior, were probably too high to be properly visualized (Fig. 4).
The same studies of the normal anatomy of the parathyroid glands demonstrate that no more than 20% of lower glands are posteriorly located. An adenoma developing from a lower parathyroid gland rarely migrates posteriorly. These tumors usually remain within the lower pole of the thyroid lobe or descend anteriorly along the thyrothymic tract. Only adenomas located in the posterior part of the lower poles of the thyroid lobes migrate posteriorly in the mediastinum. In our series only one of the nine adenomas developing on lower parathyroids was detected. This peduncular tumor was growing backward and downward in relation to the lower pole of the thyroid lobe (Fig. 5). The other eight adenomas were in an anterior position.

In this series the success rate with ultrasonography was particularly low since only six adenomas (26%) could be visualized. Paradoxically, none of the eight anteriorly located tumors were imaged by ultrasonography. Among the 15 posteriorly located tumors, four tumors were detected both by ultrasonography and endosonography, eight tumors only by endosonography, and two tumors, superiorly located, only by ultrasonography. One tumor, located against the wall of the pharynx, was visualized neither by ultrasonography nor by endosonography.

No false-negative results occurred in this study, but it should be pointed out that no attempt was made to interpret some images, given our still limited knowledge of the endosonographic anatomy of the neck. It is equally interesting to note that tumor size did not determine whether the tumor could be visualized. The mean weight of the visualized tumors was 1165 mg compared to 1334 mg for unvisualized tumors. The smallest visualized adenoma weighed 310 mg.

When performed by experienced endocrine surgeons, the success rate of operations on patients with primary hyperparathyroidism is between 95% and 98%. As Doppman wrote, “The only localizing study indicated in a patient with untreated primary hyperparathyroidism is to localize an experienced parathyroid surgeon.” Because it is simple, noninvasive, and inexpensive and may shorten operating time, ultrasonography may be routinely performed in patients who have not undergone surgery; but just like all other localization procedures, endosonography is not recommended for these patients.

If the initial operation was inadequate or if the surgical exploration was performed by an inexperienced surgeon, reoperation by an experienced parathyroid surgeon is successful in 95% of cases without previous localization studies. This explains the reason that localizing studies are not done systematically. However, because many parathyroid reoperations are carried out in dense scar tissue, if preoperative studies localize the abnormal parathyroid gland, operating time and morbidity are decreased and the rate of successful reoperation is increased.

When the initial unsuccessful surgery is performed by an experienced parathyroid surgeon, there is general agreement that localizing studies are recommended before reoperation. In these cases, endosonography should be taken into consideration. Endosonography can visualize abnormal parathyroids that are posteriorly located along the esophagus. Endosonography is therefore complementary to ultrasonography, which poorly visualizes glands located in paraesophageal or retroesophageal positions or in the tracheoesophageal groove. The fact is especially relevant since 34% of abnormal glands that cause persistent or recurrent hyperparathyroidism are located posteriorly along the esophagus. Wang claims that this is the most frequent location for adenomas discovered during surgery. Consequently, with an accurate description of the initial procedure indicating that the missed parathyroid was an upper parathyroid, endosonography has every chance of success. In their series, Grant et al. reported that 51 of 63 abnormal parathyroids (81%) arising from superior glands were posteriorly located.

Our experience with endosonography is still too small to accurately assess its success rate. It should be mentioned that no real risk exists for the patient. The