Ultrasonographic Features of Parathyroid Carcinoma

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Abstract. Although several authors have reported single cases illustrative of some ultrasonographic characteristic of parathyroid carcinoma, the value of ultrasonography for diagnosing this entity remains to be determined. The purpose of our study was to investigate the ultrasonographic features of parathyroid carcinoma in a large number of cases. We assessed the shape, contour, echogenicity, and depth-width (DW) ratio of 16 parathyroid carcinomas and 61 parathyroid adenomas. Ultrasonography showed that parathyroid carcinomas tend to be large, inhomogeneous, hypoechoic masses with lobulated contours. In contrast, parathyroid adenomas were small, homogeneous, hypoechogenic masses with smooth borders. The mean (range) DW ratios for parathyroid carcinomas were 1.21 (0.91–2.5) and 0.64 (0.33–1.47) for adenomas; the difference was statistically significant (p<0.0001). The DW ratio was ≥1 in 15 (94%) of the 16 cases of carcinoma, whereas only 3 (5%) of the 61 adenomas had a similar ratio. Ultrasonographic examination is useful not only for preoperative localization but also for differentiating parathyroid carcinoma from adenoma. Parathyroid tumors with irregular margins, inhomogeneous echogenicity, and a DW ratio ≥1 are likely to be malignant.

Key words: Parathyroid carcinoma, Parathyroid adenoma, Ultrasonogram, DW ratio, Preoperative diagnosis

PARATHYROID carcinoma is a rare cause of primary hyperparathyroidism (HPT) [1–3]. Diagnosing this entity before or during the primary operation is very important because the disease can be cured only by en bloc resection at the time of initial surgery, otherwise uncontrollable hypercalcemia may recur [4–8]. In patients with HPT, definitive preoperative diagnosis of parathyroid carcinoma usually cannot be made in light of clinical manifestations alone, although several authors have claimed that palpable neck mass, skeletal involvement, and high serum calcium levels are significantly associated with parathyroid carcinoma [9–12]. Distinguishing between benign and malignant parathyroid tumors by using preoperative examination tools such as biopsy and genetic analysis is difficult [13–15].

Because ultrasonography of the neck has been used for preoperative localization studies in patients with HPT, several investigators have described the sono­graphic features of parathyroid carcinoma in illustrative cases [16–19]. As has been demonstrated for thyroid and breast cancers [20–24], the shape, borders, internal echogenicity, and depth-width (DW) ratio of parathyroid tumors likely are indicators of malignancy. The purpose of the study was to determine ultrasonographic features important for the diagnosis of parathyroid carcinoma.

 Patients and Methods

From 1981 through 1996, 16 patients (9 women, 7 men) with parathyroid carcinoma underwent para-
thyroidectomy at Tokyo Women's Medical College Hospital, Ito Hospital, or University of Tsukuba Hospital. Other features of the patients included: age, 28 to 91 years (mean, 49.6 years); elevated serum calcium levels, 12.1 to 18.0 mg/dl (mean, 14.3 mg/dl); and elevated parathyroid hormone (PTH) levels as demonstrated by either a c-PTH value of 2.3 to 7.3 ng/ml (mean, 6.1; normal, less than 0.6) or an intact PTH value of 201 to 1760 (mean, 955; normal, 23-65). The neck tumors (length range, 1.5 to 4.5 cm; mean, 2.8 cm) were palpable in 14 of the 16 patients. Of the 16 patients, 14 had symptoms of severe hypercalcemia (appetite loss and nausea), and 12 had bone changes suggestive of hyperparathyroidism. One patient presented with lymph node metastasis; another had lung and liver metastases; the remaining 14 patients had histologic diagnosis of parathyroid carcinoma. We performed preoperative ultrasonographic examination of the neck of all 16 patients with a high-resolution (7.5-MHz), real-time scanner. When examined, the patients were supine, with the neck extended.

We compared the sonographic findings from the 16 patients with parathyroid carcinoma to those of 61 patients with parathyroid adenoma. These 61 patients underwent surgery at Ito hospital during 1996 and 1997 or at University of Tsukuba Hospital from 1986 through 1997. Preoperative ultrasonography of these patients successfully localized the pathologic parathyroid lesion.

We retrospectively analyzed the ultrasonographic findings in terms of the following five factors: echogenicity (high or low compared to thyroid); homogeneity of internal echo (homogeneous or inhomogeneous); shape of tumor (round or irregular); tumor margin (clear or unclear, irregular or smooth); and DW ratio (calculated as shown in Fig. 1). The width of the lesion was defined as the diameter at a right angle to the tangential line.

**Results**

Among the 16 patients with parathyroid carcinoma, the mean maximum tumor diameter was 27.5 mm (range, 9 to 50 mm) as measured by ultrasonography. The mean maximum tumor diameter among the 61 patients with parathyroid adenoma was 18.8 mm (range, 6 to 98 mm). The echogenicity of the carcinomas and adenomas of the parathyroid varied and did not differ with regard to histology (Figs. 2 and 3). Regardless of tumor size, most carcinomas were inhomogeneous masses (Fig. 2). In contrast, most adenomas were homogeneous (Fig. 3). All carcinomas were irregular or transformed shape (Fig. 2), whereas most adenomas were round or oval in shape (Fig. 3). The two adenomas that were lobulated were associated with severe thyroiditis or thyroid tumors. On transverse scan, parathyroid carcinomas were round (Fig. 2), while adenomas were elliptical (Fig. 3). The mean DW ratio for the 16 carcinomas was 1.21 (range, 0.91 to 2.5), whereas that for the 61 adenomas was 0.64 (range, 0.33 to 1.47). These values differed significantly (p < 0.0001; Fig. 4) between the two groups. The DW ratio was ≥1 for 15 (94%) of the 16 carcinomas; in contrast, only 3 (5%) of the 61 adenomas had a similar value. Interestingly, two of the three adenomas with a DW ratio ≥1 were associated with either chronic thyroiditis or thyroid tumor, and the third adenoma did not lie beneath the thyroid gland.

**Discussion**

Because parathyroid carcinoma is a rare disease,
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accounting for fewer than 1% of cases of primary hyperparathyroidism, literature regarding its ultrasonographic features is limited [16-19, 25]. Moreover, previous reports included relatively few cases of parathyroid carcinoma. In the present study, we retrospectively reviewed the ultrasonographic characteristics of 16 cases of this rare tumor. Our aim was to identify preoperative ultrasonographic features of parathyroid carcinoma that would distinguish it from benign parathyroid lesions.

Previous reports suggested that malignancy should be considered when ultrasonography demonstrates signs of gross invasion and marked irregularity of the tumor margin. In addition, Kinoshita et al. reported that a parathyroid tumor with high echogenicity is more likely to be a carcinoma than an adenoma [16]. However, Edmonson et al. and Daly et al. did not support this conclusion [17, 18], and our findings are consistent with those reported by these authors. We found that internal echogenicity was not useful for distinguishing carcinoma from adenoma of the
parathyroid gland, because some of the parathyroid carcinomas we evaluated were hyperechoic whereas others were hypoechoic. The echogenicity of parathyroid tumor likely depends on the presence of areas of bleeding or necrosis, regardless of whether the mass is malignant or benign. Some adenomas, especially large masses, may be hyperechoic.

Except for the occasional cystic space, the internal echogenicity of parathyroid adenomas typically is consistent throughout the lesion. In our series, all adenomas were homogeneous tumors, even when large. In contrast, all of the parathyroid carcinomas we evaluated were inhomogeneous masses, even when the tumor was as small as <1 cm in diameter. These findings are consistent with those in previous reports. Therefore, we feel that an inhomogeneous signal suggests malignancy in parathyroid tumors. This ultrasonographic characteristic may reflect fibrous trabecular architecture, which is an important histologic feature of parathyroid carcinoma.

The most interesting finding in our study was that the DW ratio of the tumor can be used to distinguish parathyroid carcinoma from adenoma. Similarly, the DW ratio distinguishes benign from malignant mammary lesions [20, 22-24]. For parathyroid lesions, the association between the DW ratio and malignancy may be related to the fact that parathyroid carcinomas usually are firm, and spherical or round and are often surrounded by a thick fibrous capsule, whereas parathyroid adenomas are soft or pliable elliptical masses. In our study, parathyroid carcinomas tended to have DW ratios ≥1; masses with a DW ratio <1 usually were parathyroid adenomas. DW ratio of a parathyroid lesion is a quantitative indicator that is easier to evaluate than other qualitative indicators (tumor margins, internal echo pattern, etc.). In our series, at a cut-off point of 1, measurement of the DW ratio had a sensitivity of 94% and a specificity of 95% for the diagnosis of parathyroid carcinoma. In conclusion, ultrasonography, especially the measurement of the DW ratio of the tumor, is useful in the preoperative diagnosis of parathyroid carcinoma.

References

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