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Analysis of the Value of Ultrasound Imaging Combined with Serum Indicators in Evaluating the Invasiveness of Papillary Thyroid Carcinoma

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Abstract: *Objective:* To analyze the value of ultrasound imaging combined with serum indicators in evaluating the invasiveness of papillary thyroid cancer (PTC). *Methods:* One hundred and fifty patients with papillary thyroid cancer admitted to our hospital from September 2019 to December 2022 were selected. Pathological tissue testing was performed on all patients. According to the size, shape, boundary, internal echo, and characteristics such as microcalcification, the patients were divided into the PTC metastasis group (n = 55) and the PTC group (n = 95). The detection rate of ultrasound imaging combined with serum indicators and the invasiveness of PTC were observed and analyzed. *Results:* The detection rate of ultrasound imaging combined with serum indicators in both groups was significantly better than that of ultrasound imaging and serum indicators ($P < 0.05$). The detection rate of ultrasound imaging combined with serum indicators was compared between the groups. The removal rate of the PTC metastasis group was significantly better than that of the PTC group ($P < 0.05$). The levels of thyroid-stimulating hormone (TSH), thyroglobulin (Tg), thyroglobulin antibodies (TgAb), and thyroid autoantibodies (TPOAb) in the PTC group were lower than those of the PTC metastasis group ($P < 0.05$). *Conclusion:* Ultrasound imaging combined with serum indicators like TSH, Tg, TgAb, and TPOAb has important clinical significance in evaluating the invasiveness of PTC.

Keywords: Ultrasound imaging; Serum indicators; Papillary thyroid carcinoma

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1. Introduction

Papillary thyroid cancer (PTC) is the most common malignant tumor of the thyroid gland. It is highly malignant, mostly occurs in women, has a poor prognosis, and is very aggressive [1]. The invasiveness of PTC is related to the tumor's location, diameter, clinical stage, microcalcification, lymph node metastasis, lymph node dissection, and other factors [2]. The current assessment of PTC invasiveness is mainly based on histopathological findings. Histopathological manifestations are the most direct evidence of tumor invasiveness, but the subjectivity and uncertainty of pathological results make it difficult to evaluate the invasiveness of PTC [3]. Ultrasound imaging is a non-invasive examination method that can indirectly assess tumor invasiveness by evaluating tumor size,

shape, boundary, and other characteristics [4]. It can accurately diagnose PTC before surgery and has high application value in tumor diagnosis and evaluation. Serum indicators are important indicators for evaluating tumor invasiveness and prognosis, including serum thyroid stimulating hormone (TSH), thyroglobulin (Tg), thyroglobulin antibody (TgAb), and thyroid peroxide indicators such as thyroid peroxidase antibody (TPOAb) can be used as common indicators to predict the invasiveness of PTC. Still, their specificity and sensitivity are low [5,6]. Ultrasound imaging combined with serum indicators has high application value in assessing the invasiveness of PTC. This study intends to provide a basis for early prediction and prognosis of PTC invasiveness by analyzing the ultrasonic imaging characteristics of PTC and studying the correlation of serum indicators with the assessment of PTC invasiveness.

2. Materials and methods

2.1. General information

A total of 150 patients with PTC admitted to our hospital from September 2019 to December 2022 were selected, including 60 males and 90 females aged 25–81 years old, with an average age of 52.41 ± 6.77 years. All patients underwent pathological tissue examination and were divided into the PTC metastasis group (n = 55) and PTC group (n = 95) according to the size, shape, boundary, internal echo, and presence of microcalcification of the tumor. All patients were followed up to 12 months after surgery. Inclusion criteria: (1) Patients aged ≥ 18 years with PTC confirmed by postoperative pathology; (2) no prior history of radiotherapy, chemotherapy, or targeted therapy; (3) no contraindications to surgery. Exclusion criteria: (1) Patients younger than 18 years old or older than 70 years old; (2) patients with pathological diagnosis of non-papillary thyroid cancer; (3) patients who have received surgical treatment or chemotherapy; (3) patients with severe cardiovascular disease, liver, and kidney dysfunction; (4) patients who did not comply.

2.2. Method

Ultrasound imaging examination was carried out using a high-frequency ultrasonic diagnostic instrument with a probe frequency of 5–12 MHz. The patient was placed in a supine position with their neck fully exposed. First, a routine ultrasound scan was performed to observe the location, size, shape, boundary, internal echo, and other characteristics of the thyroid nodules. The blood flow signal inside the tumor was then observed and the blood flow grade was recorded.

Serum indicator was detected by extracting 5 mL of fasting venous blood from the patient, centrifuged to separate the serum, and stored in a -80°C refrigerator. The enzyme-linked immunosorbent assay (ELISA) was used to detect biochemical indicators related to tumor invasiveness in serum, such as tumor markers, growth factors, inflammatory factors, etc., and operated strictly with the kit's instructions.

2.3. Observation indicators

The detection rate of ultrasound imaging combined with serum indicators and the invasiveness of PTC were observed and analyzed (**Figure 1**).

2.4. Statistical methods

The SPSS 19.0 software was used to conduct a statistical analysis of the data of this study. Measurement data were expressed as mean ± standard deviation and the t-test was used for comparison between groups. Count data were expressed as %, and analyzed using the chi-squared (χ^2) test. All measurement data followed a normal distribution and homogeneous variance. An independent sample t-test or rank sum test should be performed if the data is non-

normally distributed or has uneven variances. Results were considered statistically significant at $P < 0.05$.

3. Results

3.1. Comparison of detection rates between the two groups

As shown in **Table 1**, in the PTC group, the detection rates of ultrasound imaging, serum indicators, and ultrasound imaging combined with serum indicators were 91.58%, 90.53%, and 94%, respectively. In the PTC metastasis group, the detection rates of ultrasound imaging, serum indicators, and ultrasound imaging combined with serum indicators were 87.27%, 87.27%, and 90.91%, respectively. The detection rate of ultrasound imaging combined with serum indicators within the PTC group was significantly better than that of the PTC metastasis group ($P < 0.05$).

Table 1. Comparison of detection rates between the two groups [*n* (%)]

Group	Ultrasound imaging	Serum indicators	Ultrasound imaging combined with serum indicators	χ^2	*P*
PTC group ($n = 95$)	87 (91.58)	86 (90.53)	94 (98.95)	6.760	< 0.05
PTC metastasis group ($n = 55$)	48 (87.27)	48 (87.27)	50 (90.91)	0.476	> 0.05
χ^2	0.718	0.387	3.955		
P	> 0.05	> 0.05	< 0.05		

3.2. Comparison of serological characteristics between the two groups

As shown in **Table 2**, the levels of TSH, Tg, TgAb, and TPOAb of the PTC group were lower than those of the PTC metastasis group ($P < 0.05$).

Figure 1 shows the automatic full-volume breast ultrasound scan of superficial small organs.

Table 2. Comparison of serological characteristics between the two groups (mean ± standard deviation)

Group	TSH (mIU/L)	Tg (ng /L)	TgAb (IU/L)	TPOAb (IU/L)
PTC group ($n = 95$)	3.26 ± 1.45	47.61 ± 7.36	5.16 ± 1.39	8.54 ± 2.14
PTC metastasis group ($n = 55$)	4.26 ± 1.45	52.26 ± 8.45	6.36 ± 2.14	10.41 ± 1.87
t	4.070	3.530	4.160	5.395
P	< 0.05	< 0.05	< 0.05	< 0.05

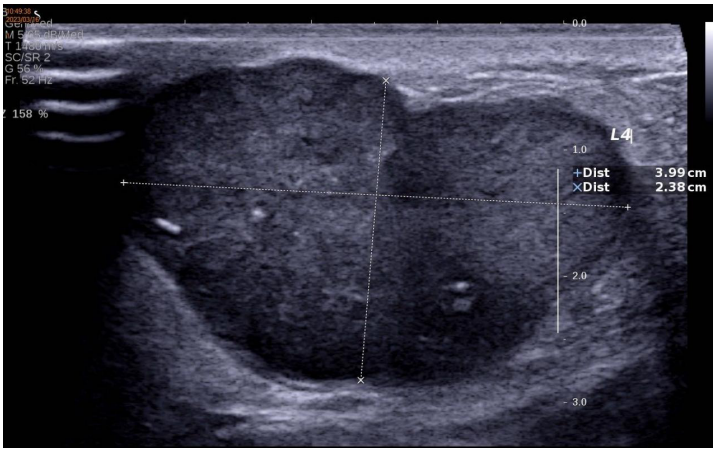

Figure 1. Automatic full-volume breast ultrasound scan of superficial small organs

4. Discussion

PTC is the most common clinical thyroid malignant tumor, accounting for approximately 80% of all thyroid cancers, the vast majority of which are papillary carcinomas. The invasiveness of thyroid cancer refers to the ability of tumor cells to break through the thyroid capsule and invade surrounding tissues, organs, and lymph nodes to cause metastasis [7]. Recently, the incidence of PTC has been increasing and tends to affect younger patients. The invasiveness of PTC is related to the size, shape, number, and blood supply of tumor cells. In clinical practice, the pathological diagnosis of PTC patients is mainly based on histopathological examination results [8]. However, due to the high degree of malignancy of PTC, its histopathological diagnosis is subjective and uncertain, and the pathological results are a dynamic process. Hence, it is difficult to accurately evaluate the invasiveness of PTC [9]. Ultrasound, a non-invasive examination method, has unique advantages in assessing tumor invasiveness. Due to its special histopathological characteristics, PTC is highly aggressive and highly invasive, prone to recurrence and metastasis, and has a poor prognosis. Therefore, early diagnosis, reasonable assessment of the invasiveness of PTC, and guidance of clinical treatment are important to improve the prognosis of PTC [10]. Recently, ultrasonic examination has become widely used in PTC. Ultrasound imaging and serum markers each play an important role in assessing the aggressiveness of PTC [11]. Ultrasound imaging can provide intuitive information about tumor shape, size, blood flow signals, etc. These characteristics are closely related to the biological behavior of tumors. Serum indicators, such as tumor markers, growth factors, and inflammatory factors, can reflect tumor activity, growth rate, and interaction with surrounding tissues [12].

In this study, the detection rates of ultrasound imaging, serum indicators, and ultrasound imaging combined with serum indicators of the PTC group were 91.58%, 90.53%, and 94%, respectively. In the PTC metastasis group, the detection rates of ultrasound imaging, serum indicators, and ultrasound imaging combined the detection rates of serum indicators were 87.27%, 87.27%, and 90.91%, respectively. The detection rate of ultrasound imaging combined with serum indicators within the PTC group was significantly better than that of the PTC metastasis group ($P < 0.05$). This indicates that ultrasonic imaging characteristics and serum indicators have a certain value in the invasiveness assessment of PTC, especially when used together. When used, the accuracy of prediction can be significantly improved, providing clinicians with a more reliable basis and helping formulate personalized treatment plans and predict patient prognosis. Combining ultrasound imaging with serum markers can more comprehensively assess the aggressiveness of PTC. Ultrasound imaging mainly focuses on observing the morphological structure and blood flow characteristics of tumors, while serum indicators reflect the biochemical characteristics of tumors. Combining the two can reveal the tumor's biological behavior and improve the accuracy of the assessment [13]. Through regular ultrasound imaging and serum index testing, the tumor's development trend and invasive changes can be observed, which is of great significance for formulating individualized treatment plans and predicting the prognosis of patients [14]. Ultrasound imaging examination and serum index detection are non-invasive, painless, radiation-free, and easily operable, making it convenient for repeated examinations and long-term follow-up [15].

The levels of TSH (mIU/L), Tg (ng/L), TgAb (IU/L), and TPOAb (IU/L) in the PTC group were 3.26 ± 1.45, 47.61 ± 7.36, 5.16 ± 1.39, and 8.54 ± 2.14, respectively. The levels of TSH (mIU/L), TG (ng/L), TGAb (IU/L), and TPOAb (IU/L) in the metastasis group were 4.26 ± 1.45, 52.26 ± 8.45, 6.36 ± 2.14, and 10.41 ± 1.87, respectively. The differences between the PTC and PTC metastasis groups were statistically significant ($P < 0.05$). There were significant differences in tumor markers among tumors with different degrees of invasiveness, which indicated that tumor markers may be related to the invasiveness of the tumors.

5. Conclusion

Ultrasound imaging combined with serum indicators demonstrated great promise in assessing the invasiveness of PTC but further research and improvement are still needed. Multidisciplinary cooperation and the introduction of advanced technology are expected to provide more accurate and personalized solutions for diagnosing and treating PTC. This study has some limitations. Firstly, a small sample size of only 150 patients was analyzed, and gender, age, clinical stage, or other factors were considered. Additionally, this study only analyzed the ultrasound imaging characteristics and serum indicators without conducting a correlation analysis with other indicators. To improve the accuracy in predicting the invasiveness of PTC, future research should conduct multi-center, large-sample studies.

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