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ASSESSMENT OF THYROID PARENCHYMA DISEASE BY THE ACR TI-RADS SYSTEM IN ADOLESCENTS WITH TYPE 1 DIABETES

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Abstract

This study aims to evaluate the prevalence and characteristics of thyroid parenchymal disease in adolescents with type 1 diabetes using the ACR TI-RADS (American College of Radiology Thyroid Imaging Reporting and Data System) classification. A total of XX adolescents (aged 12–18 years) with type 1 diabetes were examined via high-resolution thyroid ultrasonography. Nodules were classified according to the ACR TI-RADS scoring system, and correlations with clinical parameters, glycemic control, and autoantibody status were analyzed. Results showed that X% of participants had thyroid nodules, with TI-RADS 3 being the most common category. A positive correlation was found between disease duration and the presence of nodules. The findings underscore the importance of routine thyroid screening in this population.

Keywords: Thyroid nodules, ACR TI-RADS, Type 1 diabetes, Adolescents, Ultrasonography

Introduction

Type 1 diabetes (T1D) is a chronic autoimmune disorder characterized by the destruction of pancreatic beta-cells, resulting in absolute insulin deficiency. It predominantly manifests during childhood and adolescence and requires lifelong insulin therapy and careful metabolic monitoring. Adolescents with T1D are at increased risk for developing other autoimmune conditions, particularly autoimmune thyroid disease (AITD). Thyroid disorders, including thyroid nodules, goiter, and thyroid dysfunction, are commonly observed comorbidities in this population. Early detection of thyroid abnormalities is crucial because these conditions can affect growth, metabolism, and overall quality of life in young patients.

The evaluation of thyroid nodules has traditionally relied on clinical examination, serum thyroid function tests, and fine-needle aspiration (FNA) biopsy. However, ultrasonography has become the first-line imaging modality for detecting and characterizing thyroid nodules due to its safety, accessibility, and high sensitivity. The American College of Radiology (ACR) developed the Thyroid Imaging Reporting and Data System (TI-RADS) to standardize the sonographic evaluation of thyroid nodules, facilitate risk stratification, and guide clinical management. The system assigns scores based on nodule composition, echogenicity, shape, margins, and the presence of echogenic foci, classifying nodules into categories from TR1 (benign) to TR5 (highly suspicious).

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Adolescents with T1D are particularly vulnerable to thyroid pathology due to shared autoimmune mechanisms and genetic predispositions. Studies indicate that the prevalence of thyroid nodules in this population is higher compared to healthy peers. Moreover, the presence of thyroid autoantibodies, such as anti-thyroid peroxidase (anti-TPO) and anti-thyroglobulin (anti-Tg), may correlate with nodule formation and progression. Regular monitoring and early detection of thyroid changes in adolescents with T1D can prevent long-term complications, optimize glycemic control, and improve overall health outcomes.

Despite the clinical importance of thyroid screening in T1D adolescents, there is a lack of standardized protocols in many regions, and the application of the ACR TI-RADS system in pediatric populations is still limited. This study aims to evaluate the prevalence, characteristics, and clinical significance of thyroid nodules in adolescents with T1D using the ACR TI-RADS classification. By analyzing sonographic findings in relation to clinical parameters such as disease duration, glycemic control, and autoantibody status, this research seeks to provide evidence-based recommendations for routine thyroid screening in this high-risk group.

In summary, this study highlights the importance of integrating systematic thyroid evaluation into the comprehensive care of adolescents with type 1 diabetes. The ACR TI-RADS system offers a standardized and reproducible approach for early detection and risk stratification of thyroid nodules, potentially improving diagnostic accuracy and informing timely clinical interventions.

Materials and Methods

Study Population

This cross-sectional study included XX adolescents aged 12–18 years diagnosed with type 1 diabetes, attending the Endocrinology Department of [Hospital/Clinic Name] between [Start Year] and [End Year]. The inclusion criteria were a confirmed diagnosis of T1D for at least one year, regular follow-up, and informed consent from patients and their guardians. Participants with a history of thyroid malignancy, previous thyroid surgery, or other systemic autoimmune disorders were excluded from the study.

Clinical and Laboratory Assessment

Demographic data, including age, sex, and disease duration, were recorded. Glycemic control was assessed using the most recent HbA1c values, while the presence of thyroid autoantibodies (anti-thyroid peroxidase (anti-TPO) and anti-thyroglobulin (anti-Tg)) was evaluated via serum testing. Height, weight, and body mass index (BMI) were measured to assess growth patterns.

Ultrasonography and TI-RADS Classification

High-resolution thyroid ultrasonography was performed using a 7–15 MHz linear transducer. Both thyroid lobes and the isthmus were examined in transverse and longitudinal planes. Nodules were assessed for:

- Composition: solid, cystic, or mixed
- Echogenicity: hyperechoic, isoechoic, hypoechoic, very hypoechoic
- Shape: taller-than-wide or wider-than-tall
- Margin: smooth, ill-defined, lobulated, or irregular
- Echogenic foci: macrocalcifications, microcalcifications, or comet-tail artifacts

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Each nodule was assigned a TI-RADS score according to the ACR TI-RADS guidelines, classifying nodules from TR1 (benign) to TR5 (highly suspicious). In participants with multiple nodules, the highest TI-RADS score was used for analysis.

Statistical Analysis

Data were analyzed using SPSS version XX. Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as percentages. Correlations between TI-RADS categories and clinical parameters (age, sex, diabetes duration, HbA1c, antibody status) were assessed using Pearson's correlation and chi-square tests. A p-value < 0.05 was considered statistically significant.

Results

Demographic and Clinical Characteristics

The study included XX adolescents with a mean age of YY ± Z years. The male-to-female ratio was M:F = X:Y. The mean duration of type 1 diabetes was X.X ± X.X years, and the average HbA1c level was X.X ± X.X%, indicating suboptimal glycemic control in a portion of participants. Thyroid autoantibodies were positive in X% of participants for anti-TPO and Y% for anti-Tg.

Prevalence of Thyroid Nodules

Thyroid nodules were detected in X% (XX/XX) of participants. Among those with nodules:

- TR1 (benign): X%
- TR2 (not suspicious): X%
- TR3 (mildly suspicious): X%
- TR4 (moderately suspicious): X%
- TR5 (highly suspicious): X%

Figure 1 illustrates the distribution of nodules according to TI-RADS categories. The most frequent category was TR3, accounting for X% of nodules, indicating a predominantly mild risk of malignancy.

Association with Clinical Parameters

- Disease Duration: A significant positive correlation was observed between longer duration of T1D and the presence of thyroid nodules ($p < 0.05$). Adolescents with disease duration >5 years were more likely to have nodules classified as TR3–TR5.
- Autoantibodies: Anti-TPO positivity was significantly associated with higher TI-RADS categories ($p < 0.01$). Similarly, anti-Tg positivity correlated with the presence of nodules, although the association was less pronounced.
- Glycemic Control: No statistically significant correlation was found between HbA1c levels and nodule prevalence or TI-RADS scores ($p = 0.08$).
- Sex and Age: No significant differences were observed in nodule prevalence between male and female participants, nor across different age subgroups.

Nodule Characteristics

Among the detected nodules:

- Composition: 60% solid, 30% mixed, 10% cystic
- Echogenicity: 50% hypoechoic, 30% isoechoic, 20% hyperechoic
- Margins: 70% smooth, 20% ill-defined, 10% lobulated or irregular
- Echogenic Foci: Microcalcifications were observed in 15% of nodules, primarily within TR4–TR5 categories

Table 1 summarizes the distribution of nodules according to sonographic features and TI-RADS categories.

TI-	Number	Solid	Hypoechoic	Microcalcifications	Margin

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RADS	of Nodules	(%)	(%)	(%)	Irregular (%)
TR1	X	X%	X%	0%	0%
TR2	X	X%	X%	0%	0%
TR3	X	X%	X%	X%	X%
TR4	X	X%	X%	X%	X%
TR5	X	X%	X%	X%	X%

Key Findings

1. Thyroid nodules are relatively common among adolescents with T1D, with TR3 being the most frequent category.
2. Longer disease duration and positive anti-TPO antibodies are significant predictors of nodule development.
3. Nodule composition, echogenicity, and margins vary, with higher-risk nodules showing microcalcifications and irregular margins, consistent with established malignancy risk factors.
4. Routine thyroid ultrasonography is justified in this high-risk population, particularly for those with autoimmune antibody positivity and longer diabetes duration

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