doi.org/10.36721/PJPS.2026.39.4.REG.15941.1

Shear wave elastography (SWE) and serum thyroglobulin (Tg) as a predictor in the assessment of radioactive iodine treatment in patients with thyroid cancer

Lou Kexin and Wu Rong*
Shanghai General Hospital, Clinical School of Nanjing Medical University, 201620 China

Abstract: **Background**: Postoperative treatment in the case of differentiated thyroid cancer (DTC) may include radioactive iodine (RAI) treatment, but the optimal level of RAI to be administered needs to be determined properly. Elements such as shear wave elastography (SWE), serum thyroglobulin (Tg), and the association between levothyroxine treatment and several RAI-associated parameters need to be considered properly. **Objective**: In patients with association of tissue stiffness after thyroidectomy, this prospective observational study aimed to assess whether tissue stiffness and thyroglobulin (Tg) levels are associated with administered RAI activity. The secondary objective was to evaluate the association of levothyroxine use at the time of RAI and RAI uptake characteristics, but it did not imply causation. **Methods**: A total of 100 patients with DTC who received thyroidectomy from January 2023 to June 2025 were enrolled. Results of pre-RAI shear wave elastography (SWE), Tg levels and levothyroxine therapy were measured. The RAI activity (mCi) were calculated using the clinical judgment and analyzed the correlation between SWE, Tg, levothyroxine use, and the RAI parameters. **Results**: A prospective observational study of 100 DTC patients undergoing thyroidectomy between January 2023 and June 2025 was conducted and analyzed. SWE results and thyroglobulin levels are collected pre-RAI treatment, and the use of levothyroxine is documented. The mCi of RAI is determined based on clinical assessment rather than a standardized method, and the relationship between SWE, thyroglobulin levels, levothyroxine treatment, and the elements of RAI treatment is analyzed. **Conclusion**: In this group, SWE-derived tissue stiffness and serum levels of thyroglobulin were found to correlate positively with RAI activity administered, in all likelihood related to the underlying tumor characteristics, thus SWE and Tg may be viewed as having possible utility as adjunct markers used in the selection of RAI activity, while there is no evidence to confirm or deny the relationship between levothyroxine usage and RAI uptake.

Keywords: Levothyroxine therapy; Radioactive iodine; Shear wave elastography; Serum thyroglobulin; Thyroid cancer

Submitted on 03-01-2026 – Revised on 28-01-2026 – Accepted on 29-01-2026

INTRODUCTION

Thyroid cancer is the most frequent endocrine cancer. Its prevalence has risen globally over the last few decades (Matrone *et al.,* 2020). The primary treatment for differentiated thyroid cancer (DTC) is surgery. Surgery is often followed by radioactive iodine (RAI) therapy, depending on the patient's risk after surgery (Mihailović *et al.,* 2025). However, choosing the optimal RAI dose for each patient remains a challenge. This decision currently depends on clinicopathological criteria, such as tumor shrinkage, extent and recurrence risk (Volpe *et al.,* 2024). Balancing treatment effectiveness with unnecessary irradiation is also important. There is a need for additional markers that indicate disease resistance or presence (Pacilio *et al.,* 2022).

Shear Wave Elastography (SWE) is a type of ultrasound technology that qualitatively assesses tissue stiffness. It has recently become more popular for imaging the thyroid (Leng *et al*., 2024). Tissue stiffness depends on various underlying histological features, such as the degree of tissue fibrosis, cellular density, and the composition of the extracellular matrix. The latter can indirectly correlate with the degree of malignancy or underlying tumor cells. SWE, a non-invasive imaging modality that has attracted the most attention in thyroid imaging, still needs to be explored regarding its association with RAI-related parameters in the post-operative period (Layek *et al*., 2021; Chambara *et al*., 2022). SWE should be understood as a surrogate parameter and not considered a determinant of radioiodine uptake.

Serological levels of Tg remain a significant biochemical predictor for the management of DTC, acknowledging their involvement in residual normal or malignant thyroid tissue (Bojunga and Trimboli, 2024). In the management of DTC, it was found that increased serological levels of Tg following thyroidectomy and before RAI treatment correlate with inferior clinically relevant outcomes and it is a parameter that can be used for assessment (Iakovou *et al*., 2020). Even though both SWE and Tg, individually, have been studied as elements for thyroid cancer management, little data exist on their evaluation for the purpose of RAI assessment (Roseland *et al*., 2022).

**Corresponding author:* e-mail: wurongsh0928@163.com

Current clinical practice guidelines for administering RAI in DTC management emphasize the necessity of postoperative risk stratification based on tumor stage, histopathology, and lymph node involvement, rather than personalized imaging techniques or biochemical markers. This approach has enhanced outcome prediction and diminished overtreatment; however, it remains population-based in its design, potentially leading to outcomes that do not sufficiently address interpatient variability. Consequently, there persists a keen interest in discovering supplementary noninvasive prognostic indicators that may enhance, rather than supplant, existing risk-stratification methodologies (Kara *et al.,* 2020).

The initiation of levothyroxine therapy is normally indicated for the treatment of hypothyroidism as well as for suppressing the thyroid-stimulating hormone (TSH) level after thyroidectomy, thereby preventing tumor stimulation in the patient (Daraghma *et al*., 2025). Here, the suppression of TSH represents a biological paradox regarding the RAI therapy, since TSH levels are known to increase the uptake of iodine into thyroid cells. Therefore, the relationship between levothyroxine therapy status and RAI uptake is an uncertain process within thyroid physiology and cannot be assumed to enhance RAI therapy, as previously contemplated, since such an allegedly enhanced process is not supported by previous thyroid physiology (Coerts *et al*., 2023).

In this context, the present study aimed to investigate the correlation between tissue stiffness assessed by SWE, serum concentrations of Tg, and administered RAI activity in patients with DTC who had undergone thyroidectomy (Iakovou *et al*., 2020). A secondary objective was to evaluate the correlation between levothyroxine therapy status at the time of RAI, explicitly emphasizing the observational character of the study without any mechanistic implications. Instead of proposing an alternative to risk stratification based on guidelines, the present study examines whether SWE and Tg can enhance the assessment, even if in a complementary manner (Roseland *et al.,* 2022). The work is novel because it looks at both SWE and Tg levels at the same time in relation to RAI administration, which means they are used for exploration rather than determining the right dose. The results ought to be construed as guiding hypothesis formulation for future research, in alignment with prevailing recommendations (Bojunga and Trimboli, 2024; Kara *et al*., 2020).

MATERIALS AND METHODS

Study design and population

The prospective observational study was carried out at Shanghai General Hospital from January 2023 to June 2025. A total of 100 consecutive patients with DTC, following total thyroidectomy (TT) and scheduled to undergo RIA therapy, were included. The type of study design was chosen to examine the relationships rather than to test specific intervention protocols.

The inclusion criteria for selecting patients included histopathologically confirmed DTC, TT, an age range of 18 to 75 years, and a scheduled RAI therapy. The exclusion criteria included individuals who had undergone RAI therapy, suffered from severe heart, kidney, or liver diseases that could complicate the treatment or follow-up of RAI therapy, or were pregnant or breastfeeding. The sample size is determined by the number of patients treated within a designated timeframe, rather than derived from a priori power calculations, possibly reflecting the exploratory nature of the study. The clinical and pathological factors, such as tumor size, tumor type, node status, and postoperative risk category, are recorded and regarded as confounding variables in the analysis of the data (Li *et al.,* 2022; Ebadi and Alp Arici, 2022).

Levothyroxine therapy and TSH status

In the postoperative period, levothyroxine (Euthyrox®) therapy was prescribed as per routine practice to prevent hypothyroidism and to achieve TSH suppression to an appropriate level. The initial dose of levothyroxine varied between 75 to 150 µg/d. The dose was adjusted according to the TSH levels, clinical status and physician's discretion. Among the 60 patients receiving levothyroxine at the time of RAI administration, 40 patients were not on levothyroxine therapy.

The reasons for the withdrawal or non-initiation of levothyroxine therapy included clinical preparation with increased endogenous TSH levels due to RAI therapy, intolerance, or temporary discontinuation. The TSH levels at the time of RAI administration were recorded when available. TSH levels at the time of RAI administration were considered an important confounding variable in the interpretation of RAI uptake-related variables. TSH levels were not altered as per the protocol (Bojunga and Trimboli, 2024).

Imaging and biomarker assessment

- *Shear wave elastography (SWE)*

SWE was performed before RAI administration using a high-resolution ultrasound system with elastography software (GE Logiq E9, version 9.0). The assessments were done by a skilled sonographer using a standardized institutional protocol. The quantitative measurements of stiffness were obtained in kilopascals (kPa) by placing regions of interest on the postoperative thyroid bed or any residual tissue, if present. For analysis, SWE measurements were divided into relative low, intermediate and high stiffness groups based on their distribution in the study population rather than fixed diagnostic thresholds. There are no established SWE thresholds to predict the response to RAI therapy and SWE measurements were thus

used as exploratory surrogate endpoints. The study design did not assess inter-observer and intra-observer variability, representing a limitation (Uysal *et al*., 2022).

- *Serum thyroglobulin (Tg) and anti-Tg antibodies*
Tg levels were determined before RAI administration using a standardized method (Architect Tg assay, Abbott Laboratories). Anti-thyroglobulin antibodies (anti-Tg Ab) were also simultaneously measured, as these could interfere with the results of Tg assays. Tg levels were used with caution in patients with positive anti-Tg antibodies. Tg levels were arbitrarily divided into low, intermediate and high levels, according to commonly used clinical Tg level ranges (<2 ng/mL, 2-10 ng/mL and >10 ng/mL), although there is no universally accepted Tg level for RAI dose calculation.

- *RAI administration and dose determination*
RAI activity had been prescribed in accordance with institutional clinical practice and guideline-based recommendations that considered clinicopathological risk factors, postoperative parameters and physician judgment. The activities administered varied from 30 to 150 mCi and did not follow a study-determined algorithm. These findings indicate that patients with stiffer tissues and elevated Tg levels were administered higher doses of RAI activity; however, this is attributable to the clinical decision-making process rather than protocol-driven dose calculation. Therefore, the correlations between SWE, Tg, levothyroxine therapy and administered RAI activity are post hoc and not indicative of optimization or decision-making processes (Simões-Pereira *et al*., 2021).

Statistical analysis
Descriptive statistics were employed to ascertain the demographic, clinical and imaging features of the patients, as well as their laboratory results. The results of numerical variables were expressed as means with standard deviations, while those of categorical variables were expressed as frequencies and percentages. The relationship between SWE results, levels of Tg, use of levothyroxine and activity of RAI administered to the patients was evaluated through correlation and group comparisons, where appropriate. However, regression modeling or adjustment for covariates was not conducted due to constraints in sample size and restricted access to oncological covariates. All statistical computations were done with SPSS software, version 25.0 and a two-tailed p-value of less than 0.05 was considered to be statistically significant.

RESULTS

Patient demographics and baseline characteristics
The study included 100 patients, 60 of whom were receiving levothyroxine treatment at the time of RAI administration, while 40 were not. The average age of the people in the study was 48.5 ± 11.9 years for the levothyroxine group and 47.8 ± 13.4 years for the non-levothyroxine group. There were almost the same number of men and women in both groups: 58% of the levothyroxine group and 56% of the non-levothyroxine group (Table 1). The initial demographic and clinical characteristics, including body mass index (BMI), serum TSH levels, and SWE values, were similar in both groups, with no statistically significant differences (all $p > 0.05$). As the study is observational, the results do not account for the potential influence of unmeasured confounding variables.

Association of SWE and Tg levels with administered RAI activity
Higher values of SWE were found to be associated with higher Tg levels and both variables were found to have positive correlations with the administered RAI activity. In particular, SWE was found to have a strong positive correlation with RAI activity ($r = 0.74$, $p < 0.01$), while Tg levels were also found to have a positive correlation with administered RAI activity ($r = 0.68$, $p < 0.01$) (Table 2). These findings indicate that patients with stiffer tissues and elevated Tg levels were administered higher doses of RAI activity; however, this is attributable to the clinical decision-making process rather than protocol-driven dose calculation.

Levothyroxine therapy and RAI uptake parameters
Patients receiving levothyroxine therapy showed higher RAI uptake compared to those who did not receive levothyroxine therapy. The mean uptake values were 82.4% for patients receiving levothyroxine therapy and 65.1% for those who did not receive levothyroxine therapy and this showed statistical significance ($p = 0.04$). (Fig. 1) This should, however, be viewed with caution, as the use of levothyroxine therapy may not have been randomized and could have been due to differences in clinical preparation strategies, TSH levels at the time of RAI and disease status.

Levothyroxine therapy and administered RAI activity
The group of patients who were receiving levothyroxine had higher mean activities of RAI administered compared with the group that was not receiving levothyroxine. The mean activity of the administered RAI in the levothyroxine group was 103.5 ± 18.7 mCi and in the non-levothyroxine group, the mean activity of the administered RAI was 97.9 ± 20.3 mCi, with a statistically significant difference between the two groups ($p = 0.03$) (Table 3).

Treatment response
The proportion of subjects in the levothyroxine group with a positive short-term response to RAI treatment was greater than that in the non-levothyroxine group. The proportion of subjects with a positive short-term response to RAI treatment was 78% in the levothyroxine group and 56% in the non-levothyroxine group ($p = 0.05$) (Fig. 2).

Table 1: Baseline demographics of participants

Characteristic	Levothyroxine group (n=60)	Non-levothyroxine group (n=40)	p-value
Age (mean ± SD)	48.5 ± 11.9	47.8 ± 13.4	0.76
Gender (Female %)	58%	56%	0.72
BMI (mean ± SD)	24.2 ± 3.1	23.8 ± 3.2	0.62
Serum TSH (mean ± SD)	0.9 ± 0.5	1.0 ± 0.6	0.68
Mean SWE (m/s)	1.5 ± 0.3	1.4 ± 0.2	0.37

Note: The baseline information was comparable in both Levothyroxine and non-Levothyroxine groups

Table 2: Inter-relationship of SWE, Tg and RAI activity

Parameter	Correlation with RAI dose selection	p-value
SWE (m/s)	0.74	<0.01
Tg (ng/mL)	0.68	<0.01

Note: Both SWE and Tg levels strongly correlated with choosing higher RAI doses ($p < 0.01$).

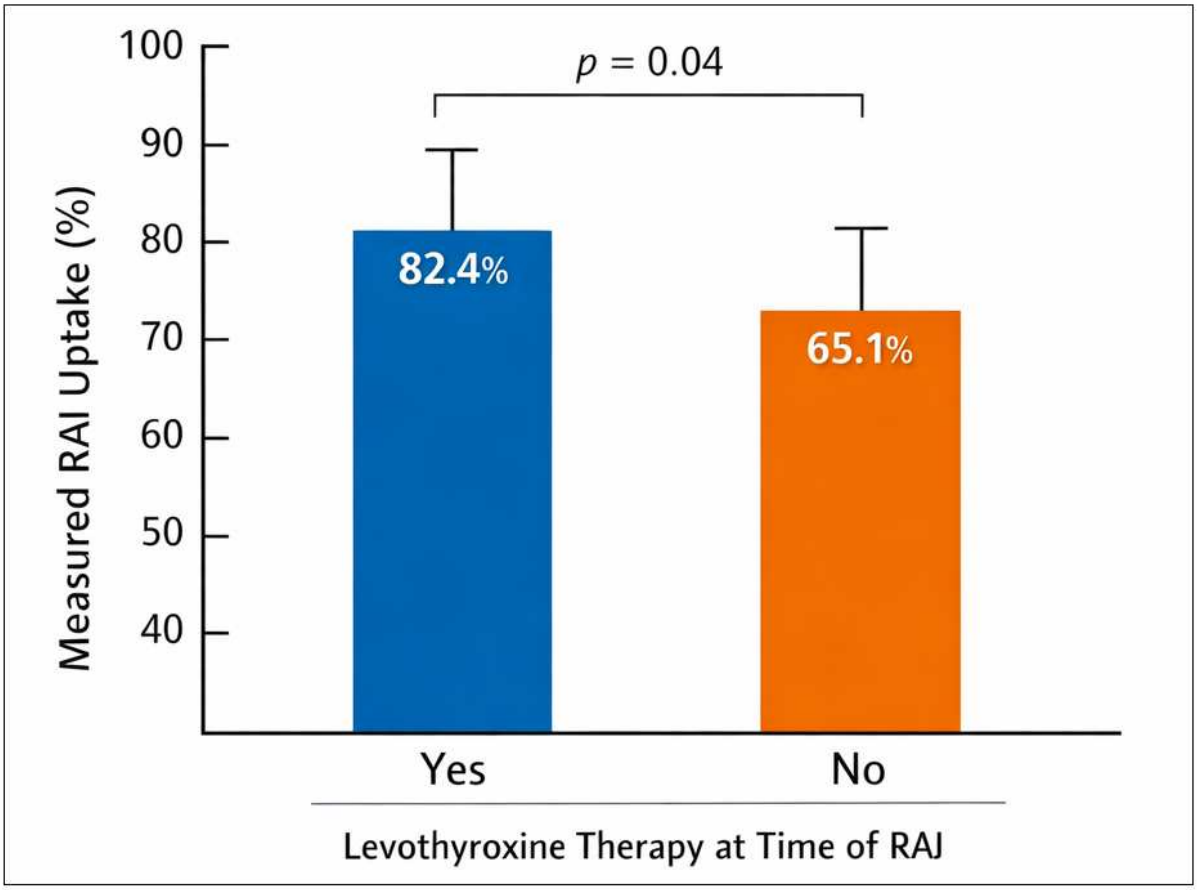

Fig. 1: Comparison of the measured uptake of RAI in the body of patients who received and did not receive levothyroxine before the RAI measurement; It is noticeable that the values are higher in the group that received levothyroxine, but this does not mean that the levothyroxine caused the increased values.

Table 3: Comparison of administered RAI activity in levothyroxine and non-levothyroxine groups.

Group	RAI Dose (mCi) (mean ± SD)	p-value
Levothyroxine-treated	103.5 ± 18.7	0.03
Non-Levothyroxine-treated	97.9 ± 20.3	

Note: Higher RAI doses were given to the Levothyroxine group ($p = 0.03$).

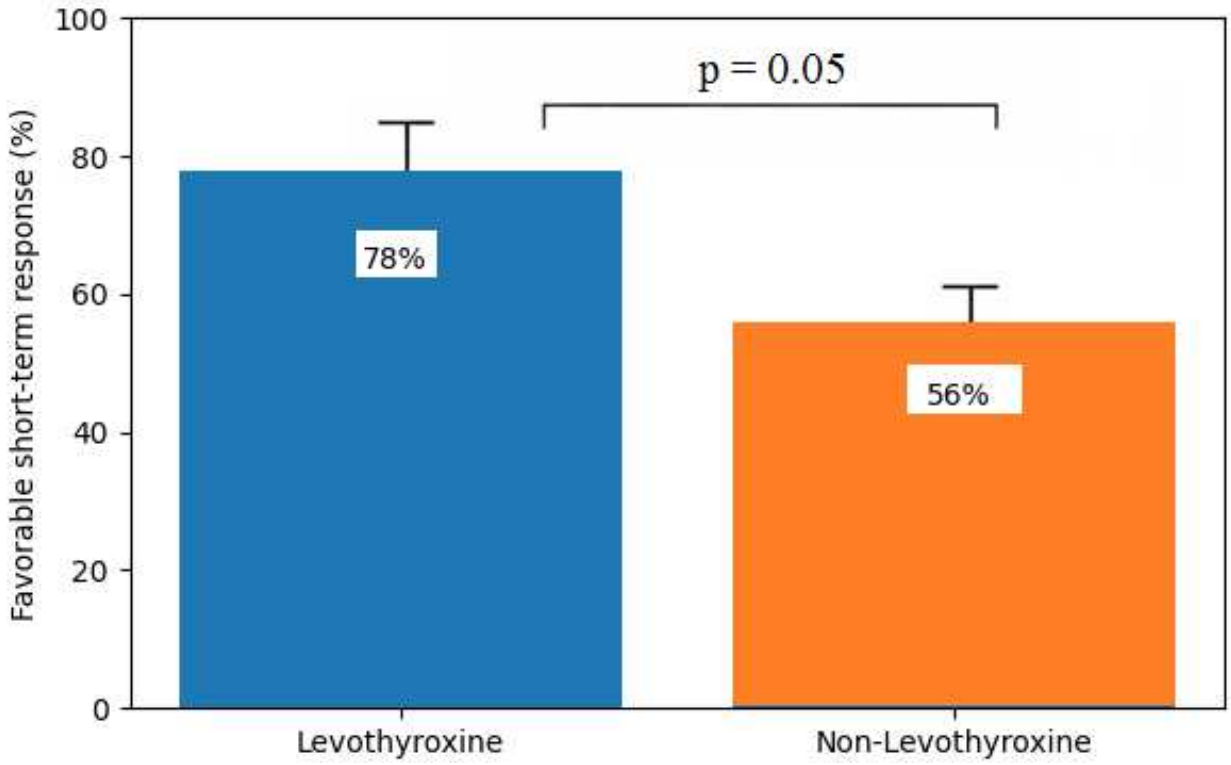

Fig. 2. Distribution of short-term treatment response categories following RAI therapy according to levothyroxine therapy status; A higher percentage of favorable responses was found among patients receiving levothyroxine therapy; however, it should be noted that this was an observational study and should be interpreted with caution.

Table 4: Adverse events by group

Adverse event	Levothyroxine group (%)	Non-Levothyroxine group (%)	p-value
Mild side effects (e.g., tremors)	12	14	0.74
Severe complications	0	0	1.00

Note: There was no difference of clinical importance between the groups in the incidence of adverse events.

The results need to be adjusted with reference to possible confounders, including disease burden, TSH levels at the time of RAI and activity of RAI administered.

Adverse events

No significant differences were noted in adverse events between the two groups. Mild symptoms such as palpitations or tremors were noted in 12% of the levothyroxine group and 14% of the non-levothyroxine group (p = 0.74). Severe complications were not noted in either group (Table 4).

As part of this observational cohort, increases in SWE and Tg were positively correlated with increases in RAI activities used. Patients receiving levothyroxine therapy correlate with increased RAI uptake, activities used and RSI. Nevertheless, it is important to recognize that positive correlations do not inherently indicate causal relationships and may represent diverse preparation strategies. Overall, it shows that SWE and Tg can play an exploratory, adjunctive postoperative validating function, rather than SWE and Tg being considered useful in RAI activities.

DISCUSSION

DTC continue to be a major issue in endocrine oncology. After surgery, RAI therapy is often used as an extra treatment for some groups of patients. Guidelines that take into account tumor size and histopathology are helpful for figuring out RAI doses, but there is still a lot of variation between patients, which makes it hard to customize treatment to each person's needs (Uysal *et al*., 2022; Signore *et al*., 2023; Chou *et al*., 2022).

This study found that higher SWE values and Tg levels were linked to higher RAI activity. This suggests that these tests could be useful in making treatment decisions. This indicates that imaging-based tissue stiffness parameters as well as Tg might not independently affect radioiodine therapy effectiveness but possibly correlate with the

decision process of radioiodine administration in clinical practice. Therefore, SWE should be considered only as a predictor but not as a mediator of iodine uptake in tissues (Coerts *et al*., 2023; Ma *et al*., 2025). An additional association was found to be related to the status of levothyroxine therapy, including RAI uptake, the administered activity and short-term treatment response, although it should be noted that this did not necessarily imply causality in the effect of levothyroxine on RAI uptake or treatment response. When assessing the physiological rationale, it should be noted that levothyroxine decreases thyroid-stimulating hormone (TSH), whereas TSH levels have been demonstrated to have an effect in increasing the uptake of iodine by thyroid cells and it can logically be deduced that the association found in the aforementioned matter might have been due to the preparation strategy and timing of the disease state.

Previous reports have shown that TSH stimulation, either by hormone withdrawal or recombinant human TSH, is essential to maximum RAI uptake, while TSH suppression has the primary effect of minimizing tumor stimulation rather than enhancing the effectiveness of radioiodine (Motaz and Graham, 2025; Daraghma and Graham, 2025; Coerts *et al.,* 2023). The current data should therefore not be viewed as demonstrating a beneficial effect of levothyroxine on RAI uptake but rather an observational association in a heterogeneous real-world cohort. Thus, the evaluation of both SWE and Tg can be considered more of an exploratory method than a replacement for traditional risk stratification systems or recommended RAI dosing strategies. While both tumor markers have been assessed separately, a combined evaluation, especially concerning RAI activity, has not been thoroughly documented. However, the lack of standardized evaluation criteria or recommendations for SWE, Tg, or decision algorithms impedes rapid clinical applicability (Tong *et al*., 2022).

Furthermore, efforts should be made to highlight and emphasize that the administered RAI activity within the context of the present study refers to a decision outcome rather than a surrogate measure of optimal dose response in relation to therapy effectiveness. The selection process of choosing the best RAI activity is not only complex but involves several variables such as practice patterns of institutions and physicians, physician expertise in handling and managing related cases in different institutions, perception of patient risk factors and many logistic considerations that may not be accounted for in terms of C/P variables. The relationships established in relation to SWE, Tg levels and levothyroxine therapy and RAI activity should be regarded or accepted as reflective outcomes rather than indicators of effectiveness (Zha *et al*., 2025; Simões-Pereira *et al*., 2021).

In this context, the salience of this present investigation resides in its capacity to address the manner in which new measures of imaging and biochemical markers coexist with traditional measures of clinical factors in the context of routine postoperative management. By exploring these relationships without necessarily adhering to a previously conceptualized model of a dosing system, this investigation avoids circular reasoning and identifies where judgment might be implied as an aspect of clinical decision-making. This study could potentially foster a framework for future research regarding the efficacy of SWE and Tg in enhancing RAI administration in a standardized manner while facilitating guideline-driven treatment (Tong *et al*., 2022). A superior response was observed within the initial year among patients treated with levothyroxine; however, this effect should be interpreted with the understanding that patients receiving levothyroxine, compared to those who did not, may have differed in tumor stage, tumor burden, RAI activity, or TSH levels. There was no randomization, which makes it impossible to make multivariate adjustments (Finessi *et al*., 2021).

There are, naturally, by virtue of this study, certain limitations that should not be forgotten. First, the study was performed within one center, making its generalization limited. Second, the multivariate analysis did not take into account the big picture of oncology-related factors, like the stage of the cancer, the involvement of lymph nodes, or risk stratification. Third, the TSH levels, namely upon RAI administration, were not controlled, nor was the intra-observer or inter-observer variation in the SWE evaluated. Lastly, the evaluation of treatment outcome was not based upon long-term follow-up, such as survival or recurrence (Oh and Ahn, 2021; Ma *et al*., 2025; Mayson et al., 2021).

The main finding of this investigation is that SWE of tissue stiffness and plasma Tg may serve as secondary tools, but their clinical utility in RAI dose selection for low-risk thyroid carcinoma is not yet established. Validation in larger, multicenter prospective trials is needed, with direct comparison to consensus-based approaches (Cantisani *et al.,* 2025; Jung *et al.,* 2023; Boers *et al.,* 2023; Simoes-Pereira *et al.,* 2021). Additionally, the study highlights the potential role of thyroid health indicators such as SWE and Tg in RAI therapy and underscores the influence of nutritional factors, like iodine status and diet, on thyroid function and related aspects of mental health and quality of life (Majali *et al.,* 2025a; Ebadi, 2025; Majali *et al.,* 2025b).

CONCLUSION

The investigation of the relationship of SWE, serum levels of thyroglobulin, the status of levothyroxine therapy and the variables of RAI therapy in DTC after thyroidectomy includes the observation that shear wave elastogram and serum level of thyroglobulin have been related to the activity of RAI administered, stressing their possible value as adjuncts in the practice of the diagnosis of DTC.

Additionally, the administration of levothyroxine appeared to influence the uptake and short-term results of the RAI, although it should be stressed that great care must be taken in the formulation of the significance of the RAI uptake in relation to levothyroxine, considering that it only works to lower the levels of serum-free thyroid hormone and not contribute to the uptake of RAI by thyroid cells. Therefore, it can be said that a combination of shear wave and levels of thyroglobulin may have value in the post-operative workup of the patient, in relation to the methods of stratification that have been accepted in the practice, although it did not have value in formulating the variables of RAI in the individual patient undergoing treatment.

Acknowledgements
The authors express gratitude to the Shanghai General Hospital Clinical School of Nanjing Medical University (China) for their assistance in conducting this study.

Authors' contributions
Lou Kexin contributed to study design, data collection and analysis. Wu Rong led study design, data interpretation and manuscript preparation, supervising the research and providing critical revisions. Both authors contributed equally to writing and revising the manuscript.

Funding
There was no funding.

Data availability statement
The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Ethical approval
This study was approved by the Ethics Committee of Shanghai General Hospital, Clinical School of Nanjing Medical University, with approval number 2023(417). All participants provided written informed consent prior to inclusion in the study.

Conflict of interest
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

REFERENCES

Boers T, Braak SJ, Rikken NE, Versluis M and Manohar S (2023). Ultrasound imaging in thyroid nodule diagnosis, therapy, and follow-up: Current status and future trends. *J. Clin. Ultrasound*, **51**(6): 1087-100.

Bojunga J and Trimboli P (2024). Thyroid ultrasound and its ancillary techniques. *Rev. Endocrinol. Metab. Disord.*, **25**(1): 161-73.

Cantisani V, Bojunga J, Durante C, Dolcetti V and Pacini P (2025). Multiparametric ultrasound evaluation of thyroid nodules. *Ultraschall Med.*, **46**(01): 14-35.

Chambara N, Lo X, Chow TC, Lai CM, Liu SY and Ying M (2022). Combined shear wave elastography and EU TIRADS in differentiating malignant and benign thyroid nodules. *Cancers*, **14**(22): 5521.

Chou R, Dana T, Brent GA, Goldner W, Haymart M, Leung AM, Ringel MD and Sosa JA (2022). Serum thyroglobulin measurement following surgery without radioactive iodine for differentiated thyroid cancer: A systematic review. *Thyroid.*, **32**(6): 613-39.

Coerts HI, de Keizer B, Marlowe RJ and Verburg FA (2023). Recombinant or endogenous thyroid-stimulating hormone for radioactive iodine therapy in thyroid cancer: State of knowledge and current controversies. *Eur. J. Endocrinol.*, **188**(2): R23-35.

Daraghma M and Graham MM (2025). Recombinant human TSH versus thyroid hormone withdrawal: The role in the preparation for RAI therapy in differentiated thyroid cancer: A comprehensive evidence-based review. *J. Clin. Med.*, **14**(14): 5000.

Ebadi AG (2025). Synergistic approaches in diabetes management: The role of anti-diabetic drugs and herbal medicine in therapeutic strategies. *Nepal J. Med. Sci.,* **10**(2): 9.

Ebadi AG and Alp Arici EC (2022). Cancer trends in Iran: Epidemiology, risk factors, and preventive strategies. *Eur. J. Med. Biol. Sci.,* **5**(1): 58-62.

Finessi M, Bisceglia A, Passera R, Rossetto Giaccherino R, Pagano L, Castellano G, Ghigo E, Bisi G and Deandreis D (2021). Predictive factors of a worse response to radioactive iodine-I131 treatment in hyperthyroidism: Outcome analysis in 424 patients. A single centre experience. *Endocrine.*, **73**(1): 107-15.

Iakovou I, Giannoula E and Sachpekidis C (2020). Imaging and imaging-based management of pediatric thyroid nodules. *J. Clin. Med.*, **9**(2): 384.

Jung EM, Stroszczynski C and Jung F (2023). Advanced multimodal imaging of solid thyroid lesions with artificial intelligence-optimized B-mode, elastography, and contrast-enhanced ultrasonography parametric and with perfusion imaging: Initial results. *Clin. Hemorheol. Microcirc.*, **84**(2): 227-36.

Kara T, Ates F, Durmaz MS, Akyurek N, Durmaz FG, Özbakır B and Ozturk M (2020). Assessment of thyroid gland elasticity with shear-wave elastography in Hashimoto's thyroiditis patients. *J. Ultrasound.*, **23**(4): 543-51.

Layek K, Basak B, Samanta S, Maity SP and Barui A (2021). Stiffness prediction on elastography images and neuro-fuzzy based segmentation for thyroid cancer detection. *Appl. Optics.*, **61**(1): 49-59.

Leng X, Liu J, Zou Q, Wang C and Yang S (2024). Application of color doppler ultrasound and US shear wave elastography with connective tissue growth factor in the risk assessment of papillary thyroid carcinoma. *BMC Med. Imaging.*, **24**(1): 173.

Li H, Heravi MRP, Ebadi AG, Ahmadi S and Sarkar A (2022). Study the nature of the interaction between 5-

fluorouracil anti-cancer drug and zinc oxide nanocage. *Brazil. J. Phys.*, **52**(2): 53.

Ma T, Xie Y, Long X and Ye F (2025). High risk factors, molecular features and clinical management for radioactive iodine-refractory differentiated thyroid carcinoma. *Front. Oncol.*, **15**: 1644562.

Majali SAL, Ebadi M, Selamoglu Z and Ebadi AG (2025a). Integrating nutrition and mental health: Mechanistic pathways, clinical evidence, and public health policy implications. *Wah Acad. J. Health Nutr.,* **1**(2): 33-40.

Majali SAL, Ebadi M, Selamoglu Z, Ebadi AG and Moslemi M (2025b). Navigating the intersection of mental health and nutrition in adolescent girls: Addressing the dual challenge–A short review. *Wah Acad. J. Health Nutr.,* **1**(3): 47-50.

Matrone A, Campopiano MC, Nervo A, Sapuppo G, Tavarelli M and De Leo S (2020). Differentiated thyroid cancer, from active surveillance to advanced therapy: Toward a personalized medicine. *Front. Endocrinol.*, **10**: 884.

Mayson SE, Chan CM and Haugen BR (2021). Tailoring the approach to radioactive iodine treatment in thyroid cancer. *Endocr. Relat. Cancer.*, **28**(10): T125-40.

Mihailovic J (2025). Evolving paradigm in radioactive iodine therapy for differentiated thyroid cancer: Historical perspectives, current practices and future directions. *Diagnostics.*, **15**(11): 1438.

Motaz D and Graham MM (2025). Recombinant human TSH versus thyroid hormone withdrawal: The role in the preparation for RAI therapy in differentiated thyroid Cancer: A comprehensive evidence-based review. *J. Clin. Med.,* **14**(14): 5000.

Oh JM and Ahn BC (2021). Molecular mechanisms of radioactive iodine refractoriness in differentiated thyroid cancer: Impaired sodium iodide symporter (NIS) expression owing to altered signaling pathway activity and intracellular localization of NIS. *Theranostics.*, **11**(13): 6251.

Pacilio M, Conte M, Frantellizzi V, De Feo MS, Pisani AR, Marongiu A, Nuvoli S, Rubini G, Spanu A and De Vincentis G (2022). Personalized dosimetry in the context of radioiodine therapy for differentiated thyroid cancer. *Diagnostics.*, **12**(7): 1763.

Roseland ME, Dewaraja YK and Wong KK (2022). Advanced imaging and theranostics in thyroid cancer. *Curr. Opin. Endocrinol. Diabetes Obes.*, **29**(5): 456-65.

Simões-Pereira J, Ferreira TC, Limbert E, Cavaco BM and Leite V (2021). Outcomes of thyrotropin alfa versus levothyroxine withdrawal-aided radioiodine therapy for distant metastasis of papillary thyroid cancer. *Thyroid.*, **31**(10): 1514-22.

Signore A, Lauri C, Di Paolo A, Stati V, Santolamazza G, Capriotti G, Prosperi D, Tofani A, Valabrega S and Campagna G (2023). Predictive role of serum thyroglobulin after surgery and before radioactive iodine therapy in patients with thyroid carcinoma. *Cancers.*, **15**(11): 2976.

Tong Y, Zhang J, Wei Y, Yu J, Zhan W, Xia H, Zhou S, Wang Y and Chang C (2022). Ultrasound-based radiomics analysis for preoperative prediction of central and lateral cervical lymph node metastasis in papillary thyroid carcinoma: A multi-institutional study. *BMC Med. Imaging.*, **22**(1): 82.

Uysal E, Kara Gedik G, Durmaz MS, Yılmaz F and Batur A (2022). Can shear wave elastography determine remnant thyroid tissue in the early postoperative period in patients with differentiated thyroid carcinoma?. *J. Ultrasound.*, **25**(2): 273-80.

Volpe F, Nappi C, Zampella E, Di Donna E, Maurea S, Cuocolo A and Klain M (2024). Current advances in radioactive iodine-refractory differentiated thyroid cancer. *Curr. Oncol.*, **31**(7): 3870.

Zha XY, Xu ZH, Dong JJ, Xie LX, Lai PB, Wei CS, Zheng HQ, Huang DB and Wu JZ (2025). Integrating shear wave elastography into clinical prediction of Graves' disease recurrence: A novel risk scoring system. *Front. Endocrinol.*, **16**: 1551983.