Original Article

Relationship between preoperative FT3 levels and new-onset atrial fibrillation after off-pump coronary artery bypass grafting

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Background: Postoperative atrial fibrillation (POAF) is the most common arrhythmia after cardiac surgery. While thyroid dysfunction can predict POAF, the association between preoperative serum free triiodothyronine (FT3) levels and POAF in patients undergoing off-pump coronary artery bypass (OPCAB) grafting remains unclear. This study aimed to investigate the relationship between preoperative FT3 levels and POAF in OPCAB patients.

Methods: This prospective observational study included patients with sinus rhythm and no history of atrial fibrillation or thyroid disease who underwent OPCAB and FT3 testing at the Tianjin Chest Hospital from June 2021 to March 2023. The relationship between FT3 level and POAF was evaluated using restricted cubic spline. Cox proportional hazards regression models were used to analyze the associations between FT3 concentration categories [low T3 syndrome (LT3S) (FT3 below the normal range), low normal FT3 (3.10–4.59 pmol/L), high normal FT3 (4.60–6.80 pmol/L)] and POAF, adjusting for potential confounders. Stratified analyses were performed to assess effect modification by gender and age (<60 *vs.* ≥60 years old).

Results: Among 875 patients, 259 (29.6%) developed POAF within 2 days after surgery. Restricted cubic spline analysis showed an S-shaped association between FT3 concentration and POAF risk. Compared to the low normal FT3 group, LT3S was associated with an increased risk of POAF [hazard ratio (HR), 1.41; 95% confidence interval (CI): 1.90–2.19], while high normal FT3 was associated with a decreased risk (HR, 0.72; 95% CI: 0.51–0.99). The association between FT3 and increased POAF risk was more pronounced in patients aged ≥60 years (HR, 1.41; 95% CI: 1.89–2.22).

Conclusions: Preoperative FT3 levels most likely could predict POAF risk after OPCAB, especially in patients aged 60 years and older. Measuring FT3 preoperatively may identify high-risk patients benefiting from close monitoring and prophylactic treatment. Further investigation of thyroid hormone replacement therapy for LT3S is warranted.

Keywords: Free T3 (FT3); low T3 syndrome (LT3S); off-pump coronary artery bypass grafting (OPCAB); postoperative atrial fibrillation (POAF); thyroid hormone

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Introduction

Postoperative atrial fibrillation (POAF) represents the most common arrhythmia following cardiac surgery, affecting 20–55% of patients (1). Its occurrence portends an array of adverse cardiovascular events, including stroke, heart failure, and increased mortality. Furthermore, the development of POAF significantly prolongs hospital length of stay and elevates healthcare costs (2-4). Moreover, patients who experience an episode of POAF face heightened susceptibility to recurrent or persistent arrhythmia (5). Despite extensive research efforts to elucidate the pathophysiologic mechanisms underlying POAF and evaluate preventive therapies, no pharmacological interventions have definitively demonstrated efficacy in reversing or abbreviating the arrhythmic course once manifested in the postoperative setting (6,7). Therefore, gaining deeper insights into novel risk factors and elucidating the key cellular and molecular drivers are critical priorities to guide more effective risk stratification and prophylactic treatment strategies against POAF.

Perturbations in thyroid hormone levels have been implicated as potential triggers for arrhythmia development. Indeed, both overt hyperthyroidism and hypothyroidism, as well as more subtle subclinical manifestations, have been identified as risk factors for POAF onset (8,9). Low T3 syndrome (LT3S), a condition characterized by decreased serum triiodothyronine (T3) levels that can occur secondary to severe illness, trauma, malignancy, or major surgery, represents one such subclinical thyroid abnormality of particular relevance. Despite an absence of primary thyroid disease, LT3S reflects a form of non-thyroidal illness syndrome (NTIS) or euthyroid sick syndrome, wherein thyroid-stimulating hormone (TSH) levels remain normal (10). This condition is observed in approximately 15–20% of individuals who have experienced myocardial infarction, with a median annual incidence of heart failure ranging from 20% to 30% (11). Crucially, LT3S has been significantly associated with adverse prognosis following cardiac surgery, portending a 20–80% increase in mortality risk (11,12). These observations underscore the potential prognostic implications of dysregulated thyroid hormone homeostasis, even in subclinical states like LT3S, in the cardiac surgical population.

Off-pump coronary artery bypass grafting (OPCAB) has emerged as an established surgical technique over the past three decades. Compared to traditional on-pump procedures, OPCAB offers several potential advantages by circumventing the physiologic insults associated with cardiopulmonary bypass and aortic manipulation. Specifically, OPCAB has been demonstrated to reduce early mortality risk, neurological complications, acute kidney injury, transfusion requirements, and length of hospital stay (13). Despite these clinical benefits, the relationship between preoperative thyroid status, as reflected by circulating free T3 (FT3) levels, and the risk of POAF in OPCAB patients remains unclear. Accordingly, this study aimed to characterize the association between preoperative FT3 levels and POAF susceptibility among patients undergoing OPCAB. We present this article in accordance with the STROBE reporting checklist (14) (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-655/rc).

Highlight box

Key findings

- Low preoperative serum free triiodothyronine (FT3) levels were associated with an increased risk of postoperative atrial fibrillation (POAF) in patients undergoing off-pump coronary artery bypass grafting (OPCAB), particularly in those aged 60 years and older.

What is known and what is new?

- POAF is the most common arrhythmia following cardiac surgery. Thyroid dysfunction is a clinically significant predictor for POAF.
- This study elaborated the correlation between FT3 and POAF, and provided new evidences for the management of complications of OPCAB.

What is the implication, and what should change now?

- For patients with decreased preoperative FT3 levels, close perioperative and postoperative electrocardiogram monitoring is recommended, along with the administration of antiarrhythmic medications as needed to prevent POAF.

Methods

Study design and patient selection

This prospective observational study is a subanalysis of the Tianjin Science and Technology Program project "Early warning method and application of perioperative adverse events in OPCAB surgery based on artificial intelligence data analysis" (ChiCTR2100045079). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of Tianjin Chest Hospital (No. 2020YS-022-01) and informed consent was taken from all the patients.

The clinical data of 1,442 consecutive patients who

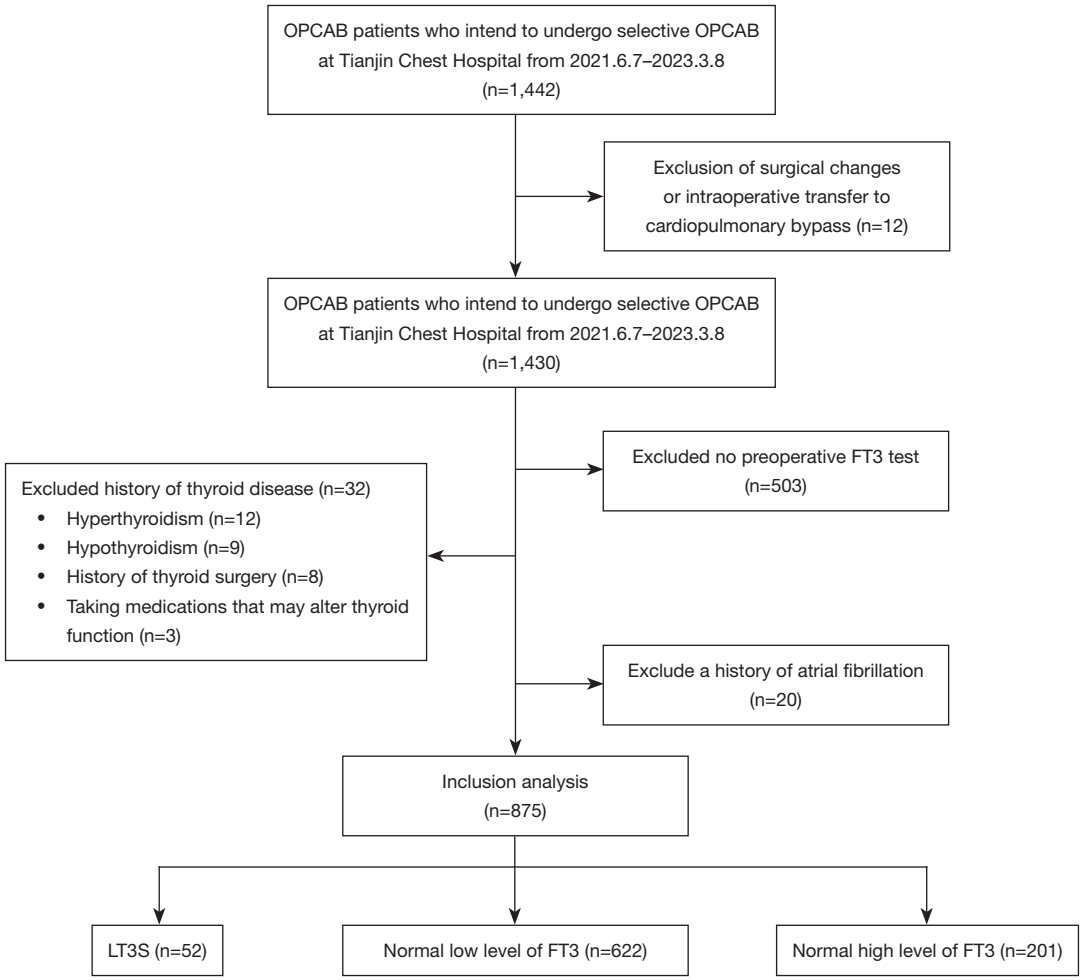

Figure 1 Patient inclusion flowchart. OPCAB, off-pump coronary artery bypass grafting; FT3, free triiodothyronine; LT3S, low T3 syndrome.

underwent OPCAB at Tianjin Chest Hospital from June 7, 2021 to March 8, 2023 were prospectively collected. The inclusion criteria were as follows: (I) elective OPCAB surgery; (II) American Society of Anesthesiologists (ASA) classification ≥ II; and (III) availability of preoperative FT3 data. The exclusion criteria were as follows: (I) refusal to participate; (II) acute or decompensated heart failure or respiratory failure; (III) intraoperative conversion to on-pump cardiopulmonary bypass; (IV) preoperative diagnosis of hyperthyroidism or hypothyroidism; (V) use of medications impacting thyroid function (e.g., amiodarone); (VI) history of thyroid surgery; (VII) preoperative atrial fibrillation (AF) or antiarrhythmic drug use; and (VIII) incomplete data. After applying these criteria, the final analysis cohort comprised 875 patients (*Figure 1*).

Thyroid function tests and stratification

Serum TSH, FT3, and free tetraiodothyronine (FT4) levels were determined using the COBAS e 602 (Roche Diagnostics, Rotkreuz, Switzerland) automated electrochemiluminescence immunoassay. The normal ranges for serum FT3, FT4, and TSH were established as 3.10–6.80 pmol/L, 12.00–22.00 pmol/L, and 0.27–4.20 mIU/L, respectively. LT3S was defined as an FT3 concentration below the lower limit of the normal range and a TSH concentration within the normal range. To clarify the potential association between FT3 and POAF, participants with normal FT3 concentrations were further stratified into a low normal concentration (3.10–4.59 pmol/L) group and a high normal concentration (4.60–6.80 pmol/L) group based on the median of the FT3 concentrations in the Cox

proportional hazards regression model.

Outcome and variables

The primary outcome was new-onset (or first detected) AF within 30 days after surgery. Patients were routinely monitored for the occurrence of arrhythmias during intensive care unit stay or general ward, and all cases underwent 12 lead electrocardiogram check during hospitalization every day. Independent researchers who oversaw the follow-up informed the patients or their families to go to the outpatient clinic of Tianjin Chest Hospital to review their postoperative conditions and recorded their information including POAF at 1 week and 1 month after surgery. POAF diagnosis arose from any of the following: (I) patient-reported symptoms suggestive of AF or detection of an irregular pulse during routine examinations, such as an ultrasound performed for other reasons; (II) AF detection by a bedside monitoring; (III) AF identification based on electrocardiographic findings obtained for different clinical indications; (IV) AF detection through cardiac rhythm recording devices, such as an external or implanted monitoring device or a pacemaker. POAF may have been presented as paroxysmal (self-terminating within 7 days) or persistent.

Potential confounding variables were predefined based on literature review and clinical experience, including: age, gender, body mass index, smoking history, diabetes mellitus, hypertension, dyslipidemia (assessed by statin use due to frequent missing lipid data), prior stroke, left atrial size (left atrial anterior-posterior diameter), left ventricular ejection fraction, European System for Cardiac Operative Risk Evaluation (EuroScore) II, preoperative serum creatinine level, duration of surgery, number of grafted vessels, and severe perioperative bleeding. The latter was graded according to the universal definition of perioperative bleeding (14). This assessment includes eight distinct events occurring either during surgery or on the first postoperative day: chest tube drainage, packed red blood cell transfusion, fresh frozen plasma transfusion, platelet transfusion, fibrinogen transfusion, prothrombin complex infusion, recombinant activating factor VII infusion, and surgical bleeding exploration. Severe bleeding was defined as class 3 or 4 per these criteria (Table S1).

Statistical analysis

Continuous variables with a normal distribution are expressed as means ± standard deviations, while those with a nonnormal distribution are summarized as medians [interquartile ranges (IQRs)]. Categorical variables are reported as frequencies (percentages). Normality was assessed using the Kruskal-Wallis test. The relationship between FT3 levels and POAF risk was evaluated through multivariate Cox proportional hazards regression model. Restricted cubic splines with four nodes (5th, 25th, 75th, and 95th percentiles of FT3) were used to flexibly model the FT3-POAF association. Three nested models were constructed: model 1 adjusted for age, gender, and body mass index; model 2 additionally adjusted for smoking, diabetes mellitus, hypertension, dyslipidemia, prior stroke, left atrial size, left ventricular ejection fraction, EuroSCOREII, and serum creatinine level; model 3 further adjusted for duration of surgery, number of grafted vessels, and severe perioperative bleeding. To handle missing data, multiple imputation using chained equations was performed for variables with <10% missingness. Cases with >10% incomplete data were excluded from primary analyses.

Since FT3 distribution varies by gender and age, stratum-specific analyses were conducted to assess effect modification based on gender and age (<60 *vs.* ≥60 years old). Low normal FT3 and high normal FT3 cut-points were defined separately within each stratum.

Statistical analysis was conducted using R version 4.3.1 (R Foundation for Statistical Computing, Vienna, Austria) and RStudio (PBC, Boston, MA, USA). All tests were two-tailed, and the significance level was set at $P<0.05$.

Results

Among the 875 included patients, 630 (72.0%) were male, and the mean age was 66.7±7.0 years old. The median hospital stay was 9 (IQR, 7–12) days. Participants with LT3S and low normal FT3 tended to be older, while male patients exhibited higher FT3 levels on average (*Table 1*).

A total of 259 (29.6%) patients developed POAF, with a median time to arrhythmia onset of 2.0 (IQR, 1.0–3.0) days. In the fully adjusted model 3, restricted cubic spline analysis revealed an S-shaped relationship between preoperative FT3 levels and POAF risk (*Figure 2*). Specifically, POAF risk decreased with incrementally higher FT3 when levels were <3.37 pmol/L. However, within the FT3 range of 3.37–4.45 pmol/L, there was no significant association with POAF. For FT3 concentrations >4.45 pmol/L up to the upper limit of 6.8 pmol/L, higher levels conferred a progressively lower POAF risk. Compared to the low normal FT3 group, patients with FT3 in the high normal

Table 1 Baseline characteristics of patients

Characteristics	LT3S	FT3 level	
		Low normal level (3.10–4.59 pmol/L)	High normal level (4.60–6.80 pmol/L)
Preoperative variables			
Number of patients	52 (5.9)	622 (71.1)	201 (23.0)
FT3 (pmol/L)	2.62±0.45	3.94±0.37	5.01±0.39
TSH (mU/L)	2.35±1.55	2.83±2.89	2.29±2.21
Age (years)	67.65±5.74	67.02±7.12	65.25±6.89
Male gender	35 (67.3)	439 (70.6)	156 (77.6)
BMI (kg/m^2)	25.22 [23.31–27.70]	25.35 [23.51–27.66]	25.62 [23.97–27.41]
History of smoking			
Never	26 (50.0)	277 (44.5)	82 (40.8)
Previous	19 (36.5)	223 (35.9)	69 (34.3)
Present	7 (13.5)	122 (19.6)	50 (24.9)
Diabetes mellitus	23 (44.2)	269 (43.2)	81 (40.3)
Hypertension	44 (84.6)	431 (69.3)	136 (67.7)
Dyslipidemia	48 (92.3)	564 (90.7)	179 (89.1)
Stroke	7 (13.5)	144 (23.2)	46 (22.9)
Left atrial dimension (mm)	39 [35–43]	38 [35–41]	38 [35–40]
LVEF (%)	59 [55–62]	59 [55–62]	58 [53–62]
EuroSCORE	4 [2–5]	4 [2–5]	3 [2–5]
Serum creatinine (μmol/L)	82 [71–92]	78 [66–92]	76 [66–85]
Intraoperative variables			
Duration of surgery (min)	205 [160–233]	195 [165–230]	190 [162–227]
Number of grafted vessels	3 [2–3]	3 [2–3]	3 [2–3]
Severe perioperative bleeding	0	18 (2.9)	3 (1.5)

Data are presented as frequency (percentage), mean ± standard deviation, or median [interquartile range]. BMI, body mass index; FT3, free triiodothyronine; LT3S, low T3 syndrome; LVEF, left ventricular ejection fraction; TSH, thyroid-stimulating hormone.

range had a 28% reduced POAF hazard [hazard ratio (HR), 0.72; 95% confidence interval (CI): 0.51–0.99], while those with LT3S faced a 41% relative risk increase (HR, 1.41; 95% CI: 1.90–2.19) (*Table 2*, *Figure 3*).

In stratified analyses, there was no significant effect modification by gender on the FT3-POAF relationship (*Figure 4A*). However, the association was amplified among patients aged ≥60 years, with the LT3S group exhibiting a 41% higher POAF risk compared to the low normal FT3 group (HR, 1.41; 95% CI: 1.89–2.22) (*Figure 4B*, *Table 3*).

Discussion

Our restricted cubic spline analysis unveiled a striking S-shaped relationship between preoperative serum FT3 levels and POAF risk among patients undergoing OPCAB. A clear dose-response pattern emerged, wherein POAF susceptibility increased incrementally as FT3 concentrations declined below 3.37 pmol/L. Patients diagnosed with LT3S exhibited a substantially elevated POAF hazard compared to those with low normal FT3 status. Conversely, at FT3

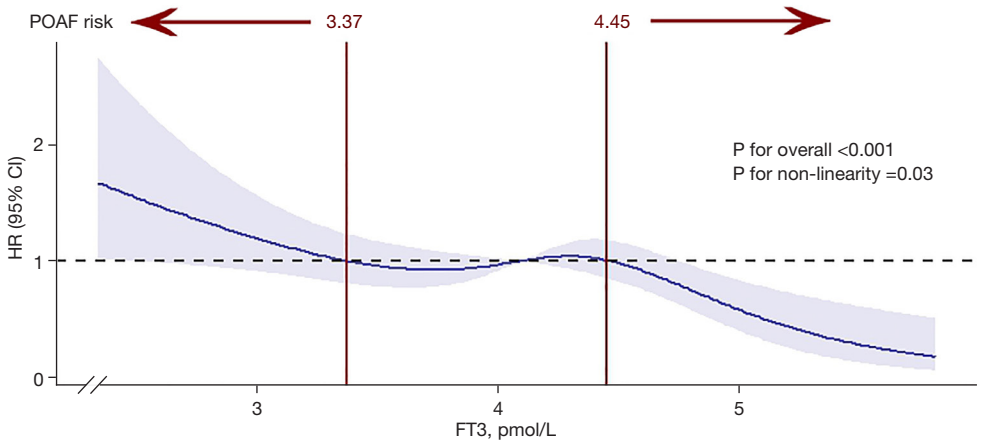

Figure 2 Relationship between FT3 concentration and risk of postoperative atrial fibrillation. HR, hazard ratio; CI, confidence interval; FT3, free triiodothyronine; POAF, postoperative atrial fibrillation.

Table 2 Relationship between FT3 concentration and POAF risk

FT3 concentration	POAF/total (n)	Adjusted HR (95% CI)		
		Model 1	Model 2	Model 3
<3.10 pmol/L	23/52	1.53 (1.99–2.36)	1.35 (1.89–2.12)	1.41 (1.90–2.19)
3.10–4.59 pmol/L	190/622	1 (reference)	1 (reference)	1 (reference)
4.60–6.80 pmol/L	46/201	0.75 (0.54–1.03)	0.70 (0.50–0.98)	0.72 (0.51–0.99)

Model 1: adjusted for age, gender, and BMI; model 2: adjusted for smoking history, diabetes mellitus, hypertension or dyslipidemia, history of stroke, left atrial size, left ventricular ejection fraction, EuroSCORE, and serum creatinine level; model 3: included all the covariates in model 2, in addition to the duration of surgery, number of grafted vessels, and severe perioperative bleeding. CI, confidence interval; FT3, free triiodothyronine; HR, hazard ratio; POAF, postoperative atrial fibrillation; BMI, body mass index.

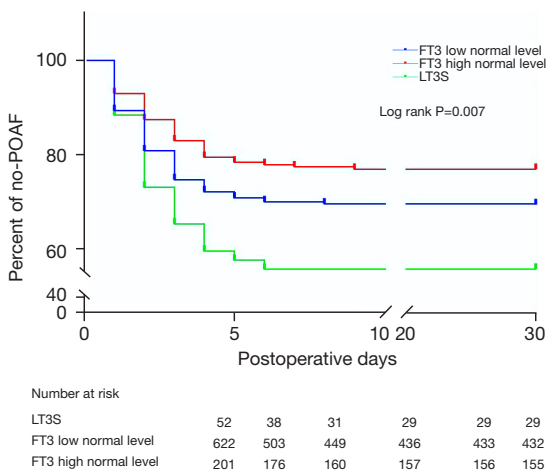

Figure 3 Survival curves of patients with POAF stratified by FT3 concentration. POAF, postoperative atrial fibrillation; FT3, free triiodothyronine; LT3S, low T3 syndrome.

levels exceeding 4.45 pmol/L up to the upper threshold of 6.8 pmol/L, incrementally higher values conferred a stepwise risk reduction for POAF development in a dose-dependent manner. Notably, this inverse relationship between FT3 and POAF appeared particularly amplified among older surgical candidates aged 60 years or above.

The concept of nonthyroidal illness syndrome, characterized by alterations in thyroid hormone levels secondary to systemic illness rather than primary thyroid dysfunction, was first described by Reichlin *et al.* in 1973 (15). Bremner *et al.* (16) subsequently identified the LT3S subtype, observing a rapid decline in circulating T3 below the normal range following initiation of cardiopulmonary bypass for cardiac surgery. This decrease in T3 persisted postoperatively, accompanied by increased reverse T3 levels but normal T4 and TSH, suggesting

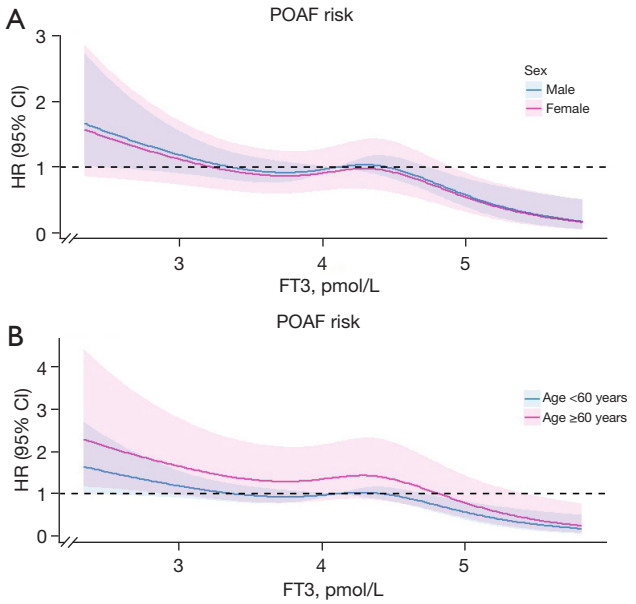

Figure 4 Stratified analysis of the relationship between FT3 concentration and POAF risk. (A) Multivariable-adjusted HRs (solid lines) and 95% CIs (shaded areas) for risk of POAF according to FT3 in men and women. (B) Multivariable-adjusted HRs (solid lines) and 95% CIs (shaded areas) for risk of POAF according to FT3 in patients aged ≥60 and <60 years. HR, hazard ratio; CI, confidence interval; FT3, free triiodothyronine; POAF, postoperative atrial fibrillation.

Table 3 Relationship between FT3 concentration and POAF risk at different age stratifications

FT3 (pmol/L)	Adjusted HR (95% CI)
<60 years old	
<3.10	1.05 (1.00–2.53)
3.10–4.59	1.00 (reference)
4.60–6.80	0.49 (0.15–1.56)
≥60 years old	
<3.10	1.41 (1.89–2.22)
3.10–4.59	1.00 (reference)
4.60–6.80	0.67 (0.47–0.96)

FT3, free triiodothyronine; POAF, postoperative atrial fibrillation; HR, hazard ratio; CI, confidence interval.

impaired outer ring deiodination as the underlying mechanism.

LT3S has since been associated with numerous adverse perioperative outcomes in extracorporeal cardiovascular surgery, including mortality (17), low cardiac output (18,19), acute kidney injury (20), delirium (21), prolonged ventilation, and extended hospitalization (22,23). Similar changes of a euthyroid sick response have also been observed in cardiac surgery with or without cardiopulmonary bypass (24). However, whether this biochemical abnormality warrants treatment remains controversial. Currently, there is no evidence-based consensus or guideline advocating the use of thyroid hormone replacement therapy for nonthyroidal illness syndrome in critically ill patients. A recent meta-analysis evaluating T3 supplementation in LT3S patients undergoing cardiovascular surgery found no improvement in cardiac index or left ventricular function (25), however, effects on other clinical endpoints are unclear.

Our findings suggest that even mild reductions in FT3, including subclinical levels still within the normal range, confer an increased POAF risk following OPCAB. This conclusion is reinforced by the dose-response relationship demonstrated through restricted cubic spline modeling. While previous studies have linked LT3S with unfavorable postoperative outcomes (10,26), our study specifically implicates preoperative FT3 as a novel risk factor for POAF in this surgical population.

Several potential mechanistic links could underlie the observed relationship between low FT3 levels and increased POAF susceptibility. Thyroid hormone receptors are expressed in cardiomyocytes, forming a pituitary-thyroid-cardiac axis through which even subtle fluctuations in T3 bioavailability could adversely impact cardiovascular function. At the cellular level, T3 plays a critical role in maintaining Ca^{2+} homeostasis within cardiomyocytes by facilitating Ca^{2+} sequestration into the sarcoplasmic reticulum during diastole and promoting its coordinated release during systolic depolarization (27). Moreover, T3 exerts genomic and non-genomic effects that modulate cardiac electrophysiology and chronotropic regulation. These include influencing the adrenergic receptor signaling complex as well as the functional expression and kinetics of key Na^{+}, K^{+}, and Ca^{2+} channels governing the cardiac action potential (28). Interestingly, calcitonin (a calciotropic hormone regulated by T3 implicated in bone metabolism) also appears to act as a paracrine factor capable of modulating osteoblast and fibroblast activity, thereby impacting extracellular matrix composition (29). While the precise mechanisms warrant further investigation, these complex interactions between thyroid hormones and

cardiomyocyte structure, function, and electrophysiology provide biological plausibility for our clinical observation linking low FT3 states to heightened POAF vulnerability following OPCAB. Elucidating these pathways may reveal novel therapeutic targets for arrhythmia prevention and management.

Our stratified analyses revealed that the inverse relationship between preoperative FT3 levels and POAF risk was more pronounced in the study population aged 60 years and older. In contrast, we did not observe any significant effect modification by patient gender on the FT3-POAF association. While women generally exhibit higher rates of progression from subclinical to overt thyroid dysfunction compared to men (30), this study did not find a gender-specific impact on the relationship between FT3 and POAF risk. The predominance of male patients (72%) in our surgical cohort may have limited our ability to detect gender-based differences. Further studies with more balanced gender representation are needed to comprehensively evaluate whether the impact of preoperative thyroid status on POAF susceptibility varies between men and women. Such investigations could shed light on potential gender-specific factors, such as differential responses to perioperative stress, that may modulate the relationship between FT3 and POAF risk. Understanding these nuances could help refine risk prediction models and identify subgroups that may derive greatest benefit from thyroid hormone screening and optimization prior to cardiac surgery.

Currently, thyroid hormone supplementation is not routinely prescribed for patients with mild biochemical thyroid dysfunction or LT3S prior to surgery. However, our findings suggest preoperative FT3 screening could have clinical utility for risk stratification and personalized management of OPCAB candidates. Even modest FT3 reductions within the normal range were associated with significantly heightened POAF susceptibility—a complication known to impair postoperative recovery and adversely impact long-term outcomes. Early identification of these high-risk patients could prompt enhanced intraoperative and postoperative cardiac monitoring, along with prophylactic antiarrhythmic therapy, to mitigate POAF development.

Moreover, our results provide a compelling rationale for prospective trials evaluating preoperative thyroid hormone replacement in OPCAB patients with low baseline FT3 levels. If normalizing thyroid status preoperatively proves effective in reducing POAF incidence, this could represent a novel therapeutic strategy to improve cardiac rhythm outcomes by modifying a readily identifiable and reversible risk factor in this surgical population. Incorporation of FT3 screening into preoperative assessment could enable tailored, risk-stratified perioperative management pathways optimized to prevent this consequential complication.

Limitations

This study had several limitations that should be addressed by future research. First, as a single-center study, the findings may not be fully generalizable until validated in multi-center cohorts. Second, although the sample size of 875 patients was reasonable, it may have been underpowered to detect smaller effect sizes, particularly in subgroup analyses stratified by factors such as gender. Larger studies with more events are needed to precisely quantify associations between FT3 levels and POAF risk across different patient demographics. Third, this study examined only preoperative FT3 levels; understanding the dynamic perioperative changes in thyroid hormone levels and their relationship with POAF could provide further mechanistic insights. Prospective longitudinal studies measuring FT3 serially before, during, and after OPCAB are warranted. Fourth, the susceptibility to thyroid dysfunction is definitely different between genders, however the gender differences regarding the predisposition to develop hyperthyroidism and the gender-specific incidence of POAF were not described in our study. Finally, this was an observational study, therefore, the causal relationship between LT3S and postoperative AF cannot be concluded and randomized controlled trials of thyroid hormone replacement therapy versus placebo in OPCAB patients with low preoperative FT3 levels are the crucial next step to establish whether correcting biochemical thyroid dysfunction can reduce POAF incidence and improve clinical outcomes. Such intervention studies should systematically evaluate POAF rates, dosing and timing of thyroid hormone supplementation, and safety profiles. Overcoming these limitations through rigorously designed future studies will help clarify the prognostic value of FT3 testing and determine if thyroid hormone optimization represents a viable preventive and therapeutic strategy against POAF in OPGABG patients.

Conclusions

This study identified a correlation between low

preoperative serum FT3 concentrations and an increased risk of POAF in patients undergoing OPCAB at our single center. Notably, this association was more pronounced among individuals aged 60 years and older. Further large-scale, multicenter studies are required to validate these findings and investigate the potential clinical benefits of perioperative thyroid hormone replacement therapy in patients with LT3S undergoing OPCAB. Such trials could provide valuable insights into optimizing management strategies to reduce POAF risk and improve postoperative outcomes in this high-risk surgical cohort.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-655/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-655/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-655/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of Tianjin Chest Hospital (No. 2020YS-022-01) and informed consent was taken from all the patients.

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Supplementary

Table S1 Classification of perioperative bleeding (13)

Bleeding definition	Delayed closure of the chest	24-hour postoperative chest tube drainage (mL)	Application of perioperative blood products and hemostatic products						Surgical hemorrhage exploration
			PRBC (U)	FFP (U)	PLT (U)	Fibrinogen	Prothrombin complex	Factor VII	
Grade 0	No	<600	0	0	0	No	No	No	No
Grade 1	No	601–800	1	0	0	No	No	No	No
Grade 2	No	801–1,000	2–4	1–4	Yes	Yes	Yes	No	No
Grade 3	Yes	1,001–2,000	5–10	5–10	N/A	N/A	N/A	No	Yes
Grade 4	N/A	>2,000	>10	>10	N/A	N/A	N/A	Yes	N/A

PRBC, packed red blood cells; FFP, fresh frozen plasma; PLT, platelet; N/A, not available.

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