

Changes in Thyroid Function in Patients Undergoing Cardiac Surgery Using Cardiopulmonary Bypass

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ABSTRACT

INTRODUCTION: After open heart surgery (OHS) using cardiopulmonary bypass (CPB), abnormalities in the circulating thyroid hormone levels are found in the absence of primary thyroid disease; this is collectively called the sick euthyroid syndrome (SES).

AIMS AND OBJECTIVES: To study thyroid function test in patients planned for cardiac surgery under cardiopulmonary bypass.

MATERIALS AND METHODS: This study included a total of 150 patients, of any age, either sex, planned for cardiac surgery under cardiopulmonary bypass (like Valve replacement, CABG, myxoma excision, congenital Heart Diseases like ASD, VSD, TOF). To assess the levels of thyroid hormone, TSH, TT3 and TT4 were measured. The blood samples were collected at regular intervals: preoperatively, on 2nd postoperative day and on 7th postoperative day.

CONCLUSION: In our study the levels of thyroid hormone (TT4 and TT3) decreased significantly after cardiopulmonary bypass.

Keywords: Open Heart Surgery (OHS), Cardiopulmonary Bypass (CPB), Sick Euthyroid Syndrome (SES)

I. INTRODUCTION

Surgical procedures and various drugs used in intensive care medicine have been reported to suppress the hypothalamic-pituitary-thyroid axis [1-3]. Alterations of thyroid hormone plasma concentrations in critical illness have also been attributed to

the euthyroid sick syndrome in adults and children [4]. Whether the euthyroid sick syndrome contributes to critical illness rather than results from it has yet to be established [5]. Alterations in pituitary-thyroid axis play crucial role in non-thyroidal illness, but the mechanism of these changes is only partially understood [6]. It has been postulated that inhibitors circulating in patients with non-thyroidal illness caused decreased binding of thyroxine to proteins [7]. These changes may be caused by tumor necrosis factor and cytokines such as interleukin-6, which are released during cardiopulmonary bypass [8-10]. Symptoms of hypothyroidism are often subtle and easy to be over-looked specially in patients with a heart disease and symptoms are thought to be from the existing cardiac condition. There is a consensus that patients with known hypothyroidism should be assessed for thyroid function before any surgery [11-13]. During systemic illness, especially after open heart surgery (OHS) using cardiopulmonary bypass (CPB), abnormalities in the circulating thyroid hormone levels are found in the absence of primary thyroid disease; this is collectively called the sick euthyroid syndrome (SES) [14]. Some argue that it is unclear if the clinical picture of SES is an adaptive process, a marker of the severity of the illness or even if treatment is warranted in these patients. In this study we analysed the

changes in thyroid hormone in the perioperative period of patients undergoing cardiac surgery involving cardiopulmonary bypass.

II. AIMS AND OBJECTIVES

To study the relationship between preoperative and postoperative thyroid function tests in patients undergoing cardiac surgery under cardiopulmonary bypass.

III. MATERIAL & METHODS

This prospective observational study was conducted at a tertiary care hospital in J&K, India for a period of 2 years. A total of 150 patients, of any age, either sex, planned for cardiac surgery under cardiopulmonary bypass (like Valve replacement, CABG, myxoma excision, Congenital Heart Diseases like ASD, VSD, TOF) were included in the study. To assess the levels of thyroid hormone; TSH (thyrotrophin), TT3 (Total T3) and TT4 (Total T4) were measured. The blood samples were collected at regular intervals: preoperatively, on 2nd postoperative day and on 7th postoperative day. Then, the serum was separated from the blood by centrifugation and stored at 2-7 °C until the assay was done. The serum concentration of the hormones was measured via the Immunoassay system.

INCLUSION CRITERIA:

All patients undergoing cardiac surgery using cardio pulmonary bypass for cardiovascular diseases.

EXCLUSION CRITERIA:

1. Use of certain drugs preoperatively known to affect serum thyroid hormone concentration like glucocorticoids, amiodarone, high dose of vasopressors/inotropes (dopamine or dobutamine $\geq 15\mu\text{g}/\text{kg}/\text{min}$; epinephrine or norepinephrine $\geq 1.0\mu\text{g}/\text{kg}/\text{min}$).
2. Renal or hepatic failure.
3. Patients already labelled as hypothyroid and receiving thyroxine supplementation.

IV. RESULTS

The mean TSH of our patients preoperative, on 2nd POD and on 7th POD was $4.87 \pm 3.42 \mu\text{IU}/\text{ml}$, $4.70 \pm 3.45 \mu\text{IU}/\text{ml}$ and $6.24 \pm 4.02 \mu\text{IU}/\text{ml}$ respectively. The mean TT4 preoperative, on 2nd postoperative day and on 7th postoperative day was $8.59 \pm 2.71 \mu\text{g}/\text{dl}$, $7.76 \pm 2.7 \mu\text{g}/\text{dl}$ and $8.16 \pm 2.58 \mu\text{g}/\text{dl}$ respectively. Similarly, mean TT3 preoperative, on 2nd postoperative day and on 7th postoperative day was $1.61 \pm 0.70 \text{ng}/\text{ml}$, $1.22 \pm 0.69 \text{ng}/\text{ml}$ and $1.40 \pm 0.63\text{ng}/\text{ml}$ respectively.

TSH of our patients on 2nd postoperative day decreased by a mean of $0.11 \mu\text{IU}/\text{ml}$ with respect to preoperative TSH and increased by a mean of $1.62 \mu\text{IU}/\text{ml}$ on 7th postoperative day with respect to 2nd postoperative day, both these changes were statistically significant (p value < 0.001). TT4 decreased by a mean of $0.92 \mu\text{g}/\text{dl}$ on 2nd postoperative day with respect to preoperative TT4 and increased by mean of $0.35 \mu\text{g}/\text{dl}$ on 7th postoperative day with respect to 2nd postoperative day, both these changes were statistically significant (p value < 0.001). Similarly, TT3 decreased by a mean of $0.40\text{ng}/\text{ml}$ on 2nd postoperative day with respect to preoperative TT3 and increased by mean of $0.17\text{ng}/\text{ml}$ on 7th postoperative day with respect to 2nd postoperative day, both of these changes were statistically significant (p value < 0.001).

Table 1. Thyroid Function Test Status in cardiac surgery patients pre and post operatively

TFT	Pre-Op (Day 0)	Post-Op (Day 2)	Post-Op (Day 7)
TSH($\mu\text{IU}/\text{ml}$)			
Median	4.30	4.20	5.50
Mean \pm SD	4.87 ± 3.42	4.70 ± 3.45	6.24 ± 4.02
95% C.I.	4.32 – 5.42	4.14 – 5.28	5.57 – 6.92
Range	0.2 – 23.2	0.32 – 22.98	0.24 – 26.2
T4($\mu\text{g}/\text{dl}$)			
Median	8.60	8.10	8.20
Mean \pm SD	8.59 ± 2.71	7.76 ± 2.71	8.16 ± 2.58
95% C.I.	8.16 – 9.02	7.32 – 8.22	7.72 – 8.59
Range	2.2 – 19.0	1.44 – 16.0	1.56 – 18.0
T3(ng/ml)			
Median	1.60	1.20	1.30
Mean \pm SD	1.61 ± 0.70	1.22 ± 0.68	1.40 ± 0.63
95% C.I.	1.51 – 1.73	1.11 – 1.34	1.30 – 1.51
Range	0.13 – 5.2	0.02 – 4.60	0.10 – 4.70

Table 2. Relation of Thyroid Function Tests with respect to day of surgery

	Change on Day2 Post-OP			Change on Day7 Post-OP*		
	Mean ±SD	Change	P value	Mean ±SD	Change	P value
TSH	-0.11 ±0.50	↓	0.010	1.62 ±2.39	↑	<0.001
TT₄	-0.92 ±2.02	↓	<0.001	0.35 ±1.11	↑	<0.001
TT₃	-0.40 ±0.48	↓	<0.001	0.17 ±0.38	↑	<0.001

*Compared to Day 2 post-op

V. DISCUSSION

A variety of acute illness lead to alterations of peripheral thyroid hormone metabolism. Characteristically, serum concentrations of TT3 and fT3 (free T3) are reduced, TT4 is either normal or reduced, fT4 (free T4) is reduced, and TSH concentrations are normal or decreased[15]. There are reports on the presence of this syndrome during and after CPB in adults and children. Our study had similar results. The results in our study are similar to study conducted by **Shiva *et al*** (16) who found the effect of Short and long CPB procedure on Thyroid function Test. In the long CBP procedure TT4 before surgery, on 2nd postoperative day and 7th postoperative day was 8.04 ± 3.05 µg/dl, 6.61 ± 2.50 µg/dl and 8.03 ± 2.70 µg/dl. In the long CBP procedure TT3 before surgery, on 2nd postoperative day and 7th postoperative day was 1.33 ± 0.72 ng/ml, 0.81 ± 0.46 ng/ml and 1.04 ± 1.05 ng/ml. In the short CPB group TT4 before surgery, on 2nd postoperative day and 7th postoperative day was 8.94 ± 2.68 µg/dl, 7.06 ± 2.60 µg/dl and 7.44 ± 2.48 µg/dl respectively. In the short CPB group TT3 before surgery, on 2nd postoperative day and 7th postoperative day was 1.68 ± 1.30 ng/ml, 0.91 ± 0.75 ng/ml and 0.85 ± 0.54 ng/ml respectively All these changes are in accordance with our study.

Babazadeh *et al* (17) found that preoperative mean TSH in his study was 4.01 ± 1.94 µIU/ml which decreased to 1.79 ± 1.62 µIU/ml on 2nd postoperative day (p value <0.001). Preoperative mean TT4 and TT3 in his study was 6.79 ± 1.37 µg/dl and 1.36 ± 0.42 ng/ml which decreased to 5.09 ± 1.59 µg/dl and 0.67 ± 0.27 ng/ml respectively on 2nd postoperative day (p value <0.001). These findings were similar to our findings.No data was collected for 7th postoperative day in this study.

Our results are similar to study conducted by **Bartkowski *et al*** (18) who reported that the average level of TT4 decreased from the level 126nmol/l before bypass to the minimal level 73nmol/l after bypass, fT4 decreased from the level 18pmol/l before bypass to the minimal level 12pmol/l after bypass. The average level of TT3 decreased from the level 1.54nmol/l before bypass to the minimal level 0.42nmol/l after bypass, fT3 decreased from the level 6.12pmol/l before bypass to the minimal level 3.21pmol/l after bypass.

Our study are also comparable with **Bettendorf *et al*** (19) who reported a low plasma concentration in TSH, T3, T4, whereas their RT3 plasma concentration increased in children with congenital heart disease undergoing cardiac surgery.

This is also consistent with study of **Aslan *et al*** (20) who found that TSH followed a similar pattern in patients who underwent cardiac surgeries under CPB.

Ho *et al* (21) in his study found a similar pattern of TSH in patients undergoing cardiopulmonary bypass. In this study mean TSH was graphically presented with respect to time of surgery and stay in hospital and it showed a decrease in TSH on 2nd postoperative day and increase on 7th postoperative day compared to preoperative TSH.

VI. CONCLUSION

In our study the levels of thyroid hormone (total T4 and T3) decreased significantly after cardiopulmonary bypass This warrants to study the effect of treatment with levothyroxine and whether treatment with levothyroxine in cardiac patients undergoing cardiopulmonary bypass is indicated.

Declaration by Authors

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