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Subclinical Hypothyroidism in Cardiac Surgery, A Post-operative Quagmire: Case Review

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Abstract

Thyroid disease in cardiac surgery is a challenge in regards to patient management especially post-operative as a result of two systems, endocrine and cardiovascular systems, working in antagonism. In this case review, we narrate a unique case of a 65-year-old African female with severe mitral regurgitation and incidental atrial septal defect who underwent mitral valve replacement and atrial septal defect closure. She later developed poor cardiac function post operatively owing to initially unrecognised subclinical hypothyroidism that was not being treated. This worsened post cardiopulmonary bypass and the setting of acute severe physiological stress secondary to cardiac surgery. On administration of thyroxine 100mcg daily, she improved haemodynamic and was later discharged. A discussion is made in focus to cardiac surgery in the background of hypothyroidism. Various literature reviews provide useful information in this field. However further studies on African based population are recommended to collaborate the existing data or even demonstrate variations in this population.

Keywords: Hypothyroidism; Thyroid Hormones; Thyroxine T4; Triiodothyronine T3; Cardiac Surgery; Cardiopulmonary Bypass.

Introduction

Subclinical hypothyroidism (SCH) typically presents with a picture of elevated Thyroid stimulating hormone (TSH) levels in the background of normal Triiodothyronine (T3) and Thyroxine (T4) levels. Cardiac surgery entails operation on the heart or its great vessels that may or may not involve going into cardiopulmonary bypass. A number of studies have tried to describe possible relationships in subclinical hypothyroidism patients undergoing various cardiac surgeries. Dr. Park and associates [1] clearly demonstrated a pattern of post-operative atrial fibrillation in patient with SCH undergoing Coronary artery bypass graft surgery (CABG). Dr. Cerillo [2] and Dr. Lervasi [3] and associates highlighted the impact of low T3 syndrome in patients with myocardial infarct and heat failure with its influence in recovery post-operative. Dr Rao [4] and associates, described a challenging case they managed in a hypothyroidic patient who underwent CABG in terms of poor post op cardiac function and witnessed unreliable responses in routine inotropes. In the spirit of adding useful information pool into this area, we will highlight our hospital based-findings on a unique case of subclinical hypothyroidism in a patient who had a severe mitral regurgitation with prolapse and an incidental finding Atrial septal defect. She underwent a mitral valve replacement with ASD closure.

Materials and Methods

We had a 65-year-old lady Mrs W, whose Last Delivery was 1989. She came in with a six-year history of easy fatiguability worsening in the last three months, chest pain on moderate exertion and vomiting history 3 days to presentation. Her major coronary risk factors included her post-menopausal state and history of sudden death in a brother at 70 years. She was normotensive, non-diabetic with no history of smoking. Other systems were essentially normal. She was on medications for anti-failure

started from a peripheral clinic. These were Losartan Hydrochlorothiazide 50mg/12.5mg once daily, carvedilol 3.125mg once daily, Furosemide 40mg once daily and an antiplatelet Aspirin 75mg once daily.

On examination, she was in mild respiratory distress with audible wheezing, with noted central obesity weight of 90kg, height of 165 (BMI 33). In her vitals, blood pressure was 75/54, with Heart rate of 78, SpO_2 of 94% in room air. Cardiovascular findings showed apical pan systolic murmur. 12 lead ECG showed atrial fibrillation, signs of left ventricular hypertrophy, non-specific T wave abnormalities and inferior leads ST elevation.

2D Transthoracic Echo findings showed severe mitral regurgitation with prolapse, left ventricle moderate dilatation with mild concentric hypertrophy, left atrium moderate dilatation and trace tricuspid regurgitation. Left ventricular ejection fraction was estimated at 58.4%

Laboratory findings showed high RBC count 5.06 x 10^{12}/l, normal WBC and platelet counts, mild urea and creatinine elevation of 10.67mmol/l and 178.2 micromole/l respectively, elevated uric acid of 676.8 micromole/l, but normal sodium, chloride and potassium levels. In the liver function tests, AST and GGT were marginally elevated, 87.59 and 50.60 respectively, with the other LFT parameters essentially normal.

Chest radiography showed cardiomegaly with essentially normal lungs

A working diagnosis of severe mitral regurgitation with moderate prolapse, heart failure with preserved ejection fraction and atrial fibrillation was made in the background hyperuricemia with probable mild acute on chronic kidney injury. A recommendation was made for a coronary angiogram with later mitral valve replacement. Coronary angiogram done revealed normal coronary vessels.

She was scheduled for surgery in 2 weeks' time for mitral valve replacement.

Results

Preoperative preparations were done with necessary anaesthetic check list undertaken. Trans-oesophageal echo showed an Atrial septal defect of approximately 30mm, and a plan was made to close it after replacing the valve.

Intra-operative findings after going onto cardiopulmonary bypass (CPB) and aortic cross clamp (AXC), showed a mild pericardial serous fluid, dilated left ventricle, moderate elevated pulmonary pressures, calcified thickened and prolapsed mitral leaflets, atrial septal secundum defect of about 28mm. A mechanical valve Medtronic size 31 was put and later the ASD closed primarily. Patient was later reversed with total CPB time at 206 min, and release of AXC at 100min. Trans-oesophageal echo post MVR and ASD closure showed poor Left Ventricle Ejection Fraction (LVEF) despite being on inotropes dobutamine at 15mcg/kg/min, noradrenaline at 10mcg/kg/min and adrenaline at 10mcg/kg/min. Post-operative plan was made to do uninterrupted 48-hour ventilation in ICU with regular ECHO studies to assess LVEF.

Post-operative follow up

Day 1 post-operative, patient was vitally stable BP of 124/87. HR 98/min, SPO2 100%. Blood Gas Analysis (BGA) showed mild metabolic acidosis which was corrected with IV fluids administration. Still LVEF was low. 2nd day post op, noted worsening UECs, though urine output was more that 1ml/kg/min. No significant improvement on LVEFdespite being on moderately high doses of tripleinotropes. Decision made was to continue with ventilator support and maintain inotropes. Day 4,with still poor LVEF, more history came forth from relatives on being hypothyroidic in the past. With the new input thyroid function tests were done and noted elevated TSH 17(normal ranges 0.25 – 5.00) with normal T3 and T4. Impression of subclinical hypothyroidism was made. Patient was started on Thyroxine 100mcg once daily. Thereafter significant improvement in LVEF. Inotropes were weaned off from day 7 with only minimal dose dobutamine of 5mcg/kg/min left. Patient was extubated on day 8 and progressed well. Was transferred to ward on day 12 and later discharged home on day 18 after cardiac rehabilitation.

Discussion

In analysing the above case, we attempted to answer four important questions that arose around the subject of study.

1. Was there any benefit of doing preoperative TFTs in all elderly patients undergoing cardiac surgery?

Thyroid hormones play a fundamental role in metabolism with the active component T3 emanating from de-iodization of T4 peripherally. T4 secretion from thyroid gland is stimulated by Thyroid

stimulating hormone (TSH) which is secreted from Anterior Pituitary gland. While TSH relies on stimulation from Thyrotropin releasing hormone (TRH) produced from the hypothalamus and is regulated via negative feedback mechanism through levels of T3. In the cardiovascular system, T3 has a direct effect on increasing heart rate, myocardial contractility and reducing systemic vascular-resistance (SVR). Inreduced levels of T3, then expected events would be reduced cardiac function as a result of reduced heart rate and myocardial contractility. The cardiovascular symptoms and signs developed in hypothyroidism include; dyspnoea, oedema, cardiomegaly and effusions, all of which are suggestive of heart failure. Auer J et al. [5], demonstrated showed associations of hypothyroidisms with coronary artery disease, with noted prolongation of cardiac action potential and QT interval further noting ventricular arrhythmia in hypothyroidism patients [6].

Cerillo et al. [19] and Park et al. [1], showed a need in routine evaluation of Thyroid hormones as part of preoperative work up owing to the significant changes in levels of FT3 pre and post CBP. A high index of suspicion for hypothyroidism is advocated for in the elderly patient with poor cardiac function post-surgery. In our case, following documented poor haemodynamics, more history was sort and hypothyroidism was picked.

2. Did cardiopulmonary bypass alter thyroid hormone levels?

In physiological stress, it has been witnessed in various studies [7-10] that their changes in circulating thyroid hormone levels. Cardiac surgery in itself is a stress inducer in this regard. Chopra [7,8] and Van [9] et al, demonstrated declining levels of T3 within two hours following severe physiological stress as a result of decline in conversion of T4 to T3 peripherally. Modifications in the iodothyronine deiodinases, together with thyroid hormone receptor expression changes could be behind this [10]. Thus a typical low T3 syndrome ensues. This manifest with depressed cardiac and neurological function. Upto 70% of severely ill patients in hospital exhibit low T3 levels [7].

Murzi et al. [11], showed decline in levels of T3 following CBP as a result of stress response and haemodilution. Velissaris [12] and Pantos [13] et al. in their studies of Coronary Artery Bypass Graft Surgery (CABG) on CBP and off CBP demonstrated still similar decline of levels of T3 in both groups.Hence showing that CBP is not the only contributor to low T3 levels, and so non thyroid illness syndrome in cardiac surgery is a nonspecific response.

3. Was there benefit of prophylactic administration of thyroid hormones to target supranormal levels to achieve better cardiac function?

For the studies thatfocused on administration of T3 peri-operatively, Klemperer et al. [17] in the 142 randomised patients study described improvement in hemodynamics in the patients given T3 as compared to the placebo group as manifested by increase in cardiac index and reduction in systemic vascular resistance (SVR). Novitzky's [16] findings were similar to above showing an increase in cardiac output with reduction in SVR. Bennett-Guerro et al. [15] showed reduced T3 syndrome in the T3 group over the placebo group though still the inotrope requirement was same in both groups. Mullis Jansson et al. [18] also showed an increase in cardiac index within 12 hours post AXC removal but no significant SVR reduction.

In the studies that looked at pre-operative prophylactic administration of T3, Sirlak et al. [14], highlighted a significant improvement in both cardiac index and mixed venous oxygen saturations in the group administered oral T3 preoperatively in comparison to the placebo group.

The evidence is clear in regards to T3 supplementation in relating to better hemodynamics post operatively. In our case, aftercommencingoral 100mcg thyroxine via nasogastric tube, patient improved, was easily weaned off inotropic support and later mechanical ventilation, a course which would have been shorter had we opted to do perioperative or preoperative supplementation of T3.

4. Are there African-population based studies that can correlate above relationships orexhibit variations?

Credit is given to the above studies that have demonstrated relationships in thyroid hormones and cardiac surgery. Of note is that the studies are based on different demographic populations that mayor may not portray a similar pattern to African population. Thisinvites an opportunity for a localized study to exhibit patterns in thyroid hormones in cardiac surgery based on African-population. A study which our institution is planning to undertake in the future.

Summary

Cardiac surgery in a hypothyroidic patient is one challenging field that requires understanding of the physiology of how one system, endocrine system, could affect another system, cardiovascular. It is necessary for proper planning to carry out thorough pre-operative preparation for cardiac patients with increase high index of suspicion for pre-existing thyroid disease. More research needs to be done to establish a pattern in thyroid disease in relation to cardiac surgery in the African population.

Recommendations

African-based population study to establish thyroid hormone levels patterns in cardiac surgery.

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