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"Intentional L-Thyroxine Overdose: A Case Overview"

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KEYWORDS

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Endocrine toxicity

ABSTRACT:

Introduction:

Thyroid hormone production begins in the hypothalamus, where thyrotropin-releasing hormone (TRH) stimulates the anterior pituitary to release thyroid-stimulating hormone (TSH). TSH binds to receptors on thyroid follicular cells, activating pathways that drive thyroid hormone synthesis. Within thyrocytes, iodinated thyroglobulin is processed to release T3 (20%) and T4 (80%) into the bloodstream. These hormones influence nearly every organ system by increasing metabolic rate and energy consumption. In the heart, they enhance catecholamine effects, increasing heart rate and cardiac output; in the lungs, they improve oxygenation by stimulating respiratory center. They support muscle development, boost basal metabolic rate, regulate metabolism, and play a critical role in growth and brain maturation in children.

Objectives: The progression of the condition and thyroid hormone levels during recovery following thyroxine poisoning were evaluated and analysed.

Methods: a case analysis and summary.

Results: During the recovery period, thyroid hormone levels gradually increased; however, the patient remained largely asymptomatic. This suggests that the presentation of the condition varies and is not uniform across all age groups.

Conclusions: It remains unclear how thyroxine overdose impacts individuals of different ages with varying presentations. However, it is understood that T3 may act as a competitive inhibitor at receptor sites, mitigating L-thyroxine toxicity and potentially leading to a benign response to overdose.

1. Introduction:

Thyroid hormone production begins in the hypothalamus, which releases thyrotropin-releasing hormone (TRH) into the hypothalamic-hypophyseal portal system. TRH stimulates the anterior pituitary to secrete thyroid-stimulating hormone (TSH). Once TSH enters the bloodstream, it binds to receptors on thyroid follicular cells, activating a Gs-protein signalling pathway that increases cyclic AMP (cAMP) and activates protein kinase A (PKA), triggering thyroid hormone synthesis.

Thyroid hormone synthesis happens in thyrocytes and gets released as the Thyrocytes internalize and cleave iodinated thyroglobulin, releasing T3 (20%) and T4 (80%) into the bloodstream.[1]

Thyroid hormones influence nearly every organ system by increasing metabolic rate and energy consumption. Key effects include: In Heart: They enhance the effects of catecholamines, raising heart rate, stroke volume, and cardiac output. In Lungs: Thyroid hormones stimulate respiratory centres, improving oxygenation through increased perfusion. In Muscles: They promote the development of fast-twitch (type II) muscle fibres for rapid, powerful contractions. With Metabolism: These hormones boost basal metabolic rate, oxygen consumption, and body temperature, while regulating

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lipid, carbohydrate, and protein metabolism. High doses can cause protein breakdown. In Growth in Children: Thyroid hormones work with growth hormone to promote bone development and brain maturation, supporting nerve growth and myelination.[1].

2. Case presentation:

Patient with alleged history of consumption of L-Thyroxine tablet on 6-5-2024 at approximately 1:30 pm with intention of self-harm, later as the patient was brought in and was received in casualty at 7-5-2024. Patient was clinically normal with no symptoms related to the thyroxine overdose. No palpitations, no sweating, no tremors, no body warmth, and no loose stools complaints was raised by patient or was observed on examination.

Vitals on arrival was –

Pulse rate was elevated- 110 bpm, Spo2 (Room air) – 98%,

BP-120/80mm/Hg, Patient was put on observation for "tachycardia, temperature variation, Blood pressure, Spo2" Q 1 hourly

And prescribed, IV fluids NS at 100ml/hr two pints. Cholestyramine powder 4gms (mixed in a glass of water) thrice per day.

Investigations done- CPK-MB- 43

Haematological profile was unremarkable. Renal panel was unremarkable. Thyroid panel showed total T3 at 293.52 and total T4 >30. ECG showed normal sinus rhythm.

On day 2,

The patient, who had experienced thoughts of self-harm, was provided with psychiatric counselling. On presentation, the patient was asymptomatic but showed a raised heart rate of 110 bpm, with blood pressure recorded at 120/70 mmHg, pulse rate at 80 bpm, and SpO2 at 98% on room air (RA). The patient was admitted for observation and prescribed IV 2-pint normal saline (NS) at 100 ml/hour, cholestyramine 4 g thrice daily, and oral propranolol 20 mg SR once daily (1-0-0).

On Day 2, investigations revealed FT3 levels of 14.5, FT4 >6, TSH 0.39, TT3 293, and TT4 >30. By Day 3, the patient remained asymptomatic, with no new complaints or symptoms reported. Vital signs were stable, with BP at 110/70 mmHg, PR at 80 bpm, and SpO2 at 98% on RA. The same medications and maintenance IV fluids were continued, and the patient was kept under observation.

On Day 3, investigations showed TT3 at 300, TT4 >30, FT3 at 13, FT4 >6, and TSH at 0.03.

On Day 4, the patient remained asymptomatic with no complaints. Vital signs included BP at 120/80 mmHg, PR at 100 bpm, and SpO2 at 98% on room air (RA). The patient was kept under regular monitoring, with IV fluids (2-pint NS at 100 ml/hr) continued. The oral tablet propranolol 20 mg SR was increased to twice a day (1-0-1), and cholestyramine powder was altered to be taken twice a day in a glass of water. Investigations on Day 4 revealed TT3 at 303, TT4 >30, FT3 at 12.27, FT4 >6, and TSH at 0.03.

On Day 5, the patient was still asymptomatic with no complaints. Vital signs were BP at 120/70 mmHg, PR at 90 bpm, and SpO2 at 99% on RA. The patient continued under continuous monitoring, with fluids stopped, cholestyramine powder discontinued, and oral propranolol reduced to once a day (1-0-0).

On Day 6, the patient remained asymptomatic with no complaints. Vital signs were BP at 110/70 mmHg, PR at 96 bpm, and SpO2 at 99% on RA. The oral propranolol 20 mg SR was continued at a dose of 1-0-0.

On Day 7, the patient's parents requested discharge, and based on the patient's stable physical condition, the patient was discharged. At the time of discharge, the patient was asymptomatic, had no complaints, and had stable vitals. The patient was prescribed oral propranolol 20 mg SR (1-0-0) for 10 days. The parents were advised to visit the Emergency Department of Sree Balaji Medical College and Hospital if any symptoms such as palpitation, sweating, nervousness, tremors, fever, loose stools, or any other complaints arose.

On the day of discharge, investigations revealed TT3 at 286, TT4 at 25, FT3 at 10, FT4 at 4, and TSH at 0.03.

3. Results:

The patient's condition was assessed and found to be generally asymptomatic, with the exception of mild tachycardia. Supportive care, including cholestyramine, was provided, and the patient was discharged.

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4. Discussion

Here, a large dose of L-Thyroxine tablet ingestion is discussed, with the investigation panel which showed a rise in serum thyroid panel, which showed a gradual decline as the days progressed, overall course of presentation was benign.

According to general pharmacokinetics the L-thyroxine gets absorbed from ileum small intestine and small amount from stomach, on looking into studies its explained that there are variations in the half-life between children (lesser half-life) and adults (greater half-life) and also the drug interaction plays important role in peripheral metabolism changes of L thyroxine(drugs like phenobarbital, phenytoin increases peripheral metabolism), so in patients with multidrug therapy can have varied effect due to its interaction[6].

Acute massive doses of L-thyroxine typically have a mild clinical course that can be controlled by

- activated charcoal, based on the time the patient presents to hospital, delayed arrival to hospital will lead to gastric emptying as in this case of 16 yr old female patient, making the charcoal lavage useless,
- cholestyramine, propranolol, dexamethasone, and supporting measures, with close medical evaluation. Cholestyramine, an ion-exchange resin, can be administered in the usual dose of 4 grams every 8 hours orally. This drug binds thyroxine and enhances its elimination [2].

Propranolol is added to patient who have increased heart rate and Blood pressure which can be a symptom in patient with l thyroxine poisoning. In an article authored by Angad S. Gill [3], an elderly patient had an intentional consumption of L thyroxine 60 tablets of 150mcg dose, had history of palpitations and increased heart rate (sinus tachycardia), was treated with propranolol and titrated according to need.

Similarly, the 16-year-old patient here is also treated for the tachycardia developed but the intensity of the heart rate change was milder than the elderly patient from other case scenario mentioned above, this gives a gist that symptoms and presentation vary widely with different age group and patients with co- morbidities as documented by other articles denoted. And its unsure that if age is the factor that causes benign course of the reaction towards overdose in young adolescents and children.[4]

5. Conclusion:

Still, it's unclear how the thyroxine overdose affects the people of different ages with varied presentation, however it is understood that T3 acts as a competitive inhibitor at receptor site and prevents L thyroxine toxicity [5] and thus can be causing benign reaction towards overdose. More study is required to know more about the reactions towards the overdose of levothyroxine.

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