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The Resolution of Thyroid Storm Using Plasma Exchange and Continuous Renal Replacement Therapy

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Severe Thyrotoxicosis is a serious medical emergency that can be associated with multisystem organ failure, high mortality, and morbidity. Early diagnosis and management is important to avoid detrimental outcomes. We herein report a case of 24-year-old man with thyroid storm and multisystem organ failure who was treated successfully with a combination of plasma exchange and Continuous Renal Replacement Therapy (CRRT).

Keywords: Thyrotoxicosis; thyroid storm; plasma exchange; renal replacement therapy.

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1. INTRODUCTION

Graves disease is an autoimmune disorder characterised by the increased release of Thyroid-stimulating antibodies. These antibodies stimulate thyroid gland hypertrophy and the excessive production of thyroid hormones. When the thyrotoxicosis is severe, it is called Thyroid storm. This is a life-threatening condition which can lead to multiple organ damage and high mortality. Thionamides and iodinated radiocontrast agents have been effective in treating this disease condition. However, in severe cases, there have been few reports of the successful use of plasma exchange and renal replacement therapy.

2. CASE REPORT

A 24-year-old African American gentleman with a newly diagnosed hyperthyroidism due to Grave's disease. He was started on Methimazole 10 mg po three times daily to achieve a euthyroid status before proceeding with thyroidectomy. Unfortunately, the patient was not compliant with taking the medication and failed to show up at his primary care appointments. Two months later, he presented to the emergency room with fever (temperature of 101 degree Fahrenheit), mental status change and shortness of breath. On examination he was found to have a blood pressure of 220/120, and a heart rate of 160 beats per Minute, electrocardiogram showed atrial fibrillation with rapid ventricular response. Due to shortness of breath, he was placed on a non-rebreather oxygen mask and started on intravenous.

Cardizem drip that helped control the heart rate as well as the blood pressure. Chest radiography revealed an enlarged heart with bilateral vascular congestion. Transthoracic echocardiogram showed an estimated ejection fraction of 25%. Transaminases were 1.5 times elevated from the normal value. Creatinine phosphokinase level was normal. Septic workup was unremarkable. Free T3 level was 22.8 pg/ml (reference range 2.77-5.27), free T4 level was >7.0 ng/dL (reference range 0 .78-2.19), and TSH was <0.015 iIU (reference range 0.370-4.55 iIU). The patient condition deteriorated, he developed hypoxic respiratory failure due to pulmonary edema. Oxygen saturation was 82%requiring intubation and mechanical ventilation subsequently transferred to the intensive care unit. Because of Ileus, intravenous Methimazole was started. Intravenous diuretics were given. Sloumedrol was started at 80 mg intravenously every eight hours. Blood pressure was uncontrolled on Cardizem infusion, So Labetolol infusion was added. In an attempt to remove as much T3 and T4 hormones as possible, plasma exchange was started. After the 3rd day, the T4 free level was still above 7.0 ng/dL and T3 free level of 22 pg/mL. Because of oliguric renal failure, Continuous Renal Replacement therapy with CVVHDF (continuous venovenous hemodiafiltration) was started for the next three days in addition to plasma exchanges. The T4 level dropped from >7.0 to 3.3,2.5, and 1.3 ng/dl consecutively. T3 declined from 20.80 to 6.01, 6.25, and 4.34 pg/ml on the third day. TSH levels rose from less than 0.015 iIU to 0.033 iIU. The patient's clinical condition was stabilised. Both plasma exchange and CRRT were then stopped. Respiratory and renal failure improved. The patient was removed from dialysis and extubated. Methimazole was switched to pills. On day 11, the patient was discharged home on Methimazole and propranolol. Three months later, he underwent a Successful thyroidectomy.

3. DISCUSSION

Thyroid storm or thyrotoxic crisis is a serious, life-threatening medical condition that if untreated can lead to multisystem organ failure and a mortality rate ranging between 10.7% and 25% [1]. This condition is associated with a hypercatabolic state leading to hyperthermia [2], hypertensive crisis, atrial fibrillation, congestive heart failure [3], cerebrovascular event, and liver failure [4]. TSH hormone from the pituitary gland stimulates the thyroid gland to produce the thyroxine hormone (T4) and 3,5,3'-triiodothyronine (T3). These hormones bind to the intracellular receptors in the mitochondria of different body cells breaking down nutrients and producing ATP [5].

Renal failure induced by hyperthyroidism is typically uncommon. However, it has been reported in a number of cases. It is believed that the main mechanism of injury to the glomeruli and tubules is the hemodynamic changes related to hyperthyroidism. By affecting the genes regulating the cardiac myocytic contraction and electrochemical signals, cardiac output can be compromised resulting in decreased renal perfusion and followed by renal injury [6,7]. Also, thyroid hormone can affect the nitric oxide synthase activity in the kidneys with presumed glomerular and tubular injury [8]. Though not widely studied, there are a few reports of

successfully treating severe thyroid storm and multisystem organ failure with continuous renal replacement therapy [9]. In addition, plasma exchange in few studies has shown some beneficial effect [10,11,12].

4. CONCLUSION

Thyroid storm is a rare, life-threatening condition that is characterised by exaggerated clinical features of undiagnosed or untreated hyperthyroidism [13]. Performing either surgical thyroidectomy or radioactive iodine ablation is the definitive treatment for thyroid storm [14]. Patients who present with thyroid storm need to be stabilised before curative treatment options are considered. Severe cases of thyroid storm can present with multi-organ failure requiring CRRT. Even though TPE (Therapeutic Plasma exchange is not widely studied, it can remove both free and protein-bound T3, T4, catecholamines, cytokines and other inflammatory molecules in thyroid storm patients.

The mortality rates of severe thyroid storm can be as high as 30%. Early consideration of CRRT and plasma exchange can make a significant difference in patients' outcome as illustrated in our case report. More studies are needed to investigate their therapeutic role in thyroid storm patients.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

Authors have declared that no ethical or competing interests exist.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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