VA-ECMO for Thyroid Storm: Case Reports and Review of the Literature

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Thyroid storm-related heart failure is a rare, life threatening complication of hyperthyroidism. In refractory cases, urgent thyroidectomy is required for definitive control of thyrotoxicosis. Venoarterial extracorporeal membrane oxygenation (VA-ECMO) is a supportive measure for cardiorespiratory failure requiring continuous anticoagulation to prevent clotting. We presented two cases of thyrotoxic cardiac failure that necessitated VA-ECMO. One of the patients was successfully treated with thyroidectomy while on VA-ECMO. To the best of our knowledge, only two such cases have previously been reported.

PATIENT DESCRIPTION

CASE 1

A 48-year-old woman with a known history of poorly controlled Graves' disease resulting heart failure with reduced ejection fraction was admitted for vomiting and rapid atrial fibrillation. Initial treatment for suspected thyroid storm included propranolol, propylthiouracil (PTU), Lugol's solution, and hydrocortisone. The patient presented with cardiorespiratory collapse with refractory cardiogenic shock requiring implantation of an intra-aortic balloon pump (IABP) and VA-ECMO for circulatory support. Laboratory tests showed strikingly elevated FT3 and FT4 levels (28 pmol/l; normal range 3.5–6.5; and 86 pmol/l; normal range 10–20, respectively) and low thyroid stimulating hormone (TSH) (0.01 MU/L; normal range 0.35–5.5). Daily plasmapheresis was added, although multi-organ failure ensued. Urgent thyroidectomy was deemed necessary to definitively control thyrotoxicosis but weaning from ECMO seemed impossible. In a joint multidisciplinary decision including endocrinology, cardiology, cardiothoracic-surgery, otolaryngology, hematology, medical intensive care unit (ICU) and anesthesiology, anticoagulation was withheld for 24 hours to allow for surgery on ECMO. Total thyroidectomy with meticulous hemostasis was uneventful with preservation of recurrent nerves and parathyroids. Penrose drains were placed to secure gradual resumption of continuous heparin drip, starting at post-operative day 1. Thyrotoxicosis resolved and ECMO was explanted with normalization of cardiac function. Due to severe ICU myopathy, the patient was eventually discharged to a rehabilitation facility.

CASE 2

A previously healthy 24-year-old man presented with anterior neck pain, fever, and excessive sweating preceded by a 5-day history of sore throat. Laboratory tests showed markedly elevated FT3, FT4, and thyroglobulin levels (16 pmol/l; normal range 3.5–6.5, 91 pmol/l; normal range 10–20, and 1740 mcg/l; normal range 1.6–55, respectively), low TSH (0.02 MU/L; normal range 0.35–5.5), and elevated inflammatory markers. He was admitted with a presumed diagnosis of subacute thyroiditis. Propranolol and naproxen were initiated. However, his hemodynamic status rapidly deteriorated with concomitant multi-organ failure. Echocardiography showed severe global hypokinesia. He was treated with corticosteroids, PTU and plasmapheresis, and required support with IABP and VA-ECMO. Three days later the patient was weaned from ECMO and recovered gradually, in parallel with improvement in thyroid function tests and echocardiographic findings. Serology for respiratory viruses was negative. Thyroid scintigraphy was consistent with Graves' disease, despite negative thyroid-stimulating antibodies and anti-thyroid peroxidase antibodies. Following hemodynamic and respiratory stabilization, and recurrence of hyperthyroid state, he underwent total thyroidectomy. Histopathology of the thyroid gland was consistent with Graves' disease. In addition, a 1.5 mm focus of unencapsulated papillary microcarcinoma was detected with no extrathyroid extension, lymphovascular, or perineural invasion. The patient was eventually discharged home following complete recovery.

COMMENT

Thyroid storm is an endocrine emergency that includes high mortality rates. Hyperthyroidism may lead to heart failure in 6% of patients, but dilated cardiomyopathy with impaired left ventricle (LV) function is seen in less than 1%. Tachycardia

and increased cytosolic calcium during diastole have been proposed as potential mechanisms [1]. Cardiogenic shock is an extreme complication, which may require vasopressors and invasive hemodynamic support.

Treatment with beta blockers, especially propranolol, is commonly used in hyperthyroidism but may precipitate cardiovascular collapse in acute heart failure [2]. Both of our patients were treated with propranolol prior to development of cardiogenic shock. Thionamides (particularly PTU), iodine, and corticosteroids constitute the conventional treatment of life-threatening thyrotoxicosis. Plasmapheresis facilitates prompt removal of cytokines, autoantibodies, and free thyroid hormones and replaces bound thyroid hormones by unsaturated carrier proteins. However, the risk of infection and bleeding is increased due to removal of clotting factors and immunoglobulins. It is used when conventional treatment for thyroid storm has failed or is contraindicated. As its effect is transient, it should be combined with additional treatments to control thyroid hormone synthesis [2].

Successful use of VA-ECMO as a bridge to thyroidectomy has been reported in multiple cases. One case series demonstrated complete recovery of LV function in most thyrotoxic patients treated with ECMO [3]. However, thyroidectomy on ECMO is rarely performed due to the need for continuous anticoagulation and risk of major intraoperative and postoperative bleeding. To the best of our knowledge, only two previous cases have been published to date [4,5]. We report a third case of urgent thyroidectomy on VA-ECMO, which resulted in control of the thyroid storm and complete recovery. Heparin was withheld prior to surgery with no complications. Although more data is required, this life-saving strategy should be considered in select cases of refractory thyrotoxicosis-related cardiogenic shock.

CONCLUSIONS

VA-ECMO can be an effective bridge to thyroidectomy in hemodynamically unstable patients with thyroid storm. Urgent thyroidectomy for definitive treatment of thyroid storm is a viable option, even while on VA-ECMO. A multidisciplinary team-based approach is critical for success.

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Autumn is a second spring when every leaf is a flower.
Albert Camus (1913–1960), French philosopher, author, dramatist, and journalist

Capsule

Multiomic signatures of body mass index identified heterogeneous health phenotypes and responses to a lifestyle intervention

Multiomic profiling can reveal population heterogeneity for both health and disease states. Obesity drives a myriad of metabolic perturbations and is a risk factor for multiple chronic diseases. **Watanabe** et al. reported an atlas of cross-sectional and longitudinal changes in 1,111 blood analytes associated with variation in body mass index (BMI), as well as multiomic associations with host polygenic risk scores and gut microbiome composition, from a cohort of 1,277 individuals enrolled in a wellness program (Arivale). Machine learning model predictions of BMI from blood multiomics captured heterogeneous phenotypic states of host metabolism and gut microbiome composition better than BMI, which was also validated in an external cohort (TwinsUK). Moreover, longitudinal analyses identified variable BMI trajectories for different omics measures in response to a healthy lifestyle intervention; metabolomics-inferred BMI decreased to a greater extent than actual BMI, whereas proteomics-inferred BMI exhibited greater resistance to change. The analyses further identified blood analyte–analyte associations that were modified by metabolomics-inferred BMI and partially reversed in individuals with metabolic obesity during the intervention The findings provided a blood atlas of the molecular perturbations associated with changes in obesity status, serving as a resource to quantify metabolic health for predictive and preventive medicine.

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