



Case Report

THYROTOXIC PERIODIC PARALYSIS ASSOCIATED WITH GRAVES' DISEASE

Rizaldy Taslim Pinzon¹, Jeany Hanifa¹, Stefanus Erdana Putra¹

¹Department of Neurology, Faculty of Medicine, Universitas Kristen Duta Wacana, Yogyakarta, Indonesia; drpinzon17@gmail.com

ABSTRACT

Introduction Thyrotoxic periodic paralysis is an uncommon, life-threatening complication of hyperthyroidism characterized by acute flaccid paralysis and severe hypokalemia due to an intracellular shift of potassium.

Case Summary A 20-year-old male of Southeast Asian descent presented with sudden-onset, symmetrical flaccid quadriparesis upon waking. Neurological examination revealed proximal-predominant muscle weakness and diminished deep tendon reflexes with preserved sensory function. Biochemical evaluation confirmed severe hypokalemia (2.13 mmol/L) accompanied by primary hyperthyroidism, with a suppressed thyroid-stimulating hormone level (<0.05 μ IU/L) and elevated free thyroxine (66.7 pmol/L). Electrocardiography demonstrated ST-segment depression and QT-interval prolongation, and thyroid ultrasonography suggested diffuse edema consistent with Graves' disease.

Discussion Cautious intravenous and oral potassium replacement, coupled with oral propranolol and propylthiouracil, led to rapid normalization of potassium levels and complete motor recovery within 24 hours without rebound hyperkalemia.

Conclusion This case emphasizes the necessity of screening for underlying thyroid dysfunction in young adults presenting with unexplained hypokalemia paralysis to prevent fatal cardiopulmonary complications.

Keywords: case report; hypokalemia; paralysis; thyrotoxicosis

INTRODUCTION

Thyrotoxicosis represents a systemic hypermetabolic clinical syndrome resulting from an excess of circulating thyroid hormones.¹ It classically manifests with adrenergic symptoms such as weight loss, palpitations, fine tremors, heat intolerance, and tachycardia.¹ However, acute hypokalemic periodic paralysis is a rare and severe neuromuscular manifestation

of thyrotoxicosis that can easily be overlooked when acute neurological weakness dominates the clinical picture.² Thyrotoxic periodic paralysis is characterized by transient, recurrent episodes of flaccid muscle weakness or paralysis associated with biochemical hyperthyroidism and acute intracellular shifts of potassium.³ The weakness typically occurs during periods of rest following

heavy carbohydrate meals, alcohol consumption, or strenuous physical exertion, and often begins in the late evening or early morning.⁴

The condition predominantly affects young males of East Asian descent, with population-based cohort data indicating that more than 65% of affected individuals experience their initial episode between the ages of 20 and 40 years.¹ Graves' disease is recognized as the most common underlying etiology.⁵ Because the clinical presentation of hyperthyroidism may be extremely subtle or entirely silent in patients experiencing thyrotoxic periodic paralysis, diagnostic delay is common.⁶ Misdiagnosis as familial periodic paralysis or Guillain-Barré syndrome frequently results in unnecessary diagnostic investigations and, critically, the administration of aggressive potassium replacement, which carries a high risk of causing fatal rebound hyperkalemia.⁶ This clinical report highlights the diagnostic pathway, pathophysiological mechanisms, and cautious management protocols required to achieve safe and rapid recovery.

CASE REPORT

A male in his 20s of Southeast Asian

descent with no notable medical history presented to the emergency department of a tertiary hospital with acute, symmetrical muscle weakness in all four extremities upon waking on the day of admission. The weakness began symmetrically in the lower limbs, progressed proximally, and subsequently involved the upper limbs in a similar pattern. The proximal muscle was affected more severely than the distal muscle. The patient denied any history of prior episodic weakness, recent physical trauma, exposure to toxins, respiratory symptoms, or familial neuromuscular disorders.

On physical evaluation, the patient was alert and oriented, with a normal blood pressure of 120/80 mmHg and a regular heart rate of 102 beats per minute, accompanied by a fine hand tremor. Cardiovascular, pulmonary, and abdominal examinations were completely unremarkable. The neurological examination demonstrated intact cranial nerves and normal cognition. Motor examination revealed symmetrical flaccid quadriparesis, with muscle strength graded at 2/5 on the Medical Research Council scale in both upper and lower extremities. All deep tendon reflexes were

absent, while sensory perception remained fully intact.

Laboratory evaluation identified severe hypokalemia, with a serum potassium level of 2.13 mmol/L. An initial electrocardiogram demonstrated classic features of hypokalemia, including significant ST-segment depression and QT-interval prolongation (Figure 1). Prompt thyroid function testing revealed primary hyperthyroidism, characterized by a suppressed thyroid-stimulating hormone level ($<0.05 \mu\text{IU/L}$) and a markedly elevated free thyroxine level (66.7 pmol/L). Complete blood count, serum sodium, renal function (creatinine), and liver enzymes were within normal limits. Thyroid ultrasonography demonstrated a diffusely enlarged, edematous thyroid gland with increased vascularity, suggesting Graves' disease as the underlying cause of the thyrotoxic state (Figure 2). The complete laboratory profile and

reference ranges are structured in Table 1.

Given the severity of the hypokalemia and the associated electrocardiographic changes, the patient was initiated on cautious potassium replacement therapy under continuous electrocardiographic telemetry in the intensive care unit. Intravenous potassium chloride was administered at a rate of 25 mEq over 6 hours, supplemented by cautious oral potassium replacement. To target the underlying pathophysiological mechanism of the transcellular shift, oral propranolol was initiated at 10 mg twice daily.¹ Propranolol, as a non-selective beta-blocker, was chosen specifically to blunt the beta-adrenergic stimulation of the Na^+/K^+ -ATPase pump and stop further potassium shifting.⁷ Antithyroid therapy with propylthiouracil at 100 mg twice daily was started simultaneously to address the hyperthyroid state.¹

Table 1. Comprehensive laboratory investigations, reference ranges, and clinical significance.

Parameter	Patient Value on Admission	Reference Range	Clinical Significance
Serum Potassium	2.13 mmol/L	3.5 – 5.3 mmol/L	Severe hypokalemia, driving neuromuscular symptoms
Thyroid-Stimulating Hormone	$<0.05 \mu\text{IU/L}$	0.25 – 5.0 $\mu\text{IU/L}$	Suppressed; indicative of primary hyperthyroidism
Free Thyroxine (FT4)	66.7 pmol/L	10.6 – 19.4 pmol/L	Markedly elevated; confirms biochemically overt thyrotoxicosis
Serum Sodium	138 mmol/L	135 – 145 mmol/L	Within normal limits

Serum Creatinine	72 $\mu\text{mol/L}$	60 – 110 $\mu\text{mol/L}$	Normal renal function; excludes renal potassium wasting ^{1,6}
Post-treatment Serum Potassium	4.66 mmol/L	3.5 – 5.3 mmol/L	Normalization on the third day of hospitalization



Figure 1. Admission twelve-lead electrocardiogram (ECG). The tracing demonstrated sinus tachycardia (heart rate approximately 102 beats per minute) with characteristic repolarization abnormalities driven by severe hypokalemia. Key features included prominent, widespread ST-segment depression (most pronounced in the precordial leads V4–V6) and marked prolongation of the QT-U interval. These pathological conduction features completely resolved within 24 hours of initiating cautious, low-dose potassium repletion and oral propranolol.

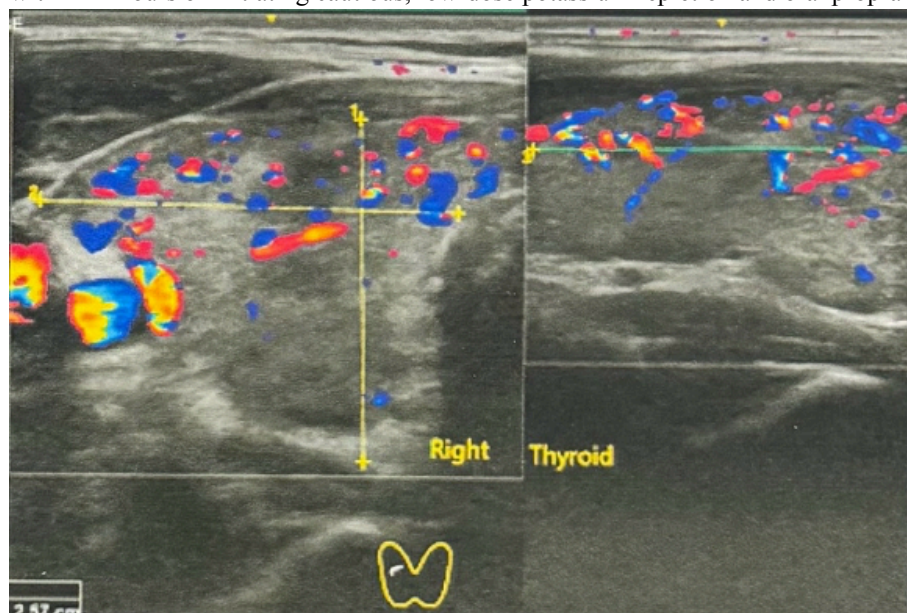


Figure 2. Thyroid ultrasonography (USG). High-resolution grayscale sonographic assessment of the neck demonstrated a diffusely enlarged, swollen, and edematous thyroid gland with a heterogeneous, hypoechoic parenchymal echotexture. These structural alterations were highly characteristic of autoimmune thyroiditis secondary to Graves' disease.

Table 2. Clinical and diagnostic comparison of acute flaccid quadriplegia etiologies.

Feature	Thyrotoxic Periodic Paralysis	Familial Hypokalemic Periodic Paralysis	Guillain-Barré Syndrome
Onset	Abrupt, typically on waking ¹	Abrupt, typically on waking ⁶	Gradual, progressive over days to weeks ¹
Thyroid Status	Hyperthyroid (suppressed TSH, elevated free T4) ¹	Euthyroid (normal thyroid panel) ⁹	Euthyroid (unrelated to thyroid status) ¹
Family History	Negative ¹	Positive (autosomal dominant) ⁴	Negative ¹
Sensory Exam	Normal and fully intact ¹	Normal and fully intact ¹⁰	Sensory loss or paresthesia is common ¹
Deep Tendon Reflexes	Diminished to absent ¹	Diminished to absent ⁸	Diminished to absent globally ¹
Urine Potassium	Low excretion (low ratio) ⁶	Low excretion (low ratio) ⁶	Normal ¹
Response to Potassium	Highly rapid, risk of rebound hyperkalemia ¹¹	Rapid, lower risk of rebound ¹²	None ¹

The patient demonstrated rapid clinical improvement, with motor strength returning to a normal grade of 5/5 in all extremities within 24 hours of initiating treatment. The serum potassium level successfully normalized to 4.66 mmol/L by the third day of hospitalization. A follow-up electrocardiogram confirmed the resolution of all hypokalemia-related repolarization abnormalities, showing a normal sinus rhythm with a normalized QT interval. The patient was discharged on the third day of admission with instructions to continue propylthiouracil and propranolol under endocrine supervision. At a scheduled follow-up evaluation one week post-discharge, the patient remained completely asymptomatic with no recurrent episodes of weakness or neurological deficits. The patient continues regular

antithyroid medications under the care of an endocrinologist to maintain a stable euthyroid state.

DISCUSSION

The presentation of acute flaccid quadriplegia with hyporeflexia and severe hypokalemia necessitated the exclusion of several critical neuromuscular and electrolyte disorders.^{1,3} Guillain-Barré syndrome was initially considered due to the rapid onset of flaccid quadriplegia and diminished reflexes.^{1,6} However, the absence of sensory symptoms, the lack of progressive cranial nerve involvement, and the presence of severe hypokalemia favored an electrolyte-mediated channelopathy rather than an acute demyelinating polyneuropathy.^{1,8}

Familial hypokalemic periodic

paralysis represents the primary genetic differential.⁸ However, the lack of a personal or family history of episodic weakness, coupled with biochemically overt hyperthyroidism and sinus tachycardia, strongly pointed to an acquired secondary cause.³ Other secondary causes of hypokalemic paralysis, such as renal tubular acidosis, hyperaldosteronism, and gastrointestinal potassium wasting, were excluded based on normal acid-base status, normal renal function, and low urinary potassium excretion.⁶ A comparative overview of these conditions is presented in Table 2.

Thyrotoxic periodic paralysis is a rare, potentially lethal complication of hyperthyroidism characterized by transient, recurrent episodes of flaccid muscle weakness and hypokalemia.³ Although hyperthyroidism is vastly more common in females, thyrotoxic periodic paralysis displays a stark male predominance, with a male-to-female ratio ranging from 17:1 to 70:1.¹² It occurs primarily in males of East Asian descent, where it affects approximately 1.8% to 2.0% of hyperthyroid individuals.⁴ The physiological basis of this gender discrepancy is thought to

involve androgens, which directly upregulate the expression and activity of the myocyte membrane Na⁺/K⁺-ATPase pump, enhancing susceptibility to intracellular potassium shifts.¹³

The fundamental pathophysiology of thyrotoxic periodic paralysis involves an acute intracellular shift of potassium rather than a true total-body potassium depletion.¹ Muscle cell resting membrane potential is maintained by the Na⁺/K⁺-ATPase pump.⁶ Thyroid hormone increases both the transcription and biochemical sensitivity of these pumps.⁷ Under conditions of excess thyroid hormone and heightened adrenergic drive, the pump's activity is profoundly accelerated, drawing potassium from the extracellular fluid into the intracellular compartment.¹ This intracellular entrapment hyperpolarizes the cell membrane, rendering the myocyte unexcitable and culminating in flaccid paralysis.¹⁴ Genetic factors also play a critical role; mutations in the KCNJ18 gene, which encodes the inward-rectifying potassium channel Kir2.6, have been strongly associated with thyrotoxic periodic paralysis.¹⁰ These mutations impair outward potassium efflux, further

compounding the intracellular retention of potassium during an attack.¹⁴

A major clinical challenge in managing thyrotoxic periodic paralysis is the prevention of rebound hyperkalemia.⁶ Because total-body potassium stores are fully intact, any potassium administered during the acute paralytic phase will eventually shift back into the extracellular space once the hyperadrenergic state resolves.⁶ Aggressive potassium replacement protocols (exceeding 90 mEq within 24 hours) have been documented to trigger severe, life-threatening rebound hyperkalemia, potentially leading to lethal cardiac arrhythmias.¹¹ Consequently, current clinical consensus advocates for cautious, low-dose potassium repletion (less than 10 mEq per hour) with continuous cardiac telemetry.^{1,6,8}

Furthermore, non-selective beta-blockade has emerged as an invaluable first-line therapeutic intervention.⁶ Propranolol directly inhibits the beta-adrenergic-mediated overstimulation of the Na⁺/K⁺-ATPase pump, effectively halting the intracellular potassium

shift and rapidly aborting the paralytic attack without causing rebound hyperkalemia.⁷ Ultimately, long-term prevention of recurrent paralytic episodes depends entirely on achieving and maintaining a stable euthyroid state through antithyroid medications, radioactive iodine ablation, or thyroidectomy.⁶

CONCLUSION

Thyrotoxic periodic paralysis should be suspected in young males presenting with sudden-onset flaccid quadriparesis and severe hypokalemia, even when classical adrenergic signs of hyperthyroidism are clinically subtle or absent. Immediate thyroid function testing is indicated in all cases of unexplained hypokalemic periodic paralysis to differentiate acquired thyrotoxic periodic paralysis from primary familial periodic paralysis. Potassium replacement must be administered with extreme caution under continuous cardiac monitoring, typically not exceeding 90 mEq within 24 hours, to prevent the dangerous development of rebound hyperkalemia once the paralytic shift reverses. Non-selective beta-blockers, such as propranolol, represent a targeted acute intervention that halts the

adrenergic-driven intracellular potassium shift. At the same time, long-term management requires definitive control of the hyperthyroid state.

ACKNOWLEDGEMENT

The authors sincerely thank the medical, nursing, and staff of the Department of Neurology at Bethesda Hospital, Yogyakarta, for their dedicated care and support throughout the patient's hospitalization and recovery.

REFERENCES

1. Wiersinga WM, Poppe KG, Effraimidis G. Hyperthyroidism: aetiology, pathogenesis, diagnosis, management, complications, and prognosis. *Lancet Diabetes Endocrinol.* 2023;11(4):282-98. doi:10.1016/S2213-8587(23)00005-0.
2. Paul J, Joseph A, Jebasingh F, et al. Thyrotoxic periodic paralysis: a retrospective study from Southern India. *Eur Thyroid J.* 2024;13(6):e240164. doi:10.1530/ETJ-24-0164.
3. Tachamo N, Lohani S, Nazir S, et al. Paralysis that easily reverses: a case of thyrotoxic periodic paralysis. *BMJ Case Rep.* 2017;2017:bcr2016218951. doi:10.1136/bcr-2016-218951.
4. Alqahtani SF, Aleithan MM. Thyrotoxic periodic paralysis as an initial presentation of Graves' disease in a Saudi patient. *BMJ Case Rep.* 2017;2017:bcr2017220224. doi:10.1136/bcr-2017-220224.
5. Li GHY, Tang CM, Li RSH, et al. Twenty-year trend of thyrotoxicosis and thyrotoxic periodic paralysis: a population-based cohort study. *Eur Thyroid J.* 2025;14(5):e250220. doi:10.1530/ETJ-25-0220.
6. Alrashidi FS. Thyrotoxic Periodic Paralysis (TPP): A Comprehensive Review with Regional Insights from the Middle East. *Cureus.* 2025;17(12):e98814. doi:10.7759/cureus.98814.
7. Sehmer B, Arnason T. Pop-provoked paralysis: silent Graves' disease presenting as thyrotoxic periodic paralysis. *BMJ Case Rep.* 2012;2012:bcr2012006292. doi:10.1136/bcr-2012-006292.
8. Gadalla K, Anastasopoulou C. Hypokalemic Periodic Paralysis. [Updated 2025 Nov 28]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK559178/>
9. Anantha Ganesan J, Ekpemandu NM. A Trajectory of Thyroid Function: From Thyrotoxic Paralysis to Post-ablative Hypothyroidism. *Cureus.* 2025;17(11):e96924. doi:10.7759/cureus.96924.
10. Mebane NB, Khan A, Bevinall M, et al. Thyrotoxic Periodic Paralysis With Hypokalemia: A Case Study. *Cureus.* 2023;15(6):e40757. doi:10.7759/cureus.40757.
11. Matsui D, Mugikura S, Goshima T, et al. Rebound Hyperkalemia After Potassium Repletion in Thyrotoxic Periodic Paralysis: A Case Report and Review of Management Implications. *Cureus.* 2025;17(6):e85551. doi:10.7759/cureus.85551.
12. Pisano TJ, Merical B, Wang Z, et al. Rebound Hyperkalemia in Hypokalemic Thyrotoxic Periodic Paralysis. *Neurohospitalist* 19418744251347781. doi:10.1177/19418744251347781.
13. Putri IS, Herdiana D, Ripa'i P, et al. Hypokalemia periodic paralysis in subtle thyrotoxicosis with renal insufficiency. *InaJEMD.* 2024;1(1):54-9. doi:10.66266/inajemd.v1i1.8.
14. Qing G, Zakaria WNA, Rom FZM, et al. Thyrotoxic Hypokalemic Periodic Paralysis: Pathophysiological Mechanisms. *Endocrinol Metab (Seoul).* 2025;40(6):821-9. doi:10.3803/EnM.2025.255