ABSTRACT

Ionized calcium is the physiologically active form of blood calcium as demonstrated by various studies. Direct measurement of ionized calcium, is limited by difficulties in standardization, and need for special handling, all resulting in increased cost; hence the need to calculate ionized calcium concentration from total calcium values that are more available and relatively inexpensive. We report a case of hyperventilation induced tetany in an asthmatic patient which illustrates the importance of measurement of ionized calcium for clinical decision-making.

KEY WORDS: Total calcium, ionized calcium

INTRODUCTION

Calcium is the abundant divalent cation in the body. Skeletal system comprises of 99% of total calcium and 1% is rapidly exchangeable with blood calcium, partly bound to protein and partly in ionized form. Ionized calcium is physiologically active form of calcium and has major role in nerve impulse transmission, muscle contraction, cardiac activity, blood clotting, and hormone secretion. Ionized calcium homeostasis is regulated by parathyroid gland, bone, kidney and intestine. Total calcium is more convenient to measure than ionized calcium, and therefore, more frequently measured in the clinical laboratories. Total calcium normally ranging from 8.9 to 10.3 mg/dl which includes ionized calcium (47%) plus physiologically inactive calcium (53%) bound to various anions, mainly albumin, as well as small anions such as bicarbonate, citrate, and lactate. Experts consider total calcium a less accurate measure of calcium status as it can be affected by serum albumin levels and pH changes.

CASE REPORT

The present case report is about a 24 year old student who was admitted in the emergency department with complaints of shortness of breath from 15 min, followed by giddiness, pain and tingling sensations in both hands, perioral tingling sensations, excessive anxiety and worry, panic attack, rapid breathing. She had asthma for the last 7 years and was on regular treatment with salbutamol and beclomethasone rotahalers and was advised salbutamol and beclomethasone nebulizations at bedtime. She revealed that in past she was admitted in the hospital for similar complaints. There was past history of surgery for right thyroid swelling - right hemithyroidectomy 7 years back, postoperative the patient was in euthyroid state.

ON EXAMINATION

She appeared anxious; developed painful spasm of both hands and was very restless. Patient was observed to have tachycardia and tachypnea but the blood pressure and oxygen saturation were within the normal limits.
Emergency blood gas analysis of a venous sample revealed respiratory alkalosis with pH 7.55, pCO₂ 17 mmHg, PO₂ 30 mmHg, HCO₃⁻ 15.7 meq/L, Na⁺ 130 mmol/L and low Ca²⁺ 0.74 mmol/L (normal being: 1.1-1.3 mmol/L), K⁺ 2.9 mmol/L on blood analysis. On further evaluation serum total calcium: 9.2 mg/dl, serum potassium: 2.9 mg/dl. Parathyroid hormone levels were normal. Vitamin D levels were near to lower limit of normal levels.

For the symptomatic relief, the patient was given 5 ml of 10% calcium gluconate IV over 10 min followed by an infusion of 10 meq of KCl over 1 h. IV midazolam was given to attenuate anxiety. Later Endocrinologist opinion was taken and was diagnosed to have secondary hyperparathyroidism with the advise to take vitamin D sachets once a week for 3 months and calcium tabs. Patient was on regular calcium diet.

DISCUSSION

Asthmatics may have an increased tendency to switch to oral breathing, a factor that may contribute to the pathogenesis of their asthma. [1] Minute volume in asthmatics is 15 litres [2] as compared to 4-6 litres of the normal breathing minute volume (WHO). Oral breathing may play a role in the pathogenesis of acute asthma exacerbations. [3] Asthmatic group had a significantly higher resting respiratory frequency and minute ventilation, and have lower mean end-tidal carbon dioxide. [4][5] Increasing evidence suggests that hypocapnia appears to induce substantial adverse physiological and medical effects. [6] Hypocapnia increases the flow resistance and creates symptoms that cannot be controlled by antiasthmatic medication taken by the asthma patients, thus compromising their perceived control over the management of their asthma, and consequently their perceived health. Ambulant, transcutaneous PCO₂ monitoring has been used to show that hyperventilation precedes exacerbation of asthma in a patient. [7]

Hyperventilation leads to carbon dioxide washout leading to respiratory alkalosis which in turn decreases hydrogen ion concentration. Since both hydrogen ions and calcium are bound to serum albumin, bound hydrogen ion dissociates from albumin in alkalosis, freeing up the albumin to bind with more calcium, and thereby decreasing the freely ionized form of calcium. For every 0.1 increase in pH, ionized calcium decreases by about 0.05 mmol/L. This hypocalcemia related to alkalosis is partially responsible for the cerebral vasoconstriction that causes lightheadedness, fainting, and parasthesia seen with hyperventilation. [8] Serum potassium concentration decreases during respiratory alkalosis when there is fall in partial pressure of carbon dioxide due to intracellular shift of potassium ions. Measurement of total calcium in secondary hyperparathyroidism may be inaccurate wherein direct estimation of ionized calcium proves to be superior to total calcium measurements. It is very difficult to make a diagnosis of hyperventilation in laboratory tests. Secondly “no mention is made of any link” between hyperventilation syndrome and asthma. [9] Patients may experience avoidable morbidity because of inappropriate diagnoses and ineffective treatment. [10] On long term, hyperventilation becomes habitual even after the primary cause is cured, thereby causing behavioral changes in the patient.

CONCLUSION

Treatment of the underlying cause is the mainstay of treatment of tetany. Behavioral interventions should be considered in the case of hyperventilation in asthma. Although direct measurement of ionized calcium remains costly and technically challenging, the calculated ionized calcium from total calcium have not proved accurate, especially in patients with complex illness. In the critical care setting, estimation of ionized calcium should be the routine practice.

REFERENCES