Emerg Radiol (2017) 24:319–324
DOI 10.1007/s10140-016-1475-1

CASE REPORT

Remarkable CT features of shock thyroid in traumatic and non-traumatic patients

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Received: 4 November 2016 / Accepted: 15 December 2016 / Published online: 21 December 2016

Abstract Shock thyroid is a part of the hypovolemic shock complex, which is a constellation of secondary computed tomographic (CT) findings that are observed in patients with hypovolemic shock. However, to the best of our knowledge, there has only been a single report on this condition, which described three cases associated with significant thoracoabdominal trauma. Here, we report four patients with profound hypotension who exhibited similar CT findings as those described in the initial report on shock thyroid, but with a more diverse clinical spectrum.

Keywords Hypovolemic shock complex · Shock thyroid · Trauma · Hypotension

Introduction

Shock thyroid is part of the hypovolemic shock complex (HSC), which is a constellation of secondary computed tomographic (CT) findings that are observed in patients with hypovolemic shock [1, 2]. In the initial description on three patients with severe thoracoabdominal trauma by Brochert et al. [2], CT showed a collection of homogenous fluid surrounding the thyroid with attenuated levels that ranged from −5 to 10 HU, along with heterogeneous enhancement of the thyroid. Since then, no similar cases have been reported in the literature. And in a study by Ames et al., the findings suggestive of shock thyroid were found in none of the 41 patients with either traumatic HSC or nontraumatic HSC [3].

Here, we report four patients with profound hypotension who exhibited CT findings similar to those described in the initial report, but with a more diverse clinical spectrum.

Patient 1

A 79-year-old male with Parkinson's disease was admitted to the emergency department (ED) for prolonged (48 h) sleep and low blood pressure (BP). Initially, 10 days before the current ED visit, the patient was transferred from an outside hospital for evaluation of elevated creatinine levels (1.9 mg/dL) associated with antibiotic therapy for pneumonia. His BP at that visit was 134/80 mmHg, and low-dose chest CT showed small areas of airspace consolidation in both lower lobes with no pleural effusions. It was decided that the patient could be managed with antibiotics; thus, he returned to the original hospital on the same day, from where he was discharged after 8 days. On the day of the ED visit, his home caretaker realized that he had been sleeping too long, for almost 48 h. Remembering that the patient had hypotensive episodes in the past (systolic BP dropping to as low as 80 mmHg), the caretaker measured his BP and found that it was profoundly abnormal (65/55 mmHg). At the ED, the patient was alert despite having a low (77/53 mmHg) BP, with unremarkable physical examination findings and routine laboratory test results. Non-contrast brain CT was unremarkable. Low-dose chest CT, in addition to remnants of pneumonic opacities, showed diffuse swelling of the thyroid (Fig. 1a) and heterogeneous soft tissue density in the nearby mediastinal fat tissue (Fig. 1b). Compared to the CT performed 10 days

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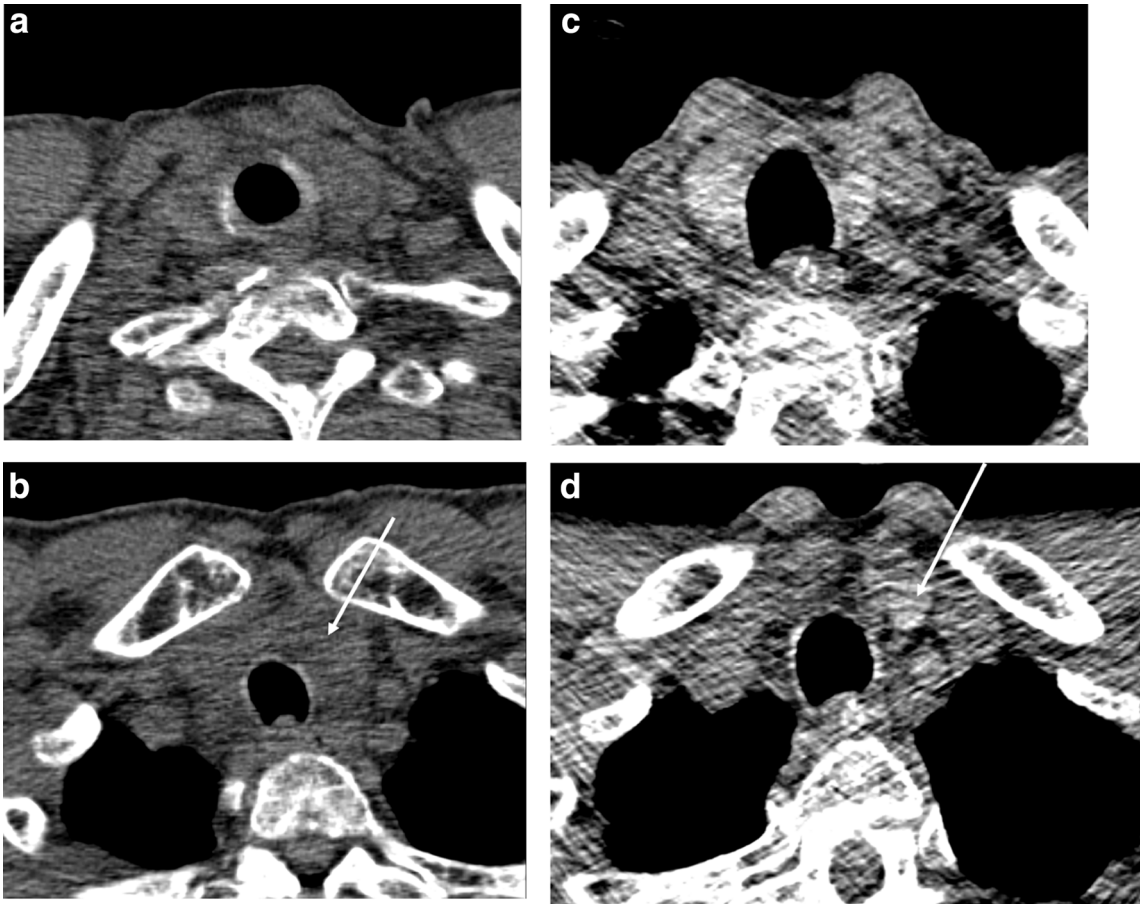

Fig. 1 A 79-year-old male with prolonged sleep and hypotension. **a** Low-dose non-contrast chest CT obtained at the emergency department (ED) visit shows diffuse swelling and hypodensity (32.4 HU) of the thyroid. **b** Low-dose non-contrast chest CT obtained at the ED visit shows heterogeneous soft tissue density in the superior mediastinal fat tissue. Due to decreased density of the thyroid parenchyma and increased density of the surrounding fat tissue, the thyroid itself (*arrow*) is poorly delineated, unlike in the previous exam (Fig. 1d). **c** Low-dose non-contrast chest CT obtained 10 days before **a** and **b** shows a normal size and density (160.3 HU) of the thyroid. **d** Low-dose non-contrast chest CT obtained 10 days before **a** and **b** shows a normal appearance of fat tissue in the superior mediastinum, with a clear demarcation between the thyroid (*arrow*) and surrounding fat tissue

before, the density of thyroid parenchyma was remarkably low (Fig. 1a). A total of 30 mg norepinephrine was continuously administered over a period of 6 h as a diluted solution via a peripheral venous line, until the systolic BP reached 130 mmHg. The patient was discharged home uneventfully with no hypotensive episodes as of the last (14 month) follow-up.

Patient 2

A 25-year-old female with bipolar I disorder was admitted to the ED for cardiac arrest of unknown origin. The patient was found unconscious and an ECG was performed by the 911 dispatcher, revealing asystole. The patient was immediately transported to the ED with continuous basic cardiopulmonary life support applied during transport. After 17 min of advanced cardiopulmonary life support in the ED, return of spontaneous circulation (ROSC) was achieved. Contrast-enhanced chest CT was performed for exclusion of internal bleeding, which showed diffuse swelling and ill-defined low densities in the thyroid (Fig. 2a). The patient was admitted to the intensive care unit (ICU). Neck CT was performed on hospital day 14 for the evaluation of diffuse neck swelling that occurred during ICU care, which showed that both the size and density of the thyroid returned to normal (Fig. 2b). The patient expired due to multiple organ failure on day 20 in the hospital.

Patient 3

A 22-year-old female was admitted to the ED after a motor vehicle collision. The patient was found unconscious in the backseat of the car and initial ECG performed by the 911 dispatcher revealed asystole. After cardiopulmonary life

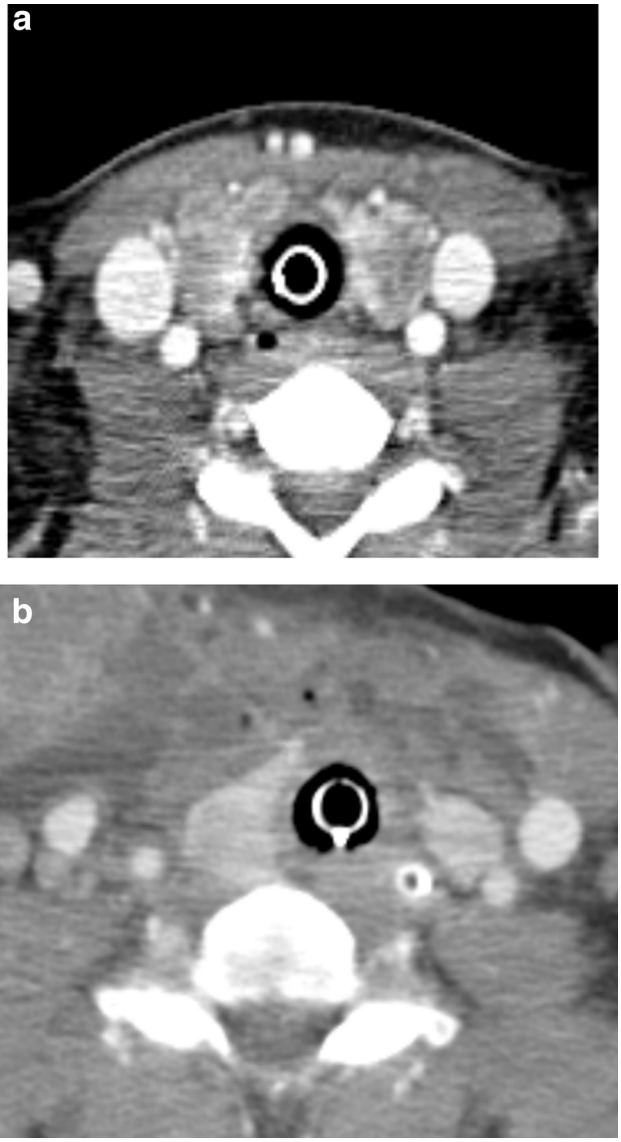

Fig. 2 A 25-year-old female with cardiac arrest from an unknown cause. **a** Contrast-enhanced Chest CT shows diffuse swelling of the thyroid, with scattered ill-defined low densities in it. **b** Contrast-enhanced neck CT on HD #14 shows normal appearance of the thyroid, with resolution of both diffuse swelling and internal low densities. Multiloculated fluid collections are seen in the neck, suggestive of a deep neck infection

support, ROSC was achieved; however, the patient fell into a coma with a Glasgow Coma Score of 3. Contrast-enhanced chest CT performed in the ED revealed pneumothorax on the right and bilateral lung contusion. Diffuse edematous swelling and ill-defined low densities were observed in the thyroid with perithyroidal fluid collections of 4–7 HU (Fig. 3a). Abdominal CT showed no definitive evidence of solid organ laceration; however, diffusely dilated small bowel loops with thickened, enhancing walls were observed, suggestive of a shock bowel pattern. Diffuse swelling of the pancreas with heterogeneous enhancement and peripancreatic fluid collections were also identified (Fig. 3b–c). Non-contrast brain CT

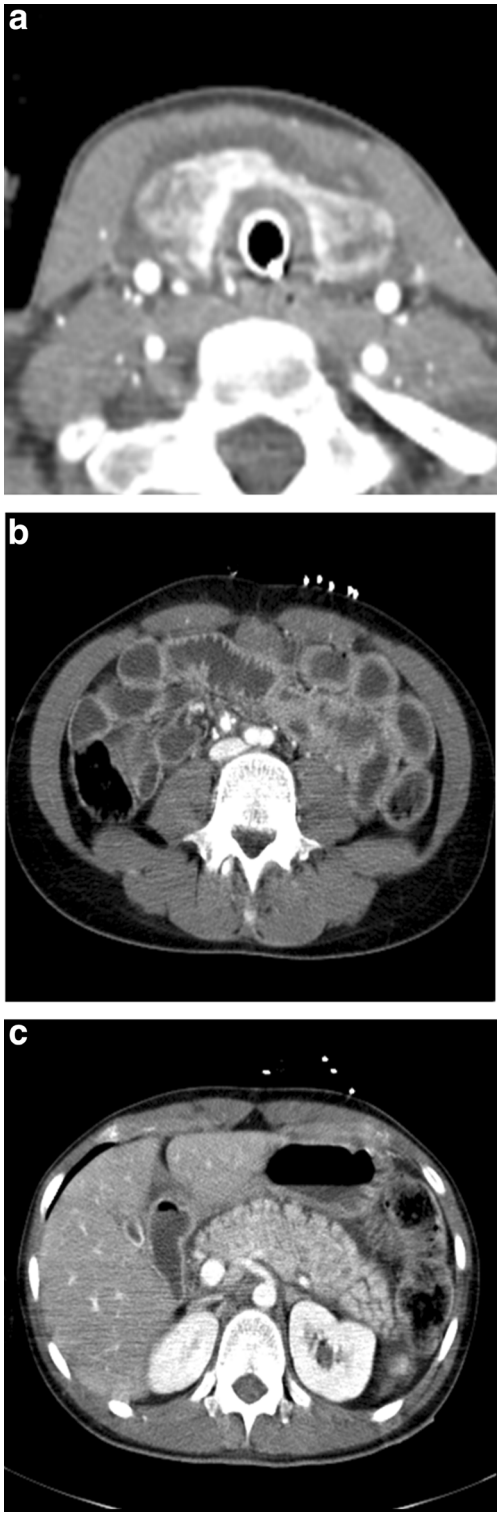

Fig. 3 A 22-year-old female after a motor vehicle collision. **a** Contrast-enhanced Chest CT obtained at the ED arrival shows diffuse swelling and ill-defined low densities in the thyroid with perithyroidal fluid (4–7 HU) collections. **b** Abdominal CT showed diffusely dilated small bowel loops with thickened, enhancing walls, consistent with shock bowel. **c** Abdominal CT showed diffuse swelling of the pancreas with heterogeneous enhancement and peripancreatic fluid collections, consistent with shock pancreas

showed multiple skull fractures with severe brain swelling and herniation. The patient expired due to multiple organ failure on day 5 in the hospital.

Patient 4

A 17-year-old male was admitted to the ED after a bicycle accident. Similar to patient 3, his heart was asystolic and cardiopulmonary resuscitation led to ROSC in the ED. Chest CT revealed extensive bilateral hemopneumothorax, lung contusion, and active contrast extravasation with hematoma in the right lower chest wall. In addition, diffuse swelling of thyroid with heterogeneous enhancement and perithyroidal fluid collections were identified. No discrete nodule or mass was visualized in the thyroid (Fig. 4a). Abdominal CT showed a shock bowel pattern, periportal edema, and small-caliber inferior vena cava (Fig. 4b–c). Diffuse hypovolemic change in the intraabdominal solid organ was also observed. Non-contrast brain CT showed severe brain swelling and traumatic subdural hemorrhage at the right frontotemporoparietal area. The patient expired due to multiple organ failure on day 2 in the hospital.

Discussion

Shock thyroid is a part of the HSC [1, 2]. Common causes of hypovolemic shock include traumatic hemorrhage such as solid abdominal organ injury, non-traumatic hemorrhage such as peptic ulcer, and non-hemorrhagic causes such as burns or emesis [1]. Common HSC findings on CT include diffuse dilation of the small bowel lumen with fluid; increased contrast enhancement of the bowel wall, kidney, mesentery, and pancreas; decreased abdominal aorta and IVC diameter; and peritoneal fluid collection [1, 4–7].

Shock thyroid has always been described as being a part of the HSC (1, 2), but actual cases have never been reported during the 10-year period following the initial description [2]. Considering that chest CT is commonly performed for evaluation or exclusion of a hemorrhagic focus in traumatic and non-traumatic patients with hypovolemia, it is difficult to understand the paucity of reports regarding shock thyroid. It is possible that it is an extremely uncommon manifestation of HSC or that the edema in shock thyroid may be a transient condition that resolves by the time CT is performed. However, we believe that the most plausible reason is a low awareness of this disorder, making it either overlooked or mistaken for another condition such as thyroid injury or an incidental tumor (Fig. 5). Because all seven cases of shock thyroid described so far, including the four cases described in this report and the three cases

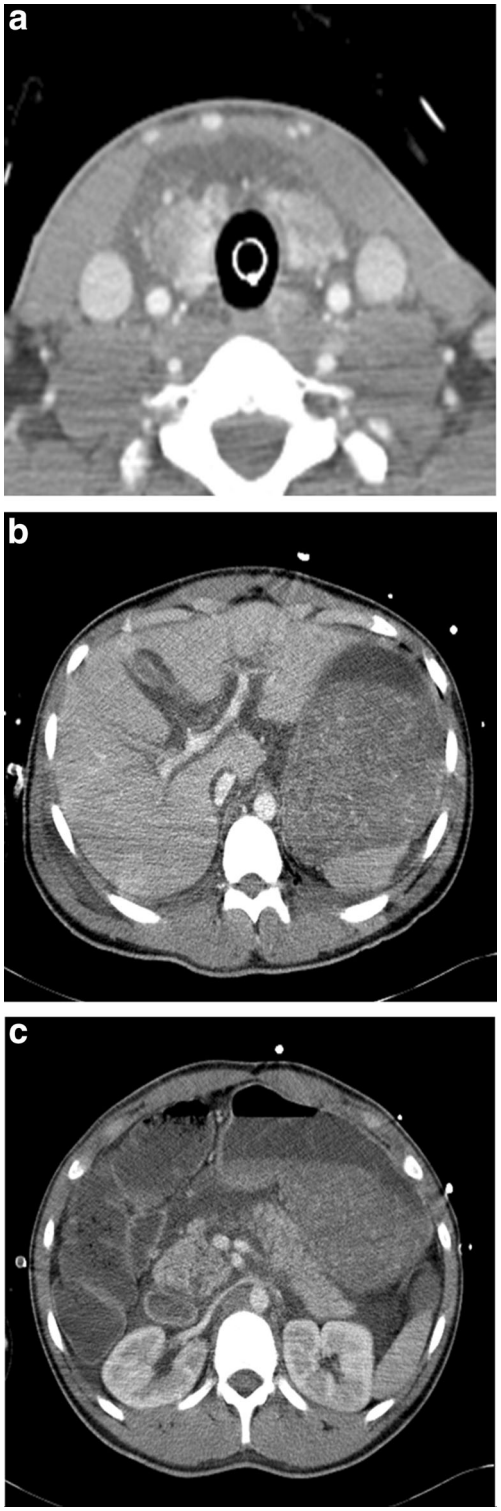

Fig. 4 A 17-year-old male after a bicycle accident. **a** Contrast-enhanced Chest CT revealed diffuse swelling of thyroid with heterogeneous enhancement and perithyroidal fluid collections. No discrete nodule or mass was visualized in the thyroid. **b**–**c** Abdominal CT showed diffuse periportal edema, a small-caliber vena cava, and a shock bowel pattern, which we consider as an image spectrum of hypovolemic shock complex

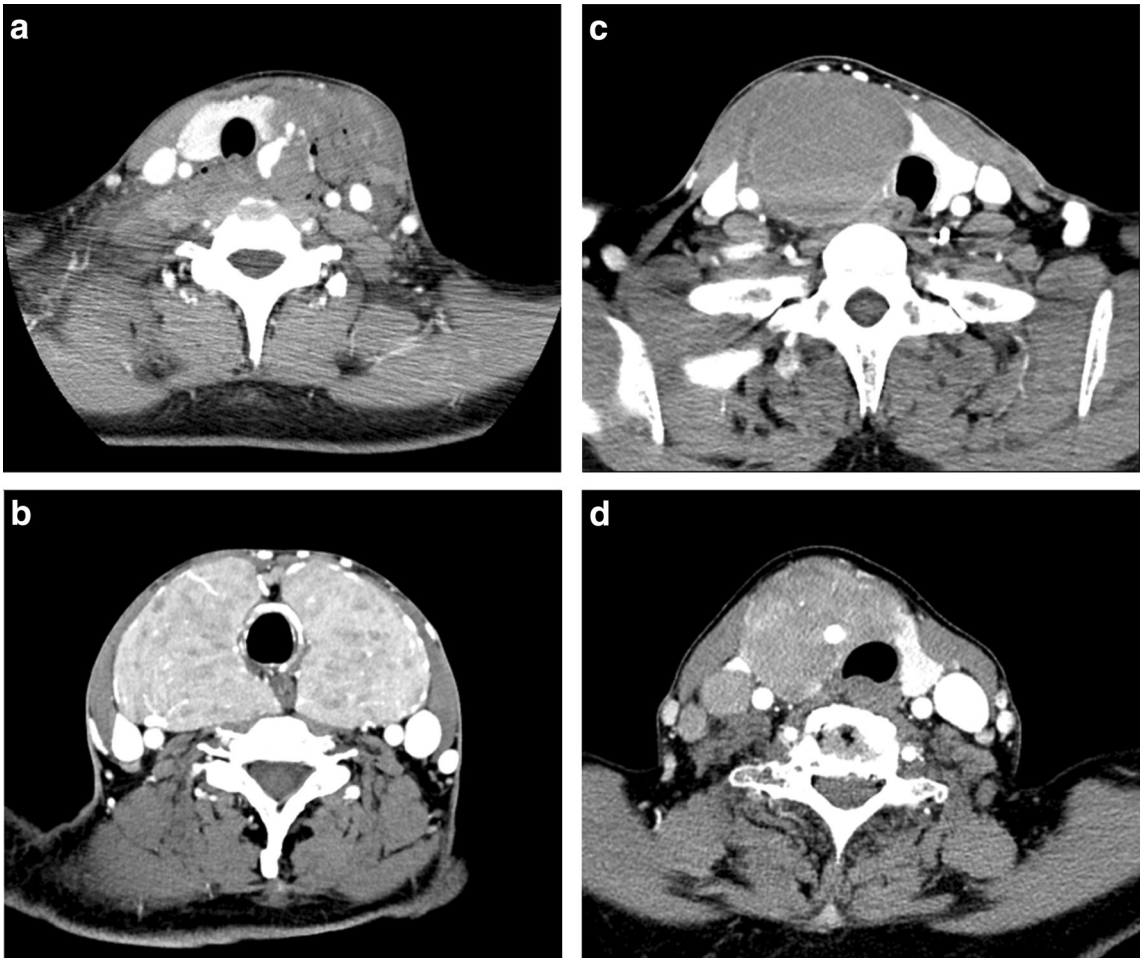

Fig. 5 Patients who visited emergency department due to various thyroid problems. **a** A 29-year-old female with stab wound in the lower neck. Contrast-enhanced CT demonstrated a transection of the left lower pole of the thyroid gland with active bleeding of the inferior thyroid artery. **b** A 45-year-old male with neck swelling and palpitation. Contrast-enhanced CT showed diffuse enlargement and heterogeneous enhancement of the thyroid gland without discrete nodule or mass. This patient was confirmed to have a Graves disease. **c** A 57-year-old male with acute neck swelling and pain. Contrast-enhanced CT revealed a large cystic mass in right thyroid gland. It was confirmed as a benign hemorrhagic cyst on fine-needle aspiration biopsy. **d** A 73-year-old female with progressive neck swelling. Contrast-enhanced CT showed a large infiltrative mass with ipsilateral metastatic lymphadenopathy. This mass was confirmed to be an anaplastic thyroid carcinoma

described in the initial report by Brochert and Rafoth [2], were found by chest CT, we believe that efforts to raise awareness of this condition should be focused on subspecialities such as thoracic radiology or emergency radiology.

The pathophysiology of shock thyroid is not well known. According to the explanation by Brochert et al. [2], many homeostatic mechanisms that serve to maintain adequate tissue perfusion to critical organs in hypovolemic shock can result in a severe reduction in vascular perfusion and oxygen delivery to the thyroid gland. The same authors explain that hypoperfusion of the highly vascular thyroid gland may cause cellular edema or death, as well as exudation of intracellular fluid. Other proposed possibilities include third-spacing of resuscitative fluid and a profound thyroid response, which induce transient thyrotoxicosis for the maintenance of cardiac output [1, 2].

Considering that HCS is not always due to trauma [3], it is not surprising that CT findings identical to those previously described for trauma-induced shock thyroid were observed in two patients in the current series who had non-traumatic hypovolemia. In one of those two cases, the patient was not even in a state of shock. Although the primary aim of CT in hypotensive patients is identifying the site of any hemorrhagic source, recognition of shock thyroid in such a setting may allow radiologists to contribute towards the clinical grading of shock severity, particularly when it is underestimated by clinical grading alone [1, 8].

Conclusions

In conclusion, shock thyroid or transient thyroid and perithyroidal edema related to profound hypotension can be

observed on CT in both traumatic and non-traumatic patients. Radiologists, particularly those who frequently read chest CT of trauma patients in their practice, should be aware of this condition.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Source of funding There is no source of funding received for this work.

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