A 55-year-old woman with a history of type 1 multiple endocrine neoplasia and primary hyperparathyroidism was referred for exertional dyspnea. She had been hospitalized 18 months earlier with septic shock caused by acute peritonitis, and she underwent subtotal parathyroidectomy 1 year before admission. She presented with New York American Heart Association class II dyspnea and no palpable neck mass. Her ECG showed diffuse negatives T waves (Figure 1A). Chest radiograph revealed moderate calcifications at the left ventricular (LV) apex (Figure 1B). Plasmatic albumin-corrected calcium and phosphorus levels were 2.7 mmol/L (normal range, 2.1–2.7 mmol/L) and 0.8 mmol/L (normal range, 1.0–1.5), respectively, and parathyroid hormone was 240 pg/mL (range, 17–70 pg/mL). The patient’s echocardiogram showed marked asynergy of the LV apical and posterior walls, and a large acoustic shadow at the LV apex with myocardial calcifications embedded in the LV apical and posterior walls (Figure 2). LV ejection fraction was 49%.
(biplane Simpson’s method). Gated cardiac 64-slice multidetector computed tomography showed no significant coronary stenosis and a clear asynergy of the LV apical and posterior walls with LV apical thrombus. Remarkably, computed tomography showed extensive subepicardial and midwall myocardial calcifications (300–500 Hounsfield Units) within the asynergic LV apical and posterior walls (Figure 3A and 3B and Movie I in the online-only Data Supplement). Cardiovascular magnetic resonance (1.5-T Magnetom Espree; Siemens, Erlangen, Germany) confirmed the asynchrony of the LV apical and posterior walls with preserved wall thickness and the presence of LV apical thrombus (Movies II and III in the online-only Data Supplement). End-diastolic LV volume index was normal (78 mL/m²); indexed myocardial mass (71 g/m²) and LV ejection fraction was 46%. T1- and T2-black blood spin-echo cardiovascular magnetic resonance showed a pronounced decrease in myocardial signal intensity in the subepicardial rim of the LV apical and posterior walls, matching the lesions seen on computed tomography (Figure 4). Late gadolinium-enhanced cardiovascular magnetic resonance acquired 10 minutes after 0.2 mmol/kg gadolinium (Dotarem; Guérbet, Aulnay-sous-Bois, France) demonstrated diffuse subepicardial enhancement of the LV apical and posterior walls, whereas no enhancement was seen in the subendocardium (Figure 5).

The most common causes of myocardial calcifications are represented either by dystrophic or metastatic calcium deposits.1 Dystrophic calcifications may accumulate within the necrotic scar long after extensive myocardial infarction. Metastatic myocardial calcifications refer to the deposition of calcium in noninfarcted tissue resulting from impaired calcium–phosphorus metabolism, most frequently described in patients with chronic renal failure and secondary hyperparathyroidism.2 The current case is peculiar owing to the extensive amount of myocardial calcifications, for which

Figure 2. Still frames extracted from echocardiogram in the subcostal (A) and 2-chamber view (B) showing an abnormal hyperechogenic myocardial signal (arrows) and apical shadowing (*) resulting from extensive myocardial calcifications.

Figure 3. (A) Postcontrast 64-slice computed tomographic scan showing extensive subepicardial and midwall myocardial calcifications (300–500 Hounsfield Units) within the apical and posterior walls, with left ventricular apical thrombus. CE indicates contrast enhanced; CT, computed tomography. (B). Reconstructed 3-dimensional volume- rendered image with extensive apical and posterior myocardial calcifications.
the primary mechanism is likely to be metastatic, because the patient had primary hyperparathyroidism with impaired calcium metabolism and longstanding elevated levels of parathyroid hormone. Indeed, before parathyroidectomy, the patient had high parathyroid hormone (up to 280 pg/mL) and serum calcium (up to 3.7 mmol/L) levels for several years and she had no prior myocardial scar. In addition, the development of dystrophic myocardial calcium deposits potentially occurred after the systemic septic injury (endotoxin-induced myocarditis), which might have participated in the development of the cardiomyopathy. Evidence exists of a similar myocardial fiber calcification process for both metastatic and dystrophic mechanisms, with an initial mitochondrial mineralization followed by total myocardial fiber involvement and subsequent extension to the interstitial space. The pivotal lesion is thought to be a primary dysfunction of the cell membrane with a subsequent increased influx of calcium, either with normal (dystrophic) or increased (metastatic) plasmatic levels of calcium. Concomitantly, myocyte calcification may trigger a pleiotropic inflammatory response, leading to cytoplasmic overload by crystals of hydroxyapatite and surrounding interstitial fibrosis, accounting for the high signal intensity on late gadolinium-enhanced cardiovascular magnetic resonance images. The risk of death from cardiovascular causes is increased among patients with moderate-to-severe primary hyperparathyroidism and persists long after subtotal parathyroidectomy. The complications may include arrhythmias, heart failure, and death. Once cardiac disease is overt, therapeutic options are limited, and cardiac transplantation may be recommended in case of severe heart failure. Thus, the prevention of calcium accumulation is of crucial importance to avoid irreversible myocardial damage. In the setting of hyperparathyroidism, it is mandatory to understand more completely the risk factors for myocardial calcium accumulation and for the development of irreversible myocardial damage. Preventive interventions should be developed promptly and tested. The role of cinacalcet, which is able to decrease serum levels of calcium, is unknown in the prevention of myocardial injury. The current patient was treated with a β-blocker, an angiotensin-converting enzyme,

Figure 4. T1- (A) and T2-weighted (B) black blood spin-echo cardiovascular magnetic resonance showed a pronounced decrease in myocardial signal intensity in the subepicardial rim of the left ventricular apical and posterior walls (arrows), matching the lesions seen on computed tomography (C) and late gadolinium-enhanced cardiovascular magnetic resonance (D).

Figure 5. Matched comparisons of late gadolinium-enhanced cardiovascular magnetic resonance (upper panel) and gated 64-slice computed tomography (lower panel) in the left ventricular short-axis view from base to apex showed a good agreement for the detection of subepicardial myocardial calcifications. Myocyte overload by crystals of hydroxyapatite and surrounding interstitial fibrosis induced by the inflammatory response led to an increased distribution volume of gadolinium and subsequent enhancement on late gadolinium-enhanced cardiovascular magnetic resonance.
and a vitamin K antagonist because of LV apical thrombus, with event-free clinical outcome at 1 year.

Disclosures

None.

References
Petrified Myocardium: The Age of Stone?
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