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فهرست

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Inverted Takotsubo Cardiomyopathy V Clinicopathologic Correlation

Khoa Tran, MBBS, FRACP, FCICM,* Nathan Milne, MBBS, FRCPA,Þ
Edwina Duhig, MBBS, FRCPA,þ and Mikhail Altman, MD, FRACP§

Abstract: We report the case of a 34-year-old woman who presented after a witnessed out-of-hospital arrest. Initial cardiac rhythm at the time of resuscitation was ventricular fibrillation. Subsequently in hospital, she developed further episodes of polymorphic ventricular tachycardia and ventricular fibrillation. Urgent echocardiography showed features suggestive of an inverted takotsubo cardiomyopathy. Twenty-four hours after admission, there was a further episode of polymorphic ventricular tachycardia from which the patient could not be resuscitated. An autopsy confirmed the cause of death as inverted takotsubo cardiomyopathy. We present the pathological findings from the postmortem autopsy.

Key Words: takotsubo, stress-induced cardiomyopathy

(Am J Forensic Med Pathol 2013;34: 217Y221)

CASE REPORT

A 34-year-old woman was brought to the emergency department (ED) of our hospital after a witnessed out-of-hospital arrest. According to her husband, she awoke from sleep complaining of a sore throat, then made gasping sounds before losing consciousness. He initiated cardiopulmonary resuscitation (CPR), and an ambulance was called. On arrival, paramedics noted that CPR was in progress, and initial electrocardiogram rhythm showed coarse ventricular fibrillation (VF). The pulse and blood pressure (BP) were unrecordable. The patient was ventilated with a bag-valve mask on 100% oxygen, and CPR was continued. The patient was defibrillated, and there was return of spontaneous circulation (ROSC) after the fourth shock with a palpable carotid pulse and a recorded BP of 135/86 mm Hg. The time from initial ambulance arrival to ROSC was 16 minutes, and it was estimated that 7 minutes had elapsed between the witnessed arrest and ambulance arrival.

The patient had attended her local medical officer the previous day for symptoms of an upper respiratory tract infection and had been prescribed amoxicillin. She had a history of hay fever, and used fexofenadine and cetirizine on an as-needed basis. No other significant medical history or medication use was noted. She did not smoke or consume excessive alcohol, and there was no history of recreational drug use. She was reportedly active and participated in organized sporting activities. There was a family history of ischemic heart disease.

On arrival in the ED, the recorded BP was 80/40 mm Hg. She was immediately intubated and ventilated, and intra-arterial cannula for invasive BP monitoring and a central venous catheter were inserted. Intravenous fluids were administered, and the BP improved to 100/50 mm Hg. Approximately 90 minutes after arrival in the ED, she developed polymorphic ventricular tachycardia (VT) and was defibrillated with a further 4 shocks before ROSC. Over the next 40 minutes, she developed further episodes of polymorphic VT and VF and received a total of 11 shocks. Drugs administered during this period of resuscitation included adrenaline (8 mg in total), amiodarone (600 mg in total), atropine 1 mg, lignocaine 100 mg, sodium bicarbonate, magnesium chloride, and calcium gluconate. A lignocaine infusion was also commenced, and a dobutamine infusion was also commenced for hemodynamic support. An electrocardiogram recorded when the patient was back in sinus rhythm showed prolonged QT interval of 463 milliseconds, with no conduction abnormalities or changes of myocardial ischemia evident.

An urgent limited bedside echocardiographic study was performed, which revealed severe left ventricular (LV) systolic dysfunction with akinesis of basal and mid segments in multivessel territory and preservation of all apical segments. No significant valvular dysfunction was observed, and right ventricular function visually appeared normal. Such peculiar distribution of impaired contractility first raised suspicion of an inverted takotsubo cardiomyopathy.

The patient was admitted to our intensive care unit. Hemodynamic support was continued with dobutamine. Therapeutic hypothermia was commenced, and the patient was cooled to a core temperature of 33.9-C. Twenty-four hours after admission to the intensive care unit, there was sudden deterioration with hypotension and development of polymorphic VT. Cardiopulmonary resuscitation was commenced, and cardioversion was performed on 7 occasions. Rhythms during the period of resuscitation included VT, asystole, and pulseless electrical activity. A transvenous pacing wire was also inserted for transvenous overdrive pacing. Cardiopulmonary resuscitation was unsuccessful, and CPR was ceased after 45 minutes.

The death was reported under the Queensland Coroners Act as the underlying cause of death was unknown. The coroner ordered a full internal autopsy, which was performed approximately 24 hours after death. External examination showed an overweight (body mass index, 29.3 kg/m^2) woman with signs of therapeutic intervention.

The heart was fixed in formalin for 2 days before examination. The heart was not enlarged and weighed 326 g. The left and right atria were of normal size. The maximum diameters of the left and right ventricles were 35 and 40 mm, respectively. At the apex of the heart, both ventricles appeared normal. However, there was dilatation of both ventricles at the base of the heart (Figs. 1Y4). This appearance supported the

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FIGURE 1. Dilated basal left ventricle, viewed from inferior aspect. Figure 1 can be viewed online in color at www.amjforensicmedicine.com.

echocardiographic findings. The epicardial and endocardial surfaces were normal. The fossa ovalis was not patent. The valves were normal in size and morphology. The myocardium showed no evidence of fibrosis or infarction.

There was mild variation in the thickness of the left ventricle and interventricular septum. The anterior and lateral left ventricles measured 9 to 11 mm in thickness. The posterior left ventricle measured 11 to 12 mm in thickness. Compared with the anterior and lateral left ventricles, the posterior left ventricle was of greater thickness basally. The interventricular septum measured 9 to 12 mm in thickness. The posterior interventricular septum was thickened apically. The right ventricle measured 2 to 3 mm in thickness.

The epicardial coronary arteries had a normal anatomical arrangement, and the circulation was right dominant. The right coronary artery had a dual ostium. There was 20% eccentric stenosis of the left main coronary artery, whereas the other major arteries showed minor nonstenotic atheroma. The aorta showed mild streaky atheroma. The pulmonary arteries and both vena cava were normal.

Histologic examination of the left ventricle showed minor and subtle changes that were nonspecific and could have resulted from ischemia, inotrope usage, or excessive endogenous catecholamines. There were very occasional wavy myocytes with contraction bands (Fig. 5). These had no particular distribution and were identified within the anterior, lateral, and posterior left ventricle. Very focally there were also changes suggesting subendocardial myocytolysis. No well-developed changes of ischemia were seen, and in particular, there was no zone of infarction. There was a single area of myocyte disarray, but this was in the deep aspect of the interventricular septum and was considered to represent a normal anatomical variant. Disarray was not seen elsewhere within the myocardium. Very focal perivascular fibrosis was seen in the subendocardial region, but no significant scars were identified (Fig. 6). No definite hypertrophy was identified. Very small numbers of inflammatory cells were identified focally within the interstitium. No true myocarditis with inflammatory cellYmediated myocyte necrosis was seen.

Within the right ventricle, there was focal subendocardial fibrosis and a suggestion of mild myocyte hypertrophy. No ischemic changes were seen, and there were no features to suggest arrhythmogenic right ventricular cardiomyopathy. The right atrium was normal, and although the left atrium was thinned, there were no pathological features. Examination of the coronary arteries confirmed the gross appearances. The valves were normal.

Electron microscopy was performed on myocardial samples from both the base and apex of the left ventricle. No abnormalities were identified, and there were no differences between the 2 regions. Skeletal muscle neuropathology, including enzyme histochemistry, was normal.

Examination of the cranial cavity showed no catastrophic event, and in fact the brain was normal on external examination and neurohistopathologic examination. Other gross and histologic findings included pulmonary congestion and edema, early acute bronchopneumonia, moderately sized pleural effusions, resuscitation-related sternal and rib fractures, ascites, centrilobular hepatic congestion, and mild hepatic microsteatosis. Of note, the bronchopneumonia appeared most likely to have developed after presentation. Toxicological analysis of antemortem blood revealed only a therapeutic concentration of the anti-inflammatory drug naproxen.

Taking into account the clinical presentation, the poor functioning of the basal part of the heart on echocardiography, the dilated basal parts of the ventricles on postmortem examination, and the lack of another cause for these changes, inverted takotsubo cardiomyopathy was certified as the cause of death.

DISCUSSION

Takotsubo cardiomyopathy, also known as stress-induced cardiomyopathy and transient apical ballooning, is a rare acute cardiac syndrome occurring predominantly in women and often associated with sudden emotional or physical stress.[1,2] Takotsubo cardiomyopathy is characterized by the rapid development of severe LV dysfunction involving the midventricular and apical segments, which cannot be attributed to obstructive coronary disease.[3]

Takotsubo cardiomyopathy was first described in the Japanese literature as a syndrome of reversible LV dysfunction with apical ballooning.[4] The shape of the heart was thought to be similar to that of a Japanese octopus trap, or “takotsubo,” from which it subsequently derived its name. Most patients with

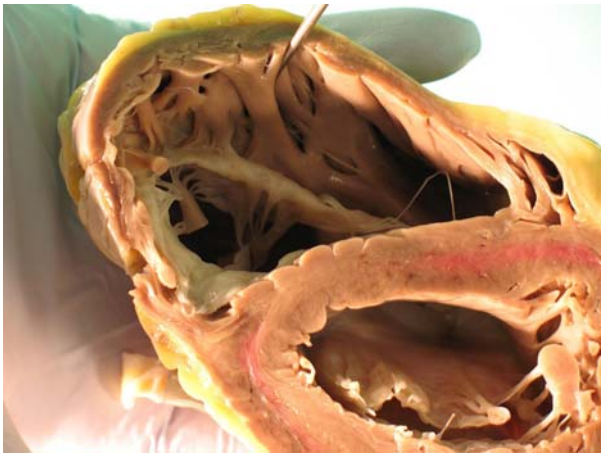

FIGURE 2. Dilated basal right ventricle, viewed from inferior aspect. Figure 2 can be viewed online in color at www.amjforensicmedicine.com.

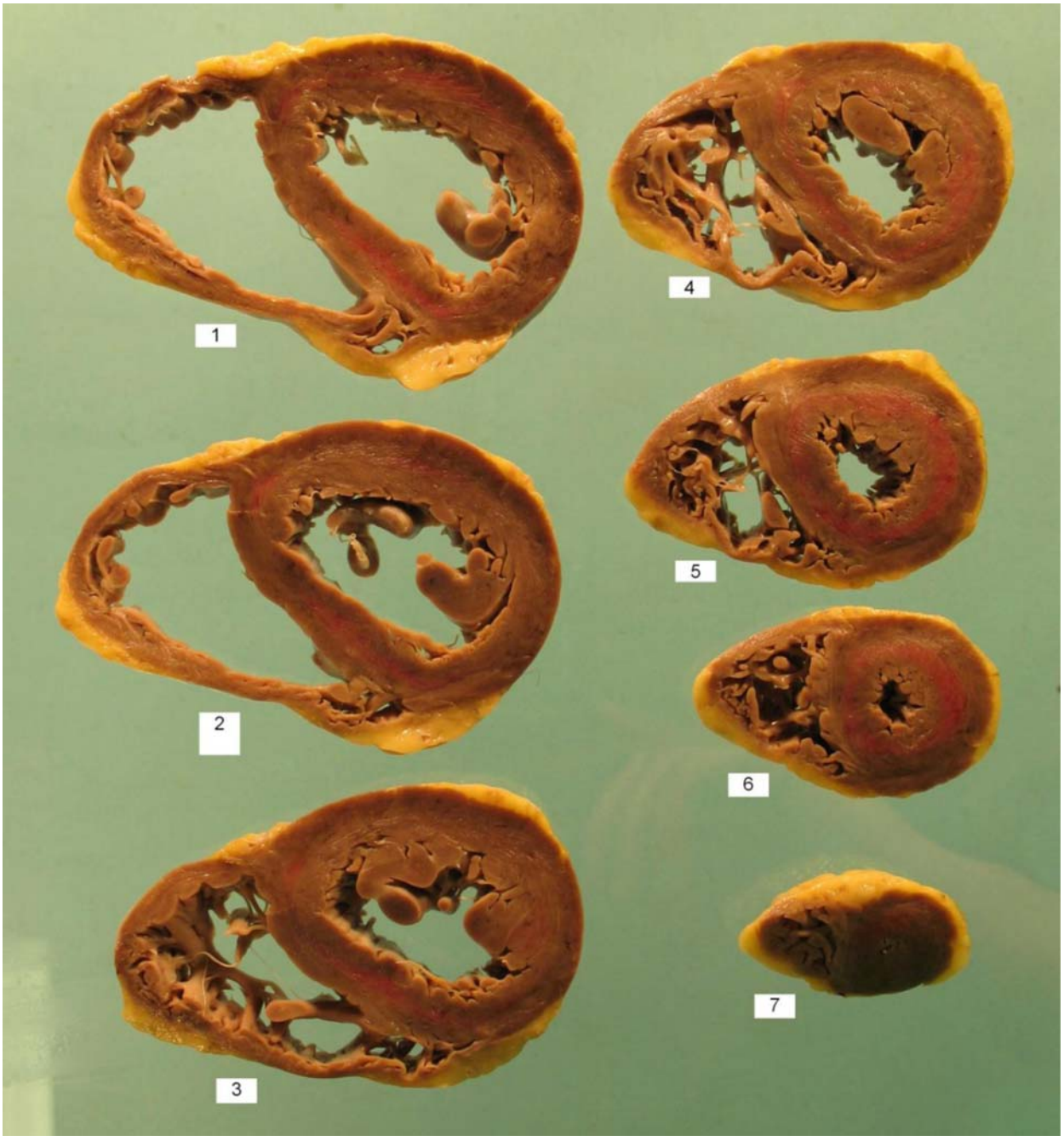

FIGURE 3. Transverse sections of the ventricles, numbered from 1 (basal) to 7 (apical), demonstrating basal biventricular dilatation. Figure 3 can be viewed online in color at www.amjforensicmedicine.com.

takotsubo cardiomyopathy who underwent myocardial biopsies have shown myocardial fibrosis, contraction bands with or without myocyte necrosis, and an interstitial inflammatory infiltrate.[1] Although the exact pathophysiology remains uncertain, a number of potential mechanisms have been postulated including multivessel epicardial coronary artery spasm, coronary microvascular impairment, catecholamine cardiotoxicity, and neurogenic stunned myocardium.[1] The LV dysfunction usually recovers within days or weeks, and the prognosis is generally good. Parodi et al[2] described only 11 deaths in their series of 116 patients, with 7 of these deaths attributed to a cardiovascular cause. Two thirds (67%) did not have a major adverse event, and recurrence of takotsubo cardiomyopathy was documented in only 2 patients.

More recently, a variant of this syndrome, the "inverted takotsubo" pattern, has been recognized, characterized by dysfunction of the basal and midventricular segments with preserved function of the apical segment.[3] This pattern has been recognized in association with pheochromocytoma,[3] head injury,[5] pancreatitis,[6] and sepsis.[7] Most of these patients survived,

FIGURE 4. The most basal of the transverse sections. Figure 4 can be viewed online in color at www.amjforensicmedicine.com.

and the patients who did not probably died of their underlying acute cerebral disorder.[8]

There has been only 1 reported case describing the pathology of inverted takotsubo cardiomyopathy in a woman with a subarachnoid hemorrhage. Marechaux et al[9] described a 40-year-old woman who presented with sudden severe headache. Cardiac arrest due to VF occurred while she was waiting for a brain computed tomography scan. Following successful resuscitation, she underwent a brain computed tomography, which demonstrated subarachnoid hemorrhage. Transthoracic echocardiography performed 2 hours after admission demonstrated severe LV dysfunction with an inverted takotsubo pattern. Brain death was diagnosed, and the patient was considered for organ donation. The heart was removed for pathological examination immediately after the liver and kidneys had been removed for transplant. At gross examination, there was no evidence of myocardial infarction. Histologic examination was similar to the present case, with sparse foci of myocyte necrosis with contraction bands in the basal and midventricular segments, with sparing of the apex. There was no fibrosis or inflammation.

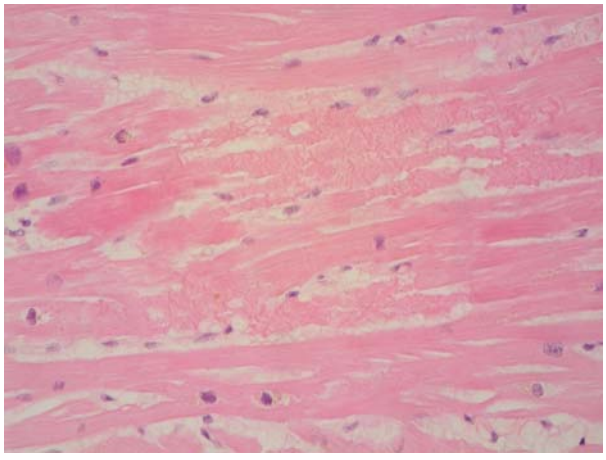

FIGURE 5. Wavy myocytes with contraction band necrosis (hematoxylin-eosin stain, original magnification ▫ 400). Figure 5 can be viewed online in color at www.amjforensicmedicine.com.

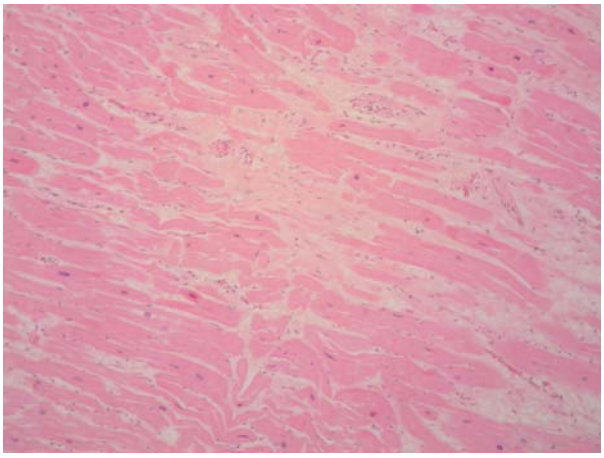

FIGURE 6. Myocardium with perivascular fibrosis (hematoxylin-eosin stain, original magnification ▫ 100). Figure 6 can be viewed online in color at www.amjforensicmedicine.com.

The reason for our patient's cardiac arrest remains unclear. The recurrent polymorphic VT raised the possibility that she had prolongation of her QT interval secondary to antihistamine use. Pathologic examination of her heart demonstrated histologic changes that were thought to be nonspecific and possibly secondary to ischemia, inotrope usage, or endogenous catecholamine. Histologically, the bronchopneumonia most likely postdated the initial cardiac arrest. Had it been preexisting, it is debatable whether the acute bronchopneumonia was sufficient stress to result in her inverted takotsubo cardiomyopathy. The patient was administered high doses of adrenaline during resuscitation and also required ongoing inotropic support for her cardiogenic shock, and this is the most likely cause of her inverted takotsubo cardiomyopathy.

In summary, we present a fatal case of inverted takotsubo cardiomyopathy, with basal biventricular dilatation identified on echocardiography and gross pathology. To our knowledge, this is the first report documenting such macroscopic pathology. Pathologists should consider the possibility of inverted takotsubo cardiomyopathy if basal ventricular dilatation is identified, particularly if there is a supportive history, such as an intracranial event or excess of endogenous or exogenous catecholamines. The association between inverted takotsubo cardiomyopathy and intracranial events is support for performing a full postmortem examination, rather than a limited examination of the head, which is typical of some jurisdictions.

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The authors thank the coroner, Mr James McDougall, for permission to report details of this case.

REFERENCES

1. Akashi YJ, Goldstein DS, Barbaro G, et al. New form of acute, reversible heart failure. Circulation. 2008;2008(118): 2754Y2762.
2. Parodi G, Bellandi B, del Pace S, et al. Natural history of tako-tsubo cardiomyopathy. Chest. 2011;139(4):887Y892.
3. Kim S, Yu A, Filippone LA, et al. Inverted-takotsubo pattern cardiomyopathy secondary to phaeochromocytoma: a clinical case and literature review. Clin Cardiol. 2010;33(4):200Y205.

4. Sato H, Tateishi H, Uchida T. Takotsubo-like cardiomyopathy due to multivessel spasm. In: Kodama K, Haze K, Hon M, eds. Clinical Aspect of Myocardial Injury: From Ischemia to Heart Failure. Tokyo, Japan: Kagakuhyouronsha; 1990:56Y64.
5. Riera M, Llompart-Pou JA, Carrillo A, et al. Head injury and inverted takotsubo cardiomyopathy. J Trauma. 2010;68(1):E13YE15.
6. van de Walle S, Gevaert SA, Gheeraert PJ, et al. Transient stress-induced cardiomyopathy with an “inverted takotsubo” contractile pattern. Mayo Clin Proc. 2006;81(11):1499Y1502.
7. Lee S, Lee KJ, Yoon HS, et al. Atypical transient stress-induced cardiomyopathies with an inverted takotsubo pattern in sepsis and in the postpartal state. Tex Heart Inst J. 2010;37(1):88Y91.
8. Ennezat PV, Pesenti-Rossi D, Aubert JM, et al. Transient left ventricula basal dysfunction without coronary stenosis in acute cerebral disorders: a novel heart syndrome (inverted takotsubo). Echocardiography. 2005;22(7):599Y602.
9. Marechaux S, Fornes P, Petit S, et al. Pathology of inverted takotsubo cardiomyopathy. Cardiovasc Pathol. 2008;17:241Y243.

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A Case of Fatal Iliac Vein Rupture Associated With May-Thurner Syndrome

Rhome L. Hughes, MD,* Kim A. Collins, MD,Þ and Karen E. Sullivan, MDÞ

Abstract: May-Thurner syndrome results from long-standing compression of the left common iliac vein (LCIV) and is characterized by the formation of intraluminal spurs leading to obstruction of blood flow and deep vein thrombosis (DVT). Increased intraluminal pressures may occur as a consequence of venous obstruction, which when coupled with other factors thought to further weaken venous wall integrity (ie, inflammation or hormonal imbalances) may produce spontaneous (nontraumatic) and potential lethal venous rupture.

We report a case of DVT in a woman with previously undiagnosed May-Thurner syndrome and heterozygosity for factor V Leiden mutation on exogenous hormone therapy, with subsequent spontaneous rupture of the LCIV leading to fatal hemoperitoneum. Autopsy revealed fibrous obliteration of the junction between the LCIV and inferior vena cava with associated DVT, transmural venous rupture, and thrombophlebitis.

Key Words: May-Thurner syndrome, spontaneous vein rupture, deep vein thrombosis

(Am J Forensic Med Pathol 2013;34: 222Y224)

Rupture of an iliac vein is an unusual event and most likely associated with traumatic or iatrogenic injury. Even more atypical is a spontaneous rupture of an iliac vein, as described in only a handful of previous reports and reviews.[1,2] Most such cases are middle-aged or elderly women, with the involved vein predominately left-sided.

May-Thurner syndrome is a rare condition in which thrombi form in the left iliac-femoral veins as a consequence of compression of the common iliac vein. May-Thurner syndrome has been previously attributed as a causative entity for spontaneous left common iliac vein (LCIV) rupture.[1] We present a case of fatal LCIV rupture associated with May-Thurner syndrome, complicated by heterozygosity for factor V Leiden mutation and exogenous estrogen use.

CASE REPORT

A 49-year-old physically active white woman on exogenous estrogens for perimenopausal symptoms complained of sudden-onset leg pain, swelling, and erythema. Upon presentation at a local hospital, she was diagnosed with extensive deep vein thrombosis (DVT) involving the external iliac, common femoral, superficial femoral, popliteal, peroneal, and gastrocnemius veins in the left lower extremity. Clinical workup further revealed she was heterozygous for a factor V Leiden mutation. She was admitted for thrombolysis and inferior vena cava (IVC) filter placement.

Following the procedure, the deceased experienced acute intra-abdominal hemorrhage and subsequent hypovolemic shock. A CT scan of the abdomen and pelvis revealed a hemoperitoneum with large hematoma in the left pelvic sidewall and acute thrombosis of the LCIV. She died before operative intervention, and an autopsy was performed to determine the cause of death.

At autopsy, internal examination showed a hemoperitoneum of approximately 1400 mL, with additional hemorrhage involving the mesentery of the distal colon, the soft tissue surrounding the bladder, the left perirenal adipose tissue, and the left adnexa with extension onto the diaphragmatic surface. In situ dissection of the inferior vena cave showed a proliferation of fibrous bands at the junction of the LCIV and the IVC, creating an intraluminal obstruction (Fig. 1). Within the LCIV distal (upstream) to the obstruction, a large thrombus was adherent to the venous wall (Fig. 2). In addition, approximately 5 cm distal (upstream) to the obstruction, a 0.5-cm transmural defect of the LCIV was identified (Figs. 1 and 3). The aforementioned thrombus overlaid this area of rupture. A metal intraluminal filter was recovered from the IVC, and dissection of the abdominal aorta and pelvic arteries did not disclose any evidence of laceration or mural dissection.

Histologic examination of LCIV thrombus confirmed adherence to the venous wall and formation of the lines of Zahn. Furthermore, the venous wall showed an acute neutrophilic infiltrate with focal fibrinoid necrosis of the intimal layer, findings consistent with thrombophlebitis (Fig. 4).

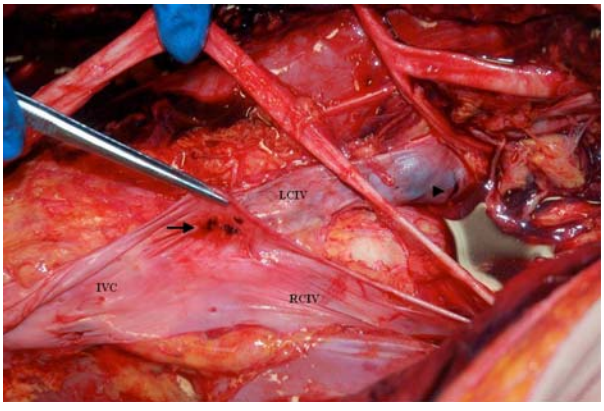

FIGURE 1. Dissection of the IVC reveals a patent opening into the right common iliac vein (RCIV) but fibrous obliteration (arrow) at the junction with LCIV. Also seen is the focus of LCIV rupture (arrowhead) underlying LCIV thrombosis. Figure 1 can be viewed online in color at www.amjforensicmedicine.com.

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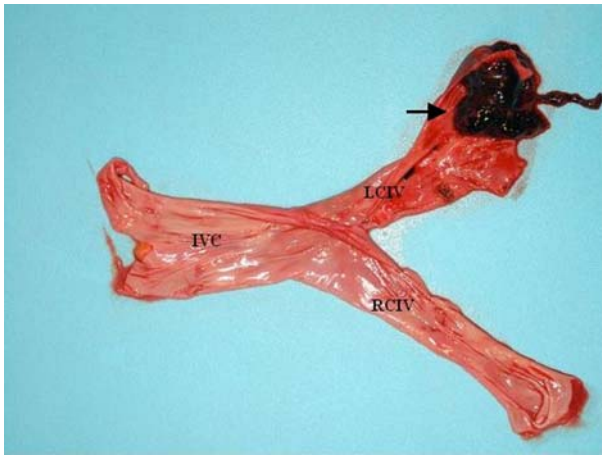

FIGURE 2. Dissected view of IVC with RCIV and intraluminal thrombus (arrow) involving the LCIV. Figure 2 can be viewed online in color at www.amjforensicmedicine.com.

DISCUSSION

In the majority of individuals with May-Thurner syndrome, it is believed that direct compression of the left iliac vein between the right iliac artery and fifth lumbar vertebrae predisposes to the formation of deep vein thrombi.[3] The syndrome is thought to progress through 3 stages: (1) asymptomatic compression of the vein, (2) the development of intraluminal spurs (fibrous bands) at the site of compression, and (3) development of deep vein thrombi.[4] Although the true prevalence of the condition is unknown, it may be detected in as high as 5% of patients undergoing evaluation for all lower-extremity venous disorders and in up to 37% of patients presenting with isolated left lower-extremity swelling.[3,4]

Spontaneous rupture of the LCIV is a rare occurrence. One comparative review of 32 reported cases indicated 85% of cases occurred in women (average age of 61 years), 94% of cases were left-sided, and 79% of cases had clinical or histologic evidence of DVT or thrombophlebitis, with a survival rate of 71%.[2] Proposed causative mechanisms for rupture include (1) mechanical factors deriving from obstruction, (2) inflammatory factors (ie, thrombophlebitis) leading to loss of vessel wall elasticity, or (3) hormonal factors relating to the loss of the protective effect of estrogen on vessels in the postmenopausal

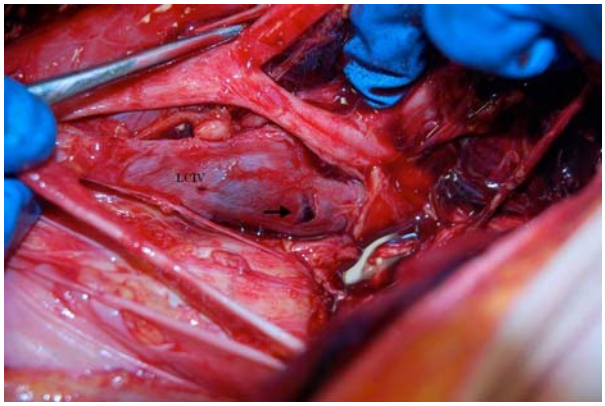

FIGURE 3. Close-up view of the LCIV and site of spontaneous rupture (arrow). Figure 3 can be viewed online in color at www.amjforensicmedicine.com.

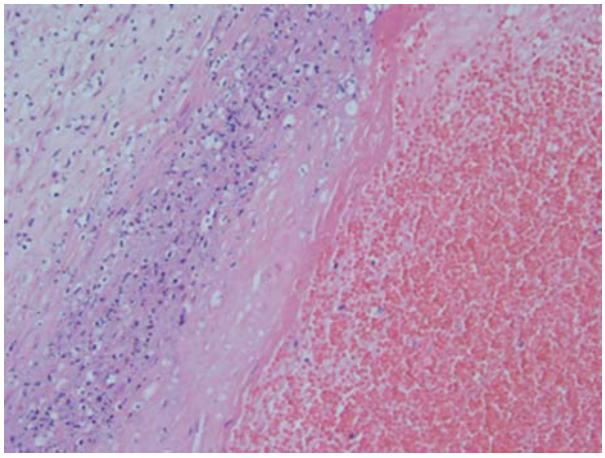

FIGURE 4. Left common iliac vein (left) and intraluminal thrombus (right). Note acute inflammatory infiltrate and intimal fibrinoid necrosis of the vein wall (acute thrombophlebitis; original magnification ▫ 200). Figure 4 can be viewed online in color at www.amjforensicmedicine.com.

period.[1,2] Presumably these factors work in concert, as no one theory alone is likely sufficient to produce venous wall rupture.

In our case, the combination of increased intraluminal pressure within the LCIV secondary to proximal obstruction from fibrous band formation, coupled with loss of vessel wall integrity as a result of thrombophlebitis, most probably accounts for the sudden rupture that produced a fatal hemorrhage. Given that the decedent was experiencing perimenopausal symptoms but was on exogenous estrogen therapy, the contribution of hormonal factors in this case is more difficult to define.

Of further interest, although May-Thurner syndrome is in and of itself sufficient to explain the development of a deep vein thrombus in this decedent, she also had several confounding factors relating to her coagulation status. She was found positive (heterozygous) for factor V Leiden mutation, the most common cause of inherited thrombophilia. Three percent to 8% of the white population is thought to be heterozygous for the mutation, carrying a 5- to 10-fold increased risk of thrombosis over the general population (homozygous mutations confer a 50- to 100-fold increased risk). However, women heterozygous for the factor V Leiden mutation who are also receiving exogenous estrogens may have up to a 30-fold increased risk of clot formation. Furthermore, it has been reported that in women with preexisting May-Thurner syndrome, the onset of exogenous estrogen therapy may precipitate the formation of symptomatic deep vein thrombi.[5]

In summary, in patients presenting with isolated left lower-extremity swelling or DVT, May-Thurner syndrome should be considered as a possible etiology. At autopsy, a simple dissection of the IVC and LCIV with discovery of intraluminal spurs may aid in confirming the diagnosis. Likewise, May-Thurner syndrome is a possible instigating factor in spontaneous (nontraumatic) rupture of an iliac vein. Vessel rupture is likely the culminating event produced by a combination of mechanical, inflammatory, and hormonal influences.

REFERENCES

1. Kim YH, Ko SM, Kim HT. Spontaneous rupture of the left common iliac vein associated with May-Thurner syndrome: successful management with surgery and placement of an endovascular stent. Br J Radiol. 2007;80:e176Ye179.

2. Tannous H, Nasrallah F, Marjani M. Spontaneous iliac vein rupture: case report and comprehensive review of the literature. Ann Vasc Surg. 2006;20:258Y262.
3. Billakanty S, Burket MW, Grubb BP. May-Thurner syndrome: a vascular abnormality encountered during electrophysiologic study. Pacing Clin Electrophysiol. 2006;29:1310Y1311.
4. Wolpert LM, Rahmani O, Stein B, et al. Magnetic resonance venography in the diagnosis and management of May-Thurner syndrome. Vasc Endovascular Surg. 2002;36:51Y57.
5. Murphy EH, Davis CM, Journeycake JM, et al. Symptomatic ileofemoral DVT after onset of oral contraceptive use in women with previously undiagnosed May-Thurner syndrome. J Vasc Surg. 2009;49:697Y703.

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Sudden Death and Isolated Right Ventricular Noncompaction Cardiomyopathy

Report of 2 Autopsied Adult Cases

Sadaf Ilyas, MD,* Charles Ganote, MD,* Dawn Lajoie, MD,Þ Julie Robertson, MD,þ and Karen Cline-Parhamovich, DOÞ

Abstract: A predominantly right ventricular variant of isolated noncompaction cardiomyopathy is a potentially lethal disease entity, which only recently has become recognized in the clinical and cardiac imaging literature. There are currently few established morphologic criteria for the diagnosis other than right ventricular dilation and presence of excessive regional trabeculation. To date, there have been no autopsy reports of cases following either clinical diagnosis or sudden death. We report 2 adult cases of sudden unexpected death in which unexplained right ventricular dilation and prominent apical hypertrabeculation were the principal findings. The gross and microscopic results suggest pathological similarities between, or coexistence of, right ventricular noncompaction and arrhythmogenic right ventricular cardiomyopathies.

Key Words: right ventricular noncompaction, cardiomyopathy, sudden death, forensic autopsy

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During the fifth to eighth week of fetal life, the intertrabecular spaces of the developing heart are obliterated, and the ventricular myocardium undergoes compaction from apex to base.[1] Isolated myocardial noncompaction cardiomyopathy (NCCM) is defined by arrest of the process of compaction of the spongiotic trabecular muscle layer with resulting hypertrabeculation and failure to obliterate intertrabecular recesses.[1] Although the left ventricle is the usual site of involvement, biventricular involvement is also common.[2Y6] In children, NCCM is the third most common cardiomyopathy after dilated and hypertrophic forms.[7] Left ventricular NCCM (LV-NCCM) has an incidence of between 0.01% and 0.25% in adults.[8] The clinical manifestations range from asymptomatic to progressive congestive heart failure, arrhythmias, thromboembolic events, and sudden cardiac death.[1,9,10] Although LV-NCCM is well known, there are relatively few clinical reports of isolated or predominant right ventricular noncompaction (RV-NCCM) and, to our knowledge, no autopsy reports following sudden unexpected death.

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MATERIALS AND METHODS

In each case, a complete autopsy was performed, including toxicological examination. The hearts were examined after en bloc fixation in formalin. If the coronary arteries were calcified, they were dissected and decalcified before sectioning.

CASE REPORTS

Case 1

A 46-year-old white woman was found unresponsive while incarcerated. Examination revealed absence of a pulse, and immediate resuscitation was begun. Emergency medical service arrived 15 minutes later and transported the patient to the nearest hospital, where she was pronounced dead upon arrival. Two days prior, multiple bruises were noticed on her right deltoid area that she attributed to a fall secondary to being on crutches following a tibial fracture a month ago. The events that led to her unconsciousness were unwitnessed. The case was reported to the county medical examiner, who ordered an autopsy. Medical history included tobacco use, chronic obstructive pulmonary disease, pulmonary hypertension, nonspecific elevations of troponin, anemia, pneumonia, tachycardia, and remote resection of an esophageal adenocarcinoma. An echocardiography study performed 2 months before death reported a dilated, hypokinetic right ventricle with normally contracting apex and a normal-size but D-shaped left ventricle. Toxicological analysis performed on postmortem femoral blood, urine, and gastric contents was negative for alcohol and drugs. Autopsy examination revealed mild chronic respiratory bronchiolitis, normal coronary arteries, and unremarkable brain examination. The heart weighed 280 g. The 10-mm-thick left ventricle, left atrium, and mitral valve were all normal (Fig. 1A). The right atrium was dilated with mildly hypertrophic pectinate muscles. The tricuspid valve was normal, but the right ventricle anterior papillary muscle and an enlarged posterior papillary muscle were attached to a mass of trabecular muscle that filled the apex (Fig. 1B). The proximal right ventricular cavity and the infundibulum were dilated and externally demarcated from the apical region by a narrow band-like indentation running diagonally across the anterior wall. The 3- to 4-mm-thick anterior and posterior walls abruptly thinned at the apex and were focally inverted at the attachments to trabeculi, allowing cavitary protrusions between the trabecular attachment sites (Fig. 1C). The infundibulum had prominent trabecular musculature. Microscopic sections from the left ventricular apex also contained deep intertrabecular recesses. Sections of the right ventricle had extensive subendocardial hyperacute contraction band necrosis. Several trabecular muscles had centrally located microfoci of healing necrosis. The apical compact muscle wall was thin and largely replaced by fat, a histology closely resembling that of the fatty infiltrative form of arrhythmogenic right ventricular cardiomyopathy (ARVC). The presence of deep intertrabecular recesses at the left ventricle apex

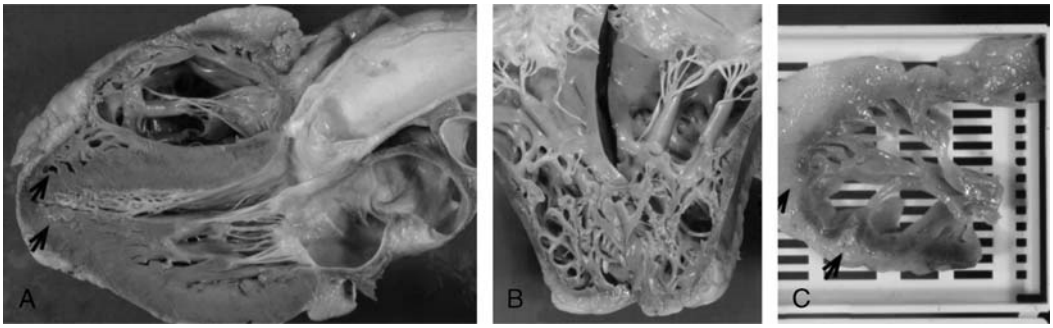

FIGURE 1. A, Long-axis section: there is an indentation of the anterior right ventricle wall at the moderator band and prominent hypertrabeculation of the right ventricle apex (upper arrow). The base of the posterior papillary muscle of the left ventricle extends to the left ventricle apex (lower arrow). B, The right ventricle posterior wall is opened to expose the tricuspid valve and the highly trabeculated apical segment. C, A long-axis section of the right ventricle apex has attenuation of the compact wall and in-foldings of the trabecular muscle layer (arrows).

implied a minor degree of biventricular involvement. Although in the present case pulmonary hypertension could not be excluded, the major cardiac pathology was predominant RV-NCCM with apical compact wall thinning and replacement by fat. The latter histology overlaps that of or is similar to ARVC. The cause of death was ventricular noncompaction of the heart.

Case 2

A 52-year-old white woman with medical history of hypertension and cerebrovascular disease was discovered lying unresponsive at home. Resuscitation efforts were unsuccessful. Postmortem toxicological examination of blood did not detect ethanol or drugs. The relevant autopsy findings were limited to the heart. The heart weighed 410 g. The epicardium had fat covering the entire right ventricular anterior surface but little of posterior surface. The right atrium and right ventricle were enlarged (Fig. 2A). The coronary artery distribution was weakly right dominant, and there was minimal atherosclerotic stenosis. The right atrium was enlarged by pectinate muscle hypertrophy. There was a shallow, leftward-bulging, 20-mm-diameter aneurysm of the fossa ovalis, without endocardial thrombosis. The tricuspid valve was diffusely opaque and mildly thickened and had minimally hooded leaflets. The nondilated left atrium measured 4.0 ▫ 4.5 cm. The mitral valve posterior leaflet measured a normal 10 mm in breadth, but had mild hooding. The left ventricle midcavity diameter was 35 mm with a circumferential wall thicknesses of 12 to 13 mm. Short-axis sections of the right ventricle contained dense, spongy, lattice-like trabecular muscle filling the lower middle and apical segments (Fig. 2B). The right ventricular wall thickness averaged 2 mm, but the myocardium was obscured by fatty infiltration in regions of the posterior and anterior walls. Microscopic sections of the left ventricle had only a single small focus of remote scarring near the posterior left ventricle papillary muscle base. The right ventricle sections had diffusely distributed patchy, fatty infiltration with sparing of the trabecular muscles. The lateral wall of the right ventricle had near total replacement of compact myocardium by adipose tissue. The histology was consistent with fatty infiltrative ARVC (Fig. 2C). The prominent right ventricular hypertrabeculation/noncompaction associated with extensive fatty infiltrative replacement of the attenuated compact myocardium was diagnosed as isolated right ventricular cardiomyopathy with features of arrhythmogenic and noncompaction cardiomyopathies.

DISCUSSION

It is difficult to attribute sudden unexpected cardiac death to a genetic cardiomyopathy when the genotypic and phenotypic variations of the cardiomyopathy are poorly defined. Right ventricular involvement commonly occurs in cases of LV-NCCM, but the initial diagnosis is made using criteria developed on the basis of left ventricular involvement.[11] Isolated

FIGURE 2. A, Posterior view of the heart: the right atrium and ventricle are enlarged. B, A short-axis section taken apical to the papillary muscle bases has a complex spongy meshwork of trabeculi filling the dilated right ventricle cavity. There is extensive focally severe fatty infiltration with replacement of the attenuated compact wall. C, Hematoxylin-eosinŸstained section of the right ventricle apex: a thick fat pad overlies the extensive fatty replacement of the compact wall, but the trabecular muscle layer is preserved.

NCCM primarily involving the right ventricle is rarely reported, but this may be due to the normal variable trabeculation of the right ventricle, which has precluded the establishment of anatomic criteria for diagnosis. Despite the absence of well-defined anatomic criteria, right ventricular hypertrabeculation cardiomyopathy has become recognized as a distinct entity on the basis of clinical imaging studies. In 2008, Song[10] published the first clinical case report using echocardiography and magnetic resonance imaging to describe a syndrome of combined right ventricular hypertrabeculation/noncompaction associated with arrhythmogenic ventricular cardiomyopathy. The description was of a 2-layered myocardium with prominent apical trabeculations and deep intertrabecular recesses. In 2009, Zhang et al[9] reviewed the literature and submitted an additional case of isolated RV-NCCM in a 23-year-old woman diagnosed by cardiac magnetic resonance imaging and angiograms on the basis of a ratio of trabecular to compact myocardium of more than 3. Fazio et al[12] in 2010 reported magnetic resonance results of 2 additional cases, one of which died suddenly, and suggested that a diagnosis can be made only when the spongy-to-compact myocardial ratio is greater than 2 in association with dilatation of the right ventricle. Song[13] in 2011 reported a 69-year-old man with right ventricular dyskinesia and diagnosed the case by 3-dimensional echocardiography on the basis of right ventricle wall thickness and deep intertrabecular recesses as isolated right ventricular noncompaction. Song discussed the lack of established imaging criteria for diagnosis of right ventricular noncompaction and suggested that the identification of true trabeculi, deep intertrabecular recesses, and a thin compact layer are necessary to confirm the diagnosis. In the present report, the cardiac abnormalities encountered at autopsy closely mirror those described in these clinical reports.

Predominant right ventricular noncompaction was present in the 2 cases comprising this report, but neither can be viewed as truly "isolated" examples of RV-NCCM. The coexistence of biventricular involvement, right ventricle fatty infiltration, and attenuation of the compact wall in areas of noncompaction is a combination of anatomic features consistent with clinical reports pointing out similar features of noncompaction and arrhythmogenic cardiomyopathies. We are aware of only 1 previous report of a patient diagnosed with ARVC whose heart had a prominent constriction crossing the right ventricle anterior wall at the level of the moderator band.[14] Arrhythmogenic right ventricular cardiomyopathy has been described as 2 subtypes: the infiltrative type, seen as a lattice-like fatty infiltration with intervening normal residual cardiomyocytes, findings that were noticed in both the hearts; the other subtype is the cardiomyopathic ARVC, with massive fatty replacement of the myocardium with associated myocyte hypertrophy and myofibril loss.[15] Some clinical reports have proposed that NCCM and ARVC may coexist as a distinct clinical syndrome.[10,16,17] Although noncompaction during fetal development implies underdevelopment of the compact muscle layer of the ventricular wall, the pathophysiologic effects of hypertrabeculation on ventricular wall morphogenesis in later life are unknown. Although the genetic and pathogenetic mechanisms may differ, the common anatomic features of right ventricular dilation in the adult, attenuation of the compact myocardial wall, and the imposition of fat may preclude unequivocal distinction of noncompaction and arrhythmogenic cardiomyopathies at autopsy. Also, the presence of microinfarcts within the trabeculi, as seen in the first case, suggests impaired trabecular blood flow and ischemia, a possible mechanism of arrhythmia.

In conclusion, it is yet to be resolved as to whether isolated RV-NCCM occurs as a distinctive pathological diagnosis or only in association with ARVC or with obligatory biventricular involvement.[8] In any case, the literature suggests an association of RV-NCCM with cardiac arrhythmias and sudden death. Cases of sudden cardiac death that at autopsy have insignificant coronary disease and unexplained right ventricular dilation warrant suspicion of a cardiomyopathy. If right apical hypertrabeculation, compact wall attenuation, and/or deep intertrabecular recesses into the right side of the interventricular septum are present, the differential diagnosis would include isolated RV-NCCM, regardless of whether there are additional features of ARVC. Further investigations will be necessary to establish diagnostic criteria and determine whether isolated right ventricle hypertrabeculation per se exists as a cause of sudden unexpected death, independent of ARVC or LV-NCCM.

REFERENCES

1. Gomathi SB, Makadia N, Ajit SM. An unusual case of isolated non-compacted right ventricular myocardium. Eur J Echocardiogr. 2008;9:424Y425.
2. Li L, Burke A, Zhang X, et al. Sudden unexpected death due to left ventricular noncompaction of myocardium: case report and review of the literature. Am J Forensic Med Pathol. 2010;31:122Y124.
3. Ichida F. Left ventricular noncompaction review. Circ J. 2009;73:19Y26.
4. Burke A, Mont E, Kutys R, et al. Left ventricular noncompaction: a pathological study of 14 cases. Hum Pathol. 2005;36:403Y411.
5. Minardi G, Manzara C, Pulignano G, et al. Adult bi-ventricular noncompaction cardiomyopathy. Anadolu Kardiyol Derg. 2010; 10:187Y188.
6. Ulosoy RE, Kucukarslan N, Demiralp E, et al. Noncompaction of ventricular myocardium involving both ventricles. Eur J Echocardiogr. 2006;7(6):457Y460.
7. Engberding R, Stöllberger C, Ong P, et al. Isolated non-compaction cardiomyopathy. Dtsch Arztebl Int. 2010;107:206Y213.
8. Sarma RJ, Chana A, Elkayam U. Left ventricular noncompaction. Prog Cardiovasc Dis. 2010;52:264Y273.
9. Zhang XJ, Zhi G, Hou HJ, et al. A rare case of isolated non-compaction right ventricular myocardium. China Med J. 2009;122:1718Y1720.
10. Song ZZ. A combination of right ventricular hypertrabeculation/ noncompaction and arrhythmogenic right ventricular cardiomyopathy: a syndrome? Cardiovasc Ultrasound. 2008;6:63.
11. Espinola-Zavelta N, Soto ME, Castellanos LM, et al. Non-compacted cardiomyopathy: clinical-echocardiographic study. Cardiovasc Ultrasound. 2006;4:35.
12. Fazio G, Lunetta M, Grassedonio E, et al. Noncompaction of the right ventricle. Pediatr Cardiol. 2010;31:576Y578.
13. Song ZZ. An isolated right ventricular hypertrabeculation and dyskinesia in an elderly man: a possible diagnosis of isolated right ventricular noncompaction? Int J Cardiol. 2011;148:e3Ye6.
14. Roberts WC, KO JM, Kuiper JJ, et al. Some previously neglected examples of arrhythmogenic right ventricular dysplasia/cardiomyopathy and frequency of it's various reported manifestations. Am J Cardiol. 2010;106:268Y274.
15. D'Amati G, Leone O, Gallo P, et al. Arrhythmogenic right ventricular cardiomyopathy: clinicopathologic correlation based on a revised definition of pathologic patterns. Hum Pathol. 2001;32(10):1078Y1086.
16. Wozniak O, Konka M, Wlodarska EK. Isolated ventricular non-compaction in a patient initially diagnosed with arrhythmogenic right ventricular cardiomyopathy. Heart. 2008;94:289.
17. Matsukuma S, Eishi K, Hashizume K, et al. Arrhythmogenic left ventricular cardiomyopathy associated with noncompaction. Ann Thorac Surg. 2010;90:2044Y2046.

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Cardiac Aneurysm

A Nature's Way of Correction

Pradeep Kumar Goud, MD, DCri Law,* Shankar M. Bakkannavar, MD, DCL,*
and Potti Chinmayee, MBBS†

Abstract: Cardiac aneurysm occurring in ventricles is usually a complication of acute transmural myocardial infarction. The development of cardiac aneurysm represents a process of continued thinning and fibrosis of the necrotic tissue of the ventricular wall. Survival of the person without any complication depends on the development of the solid fibrous scar, which seals the aneurysmal cavity.

We present an incidental case wherein a person survived with a ventricular aneurysm that sealed itself by natural means due to the development of a thrombus and fibrous tissue offering a natural protection. The person died because of head injury in a road traffic accident in this particular case.

Key Words: cardiac aneurysm, fibrous scar, transmural myocardial infarction, thrombus

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Aneurysm is a localized abnormal dilatation of any blood vessel due to weakness in the wall of that vessel. It can occur in any artery or vein in the body but commonly occurs in the aorta, the largest artery in the body, leading to serious clinical disease and often causing death by rupture.[1] Aneurysms can develop slowly over many years. Sometimes an outpouching of an abnormally thin portion of the heart wall may give rise to aneurysm called cardiac aneurysm. Cardiac aneurysm occurring in ventricles is usually a complication of acute transmural myocardial infarction.[2] These cardiac aneurysms tend to involve the left ventricle because the blood there is under greatest pressure.[3] Many people with aneurysms may be asymptomatic, whereas others may experience a number of symptoms that vary in intensity depending on the location, rate of growth, and size of the aneurysm. Many a time these aneurysms do not affect the global ventricular function until up to 18 years without production of serious symptoms.[4] Surgical intervention in the form of ventricular aneurysmectomy, the linear or circular repair of the aneurysm,[5,6] and patch endoaneurysmorrhaphy[7] is essential once the aneurysm is diagnosed. But rarely these aneurysms may be filled by the clot, which may get calcified and seals the aneurysmal cavity, thereby shunning it to get ruptured and avoiding life-threatening complications, thus offering a natural protection.

CASE REPORT

A 56-year-old man who died in a road traffic accident was brought to the mortuary of the Department of Forensic Medicine, Kasturba Medical College, Manipal, India, to complete the legal formalities of an autopsy. The cause of death was ascertained to be due to craniocerebral injuries secondary to blunt force impact to the head. At autopsy, an incidental finding was noticed in the heart. It showed a bilobed saccular projection out-pouching from the apex of the left ventricle separated by septa over an area of 9 ▫ 8 cm (Fig. 1). One lobe was measuring 5 ▫ 5 cm, and the other lobe 4 ▫ 3 cm. The bilobed saccular projection contained 2 different masses one over the other. A lower irregularly shaped, grayish brown mass was measuring 6 ▫ 4 cm in its greatest dimension. This mass was covered by an upper reddish mass measuring 6 ▫ 4 cm separating the lower mass from the left ventricular cavity (Fig. 2). Evacuation of these lesions revealed a bilobed saccular cavity in the left ventricle suggestive of an aneurysm. The thickness of the wall of the aneurysmal cavity was 2 mm against the thickness of the ventricular wall 1.5 cm. Left anterior descending coronary artery showed near-total occlusion.

Histopathologic examination of the left ventricle from the area of aneurysm showed thinned-out wall with myocardial scar formation suggestive of old myocardial infarction.

DISCUSSION

Aneurysms of the left ventricle frequently occur as a consequence of extensive myocardial infarction in 4% to 20% of

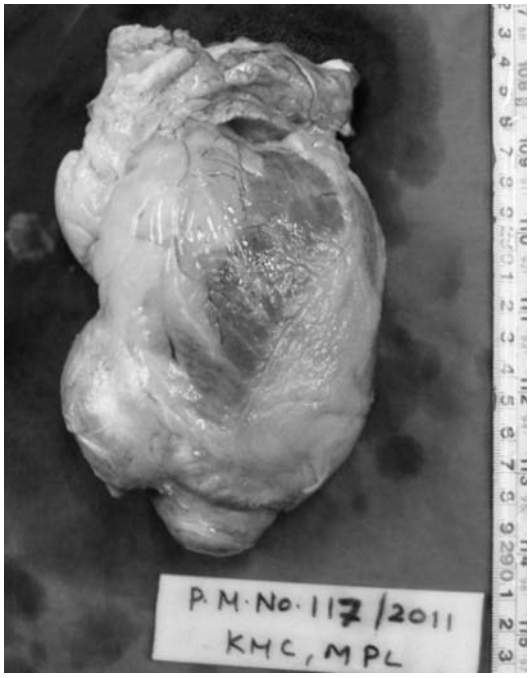

FIGURE 1. Heart showing bilobed saccular projection V ventricular aneurysm.

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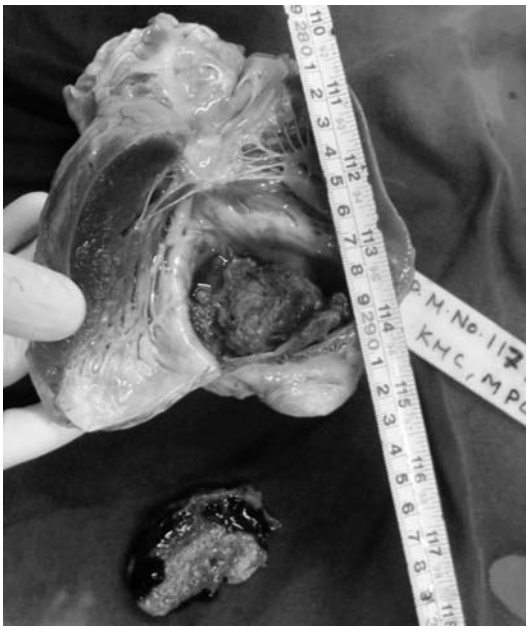

FIGURE 2. Cut section of the heart showing the saccular projection containing irregular masses (brownish mass in situ and reddish mass removed from the site).

patients.[8] An incidence varying from 3.5% to 5% has been reported in autopsy studies.[9,10] Left ventricular aneurysm (LVA) formation results from an expansion of an infarcted tissue within the first 2 to 14 days of myocardial infarction.[11Y14] Other causes of LVA include Chagas disease,[13] cardiac sarcoidosis, and presence of Lewitic gumma in the myocardium. Mid-ventricular hypertrophy and obstruction have been associated with apical infarction and LVA.[14] Greater than 80% of LVAs involve the anterior wall and/or apex and are associated with high-grade stenosis or complete occlusion of the proximal or mid-left anterior descending coronary artery.[12,15,16] The presence of only 3 muscle layers at the apex (compared with 4 layers at the base) explains the predilection of the apex to LVA formation.[17] In pathological terms, a typical ventricular aneurysm can be regarded as a "true" aneurysm in the sense that the sac contains the 3 layers of the vessel wall, the endocardium and epicardium sandwiching a layer of thinned fibrous tissue that is the remnant of the left ventricular muscle. The wall of a false aneurysm consists of adherent pericardium and associated postinflammatory scar tissue, with some remnants of the epicardium.[18] Once formed, LVA rarely resolves. Usually, these grow at a very slow pace, but can still pose problems. "False aneurysm" may burst, sometimes resulting in death of the patient. Also, blood clots may form on the inner side of a ventricular aneurysm and emanate as emboli.[17] The thrombus can form early because of altered myocardial wall motion. But the calcifications are rarely found, because they take many years to develop. Although the presence of extensive calcifications of thrombus within the aneurysms is particularly unusual,[3,4] the calcifications of smaller size are more common.[19] Many of the patients with anterior wall aneurysms may have fibrosis extending into the anterior portion of the interventricular septum.[20] The mortality rate in patients with coronary artery disease is significantly increased in the presence of ventricular aneurysm. Initially, it may be relatively well tolerated, but the long-term prognosis is poor. Five-year survival rates of between 12% and 27% have been reported,[21,22] and the average time from infarction to death has been quoted at 4.8 years.[23] Most of these are data obtained before the surgical era. Improved diagnostic techniques and therapeutic procedures have increased the survival period tremendously in patients with LVA.

Once diagnosed, the surgical intervention is essential in case of ventricular aneurysm to maintain the near-normal functioning of a heart. Various treatment modalities including ventricular aneurysmectomy, the linear or circular repair of the aneurysm,[5,6] and patch endoaneurysmorrhaphy[7] help to improve the survival rate by maintaining the normal cardiac activity.

Left ventricular aneurysms are believed not to rupture unless new infarction has occurred at the transition zone from infarction to healthy myocardium.[24] In the present case where there is no evidence of fresh myocardial infarction, undoubtedly the progressive deposit of fibrous tissue of the thinned-out ventricular wall and thrombus formation have favored the natural sealing of the aneurysmal cavity. Probably, the extended interval between the occurrence of an apparently undiagnosed myocardial infarction and the symptomless period followed by natural sealing of the aneurysmal sac by a thrombus led to the nondiagnosis of the cardiac aneurysm in this particular case.

CONCLUSIONS

The prognosis for asymptomatic LVA is relatively good.[25] Thus, no indications are established for repairing chronic, asymptomatic aneurysms. But still few investigators report repairing large, minimally symptomatic aneurysms in low-risk patients during operation for associated coronary disease.[26,27] In our case, the patient was asymptomatic, and probably he could have survived many more years if he had not met with a road traffic accident.

REFERENCES

1. Nakajima O, Sano I, Akioka H. Images in cardiovascular medicine. Marked calcified left ventricular aneurysm. Circulation. 1997; 95(7):1974.
2. Swan HJC, Magnusson PT, Buchbinder NA, et al. Aneurysm of the cardiac ventricle: its management by medical and surgical intervention. West J Med. 1978;129(1):26Y40.
3. Lee BK, Atwood JE. Images in clinical medicine. Calcified left ventricular aneurysm. N Engl J Med. 2003;348(10):918.
4. Harrison-Gomez C, Harrison-Ragle A, Arceo-Navarro A. Images in cardiovascular medicine. A ring in the heart: calcified left ventricular aneurysm. Circulation. 2007;115(13):e376Ye377.
5. Graber JD, Oakley CM, Pickering BN, et al. Ventricular aneurysm: an appraisal of diagnosis and surgical treatment. Br Heart J. 1972;34: 830Y838.
6. False aneurysm of the left ventricle [editorial]. Heart. 1998;80:7Y8.
7. Barratt-Boyes BG, White MB, Agnew TM, et al. The results of surgical treatment of left ventricular aneurysms V an assessment of the risk factors affecting early and late mortality. J Thorac Cardiovasc Surg. 1984;87:87Y98.
8. Schlichter J, Hellerstein HK, Katz LM. Aneurysm of the heart: a correlative study of one hundred and two proved cases. Medicine (Baltimore). 1954;33:43Y86.
9. Dubnow MH, Burchell HB, Titus JL. Postinfarction ventricular aneurysm: a clinicomorphologic and electrocardiographic study of 80 cases. Am Heart J. 1965;70:753Y760.
10. Davis RW, Ebert PA. Ventricular aneurysm: a clinical-pathologic correlation. Am J Cardiol. 1972;29:1Y6.

11. Eagle AE, DeSanctis RW. Diseases of the aorta. In: Braunwald E, ed. Heart Disease. A Textbook of Cardiovascular Medicine. Philadelphia, PA: WB Saunders Co: 1988;1546.
12. Kesler KA, Fiore AC, Naunheim KS, et al. Anterior wall left ventricular aneurysm repair V a comparison of linear vs. circular closure. J Thorac Cardiovasc Surg. 1992;103:841Y848.
13. Komeda M, David TE, Malik A, et al. Operative risks and long-term results of operation for left ventricular aneurysm. Ann Thorac Surg. 1992;53:22Y29.
14. Vural KM, Sener E, Ozatik MA, et al. Left ventricular aneurysm repair: an assessment of surgical treatment modalities. Eur J Cardiothorac Surg. 1998;13:49Y56.
15. Schlichter I, Hellerstein HK, Katz LM. Aneurysm of the heart: a correlative study of 102 proved cases. Medicine. 1954;33:43.
16. Dubnow MH, Burchell HB, Titus JL. Post-infarction ventricular aneurysm: clinicopathologic and electrocardiographic study of 80 cases. Am Heart J. 1965;70:753.
17. Anselmi A, Moliero F, Suarez R, et al. Ventricular aneurysm in acute experimental Chagas myocardiopathy. Chest. 1971;59:654.
18. Faxon DP, Ryan TI, Davis KB, et al. Prognostic significance of angiographically documented left ventricular aneurysm from the Coronary Artery Surgery Study (CASS). Am J Cardiol. 1982;50:157.
19. Meizlish JL, Berger MJ, Plaukey M, et al. Functional left ventricular aneurysm formation after acute anterior transmural myocardial infarction. Incidence, natural history, and prognostic implications. N Engl J Med. 1984;311:1001.
20. Berkoff HA, Rowe GG, Crummy AB, et al. Asymptomatic left ventricular aneurysm. A sequel of blunt chest trauma. Circulation. 1977;55:545.
21. Eaton LW, Weiss JL, Bulkley BH, et al. Regional cardiac dilatation after acute myocardial infarction. Recognition by two-dimensional echocardiography. N Engl J Med. 1979;300:57.
22. Kass DA, Maughn WL, Ciuffo A, et al. Disproportionate epicardial dilation after transmural infarction of the canine left ventricle: acute and chronic differences. J Am Coil Curdiol. 1988;11:177.
23. Ba'Albaki HA, Clements SD. Left ventricular aneurysm: a review. Clin Cardiol. 1989;12:5Y13.
24. Logue RB, Hurst JW, eds. Clinical Recognition of Coronary Atherosclerotic Heart Disease and Its Complications, The Heart. 2nd ed. New York: McGraw-Hill; 1970:975.
25. Grondin P, Kretz JG, Bical O, et al. Natural history of saccular aneurysm of the left ventricle. J Thorac Cardiovasc Surg. 1979;77:57.
26. Mills NL, Everson CT, Hockmuth DR. Technical advances in the treatment of left ventricular aneurysm. Ann Thorac Surg. 1993; 55:792.
27. Baciewicz PA, Weintraub WS, Jones EL, et al. Late follow-up after repair of left ventricular aneurysm and (usually) associated coronary bypass grafting. Am J Cardiol. 1991;68:193.

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Sudden Death Due to Eagle Syndrome

A Case Report

Pradeep Kumar, MV, MBBS, MD,* Anand P. Rayamane, MBBS, MD,† and Mouna Subbaramaiah, MBBS, MS(Anatomy)‡

Abstract: Eagle syndrome represents symptoms manifested by compression of regional structures by elongation of the styloid process or ossification of the stylohyoid membrane. Various theories have been put forward toward the development of Eagle syndrome. Depending on the underlying pathogenetic mechanism and the anatomical structures compressed or irritated by the elongated styloid process, symptoms vary greatly, ranging from cervicofacial pain to cerebral ischemia. Because the symptoms are variable and nonspecific, patients land up in different clinics for treatment. In the present case, the victim had previous episode of unconsciousness along with frequent headache for which she visited various clinics on numerous occasions. The elongated styloid process was appreciated during the postmortem examination, and the diagnosis of sudden death due to mechanical irritation of the carotid sinus by elongated styloid process was made as the sign of acute cardiovascular failure was present and upon exclusion of other causes of death.

Key Words: carotid sinus reflex, carotid sinus hypersensitivity, carotid sinus syndrome, Eagle syndrome

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An abnormally long styloid process or stylohyoid chain ossification producing cluster of symptoms gives rise to Eagle syndrome or stylohyoid syndrome.[1] Eagle syndrome is a rare entity that is not commonly suspected in clinical practice.[2] The elongated styloid process and a calcified stylohyoid ligament manifesting its effect are seen in only 4% of the population.[3] Eagle syndrome was first documented by Wart W. Eagle, an otorhinolaryngologist in the year 1937.[4]

The styloid process and the stylohyoid ligament are derived from the second bronchial arch. These structures are first formed in cartilage. The cartilage of this styloid process ossifies while the epihyal cartilage, which connects the styloid process and the hyoid bone, is usually reabsorbed. The stylohyoid ligament is formed from the remnants of the epihyal cartilage.[5] In some individuals, a separate epihyal bone forms when the epihyal cartilage ossifies rather than reabsorbs. It has been found that an ossified stylohyoid ligament occurs as a result of true ossification, rather than ossification due to stress or degeneration, as there is radiographic evidence of ossified stylohyoid ligaments in children.[6] The styloid process may vary from 5 to 50 mm in length (Fig. 1) and the stylohyoid ligament may ossify from its origin at the styloid process until its attachment with the hyoid bone.[7] The length of the normal styloid process is 2.5 to 3 cm. The topic of Eagle syndrome is still debatable with varied theories, which have been formulated for the development of ossified stylohyoid ligament. In the early years of its detection, it was considered to be due to surgical trauma (tonsillectomy) or local chronic irritation causing osteitis, periostitis, or tendonitis of the stylohyoid complex with consequent reactive, ossifying hyperplasia.[8] In the later years, it was argued that ossification of the styloid process is related to the endocrine disorders in women at menopause, persistence of the mesenchymal elements (Reichert cartilage residues) that undergo osseous metaplasia as a consequence of trauma, or mechanical stress during the development of the styloid process.[9] However, Eagle syndrome has been noted in children and also in individuals who have not been subjected for tonsillectomy. As per the theories of various persons, the following factors may be considered:

- the ossification of the stylohyoid ligament complex, causing contraction of the stylopharyngeal muscle and stretching of the XII cranial nerve[10]
- the fracture and medialization of the ossified stylohyoid ligament, with incomplete repair due to continuous hyoid bone movements and formation of excessive granulation tissue[11]
- the ossification of muscular tendons leading to irritation of the structures nearby[12]
- the abnormal length associated with abnormal angulation of the styloid process[13]

An individual with Eagle syndrome presents with 2 types of clinical expression. They are the classic Eagle syndrome and stylocarotid Eagle syndrome. The classic Eagle syndrome is

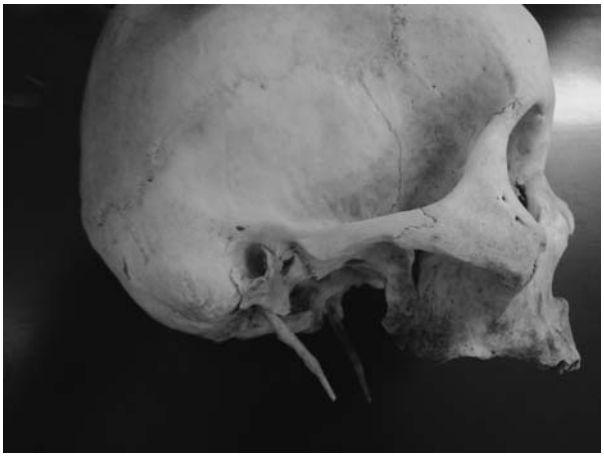

FIGURE 1. Elongated styloid process.

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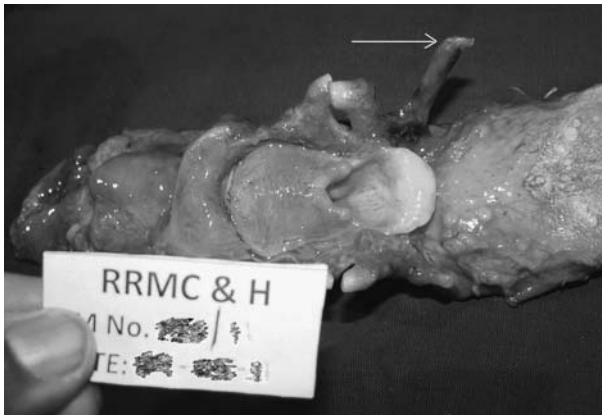

FIGURE 2. Elongated styloid process (transected during autopsy).

characterized by ipsilateral dull, persistent pharyngeal pain, centered in the ipsilateral tonsillar fossa, which can be referred to the ear and exacerbated by rotation of the head. In stylocarotid Eagle syndrome, the compression of the internal or external carotid artery is by a laterally or medially deviated styloid process causing pain along the distribution of the artery, which intensifies on rotation and compression of the neck. Depending on the underlying pathogenetic mechanism and the anatomical structures compressed or irritated by the elongated styloid process, symptoms vary greatly, ranging from cervicofacial pain to cerebral ischemia. Because the symptoms are variable and nonspecific, patients land up in different clinics for treatment.[3]

CASE REPORT

A 55-year-old female dead body was brought for postmortem examination. The investigative authority came out with the information that the deceased collapsed while sliding down from a height of 6 ft into a water body. Upon interrogation with the next of kin, it was found that the deceased has collapsed 2 times few years back before this fatal incident and also revealed that the deceased had frequent episodes of headache for which she was evaluated with both neurophysician and ophthalmologist. After those incidents, she was investigated for medical ailment. The doctors who examined her on both occasions failed to rule out any cause, and she was certified fit. During postmortem examination, no remarkable external appearance was noted. Her internal findings were also unremarkable except for the unusual length of the styloid process (Fig. 2). Retrieving the organs en mass during dissection was difficult because of the unusual length of the styloid process calcified with stylohyoid ligament. The styloid process was sawed off (Fig. 2) to retrieve the organs. The whole length of the styloid process was ossified until its attachment at the hyoid bone. The length of the styloid process in the present case was 4.75 cm in length. The tip of the styloid process had not penetrated any tissues. Histopathology opinion was sought regarding the heart pathology. Toxicological analysis was unremarkable.

DISCUSSION

An abnormally long styloid process producing autonomic effects gives rise to Eagle syndrome. On literature search through the Internet, we came across a case of sudden death due to Eagle syndrome.[14] In this particular case, the diagnosis was detected only during the postmortem examination. The magnetic resonance imaging scan done during the nonfatal episodes of syncope failed to detect the syndrome, probably because of the nonclassic features shown by the deceased. The mere presence of an elongated styloid process or mineralization of the stylohyoid complex radiographically in the presence of cervicopharyngeal pain does not automatically confirm a diagnosis of Eagle syndrome. In a study of radiographic films, the incidence of elongated styloid process was seen in 3.3% with a male-to-female ratio of 1:9. Average age was 43.35 T 14.88 years.[15] An enlarged styloid process may also compress upon the internal carotid artery, leading to transient ischemic attack, and may pose a threat. In the present case, the sudden death is probably due to vagus-mediated cardiac inhibition as a result of Eagle syndrome. This is due to the fact that elongated styloid process was found compressing the carotid artery. The compression of the carotid artery by the deviated and calcified styloid process may be the reason for the supraorbital or parietal region pain. This explains the frequent headaches she used to encounter. Because of the compression, there will be dilatation and widening of the internal carotid artery resulting in carotid sinus syndrome. Carotid sinus syndrome is more prevalent in the elderly generation and predominantly affects those older than 50 years. The chances of developing the carotid sinus syndrome increase with age. During this syndrome, the carotid sinus artery may become very sensitive to any form of stimulation and as a result can affect heart rate, amount of blood reaching the brain, and blood pressure. This is known as carotid sinus hypersensitivity. In severe cases, a loss of consciousness or convulsions and seizures may occur when a buildup of pressure occurs in these arteries due to manual stimulation. In this case, the deceased's kin said that she had 1 episode of unconsciousness when she was boarding a crowded train.

Changes in stretch and transmural pressure are detected by baroreceptors in the heart, carotid sinus, aortic arch, and other large vessels. Afferent impulses are transmitted by the carotid sinus and glossopharyngeal and vagus nerves to the nuclei tractus solitaries and the paramedian nucleus in the brain stem. Efferent limbs are carried through sympathetic and vagus nerves to the heart and blood vessels, controlling heart rate and vasomotor tone. In carotid sinus hypersensitivity, mechanical deformation of the carotid sinus leads to an exaggerated response with bradycardia or vasodilatation, resulting in hypotension, presyncope, and syncope.[16] Carotid sinus hypersensitivity, orthostatic hypotension, and vasovagal syncope are common conditions that are likely to coexist in patients with syncope and falls. Carotid sinus reflex death is due to vagus nerve impulses, which may cause the heart to stop beating, resulting in cardiac arrest. This explains the death in the present case. The diagnosis of sudden death due to mechanical irritation of the carotid sinus is possible, when there are signs of acute cardiovascular failure, and other causes of death are out of the question, along with ascertainments at the scene as well as observations by witnesses of the death process. It is also clear that a person may be completely symptom-free or asymptomatic and still have carotid sinus hypersensitivity.[17]

CONCLUSIONS

The mere presence of an elongated styloid process does not automatically confirm a case of Eagle syndrome. Depending on the underlying pathogenetic mechanism and the anatomical structures compressed or irritated by the elongated styloid process, the patient experiences a variety of symptoms, ranging from cervicofacial pain to cerebral ischemia. The diagnosis of sudden death due to mechanical irritation of the carotid sinus by elongated styloid process is possible, when there are signs of acute cardiovascular failure and upon exclusion of other causes of

death, along with ascertainments at the scene as well as observations by witnesses of the death process.

REFERENCES

1. Winker S, Sammartino FJ Sr, Sammartino FJ Jr, et al. Stylohyoid syndrome V report of a case. Oral Surg Oral Med Oral Pathol. 1981; 51:215Y217.
2. Fini, Gasparini G, Filippini F, et al. The long styloid process syndrome or Eagle's syndrome. J Craniomaxillofac Surg. 2000;28(2):123Y127.
3. Murtagh MD, Caracciolo JT, Fernandez G. CT findings associated with Eagle's syndrome. Am J Neuroradiol. 2001;22:1401Y1402.
4. Breault MR. Eagle's syndrome: review of the literature and implications in craniomandibular disorders. J Craniomandibular Pract. 1986;4(4): 323Y327.
5. Goodman RS. Fracture of an ossified stylohyoid ligament. Arch Otolaryngol. 1981;107:129Y130.
6. Porrath S. Roentgenologic considerations of the hyoid apparatus. AJR Am J Roentgenol. 1969;105:63Y73.
7. Chandler SR. Anatomic variations of the stylohyoid complex and their clinical significance. Laryngoscope. 1977;87:1692Y1701.
8. Eagle W. Elongated styloid process: further observation and a new syndrome. Arch Otolaryngol. 1948;47:630Y640.
9. Lentini A. Gli aspetti clinici e radiologici delle anomalie dell'apparato stilo-joideo. Radiol Med. 1975;61:337Y3640.
10. Monsour PA, Young WG. Variability of the styloid process and stylohyoid ligament in panoramic radiographs. Oral Surg Oral Med Oral Pathol. 1986;61(5):522Y526.
11. Moffat DA, Ramsden RT, Shaw HJ. The styloid process syndrome: aetiological factors and surgical management. J Laryngol Otol. 1977; 91(4):279Y294.
12. Lindeman P. The elongated styloid process as a cause of throat discomfort. Four case reports. J Laryngol Otol. 1985;99(5):505Y508.
13. Boddour HM, McAnear JT, Tilson HB. Eagle's syndrome. Report of a case. Oral Surg Oral Med Oral Pathol. 1978;46(4):486Y494.
14. Ruwanpura PR, Anuraddha MA, Gunathilake KMB. Sudden unexpected death probably due to Eagle's syndrome. Med Sci Law. 2008;48:350Y353.
15. Balcioglu HA, Kilic C, Akyol M, et al. Length of the styloid process and anatomical implications of Eagle's syndrome. Folia Morphol. 2009; 68(4):265Y270.
16. Miller VM, Kenny RA, Slade JY, et al. Medullary autonomic pathology in carotid sinus hypersensitivity. Neuropathol Appl Neurobiol. 2008; 34(4):403Y411.
17. Kerr SR, Pearce MS, Brayne C, et al. Carotid sinus hypersensitivity in asymptomatic older persons: implications for diagnosis of syncope and falls. Arch Intern Med. 2006;166(5):515Y520.