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Multiorgan trauma with rare fall-related aortic dissection: case report and review of the literature

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Abstract: *Multiorgan trauma that includes aortic dissection most frequently results from car crashes, which is fatal in up to 90% of these patients. Rarely, similar thoracic aortic injury can be caused by falls from significant height. Such a fall in a 43-year-old Chinese man caused multiorgan trauma including multiple fractures and aortic dissection. After immediate evaluation and stabilization of the patient's status, emergency repair of the aortic dissection was performed followed subsequently by elective surgery for the fractures. The patient was eventually discharged from hospital, and at six months follow-up, he had returned to normal living conditions. The purpose of this case report was to describe the diagnosis and treatment of this rare presentation of traumatic aortic injury as part of multiorgan trauma. Aortic dissection caused by fall injuries from height is extremely rare in clinical practice and can easily be missed or misdiagnosed.*

Keywords: *multiple trauma; aortic dissection; fracture; literature review*

1. Introduction

In the context of trauma, serious injuries are defined as involving two or more sites, of which at least one injury or the sum of all injuries is life-threatening [1]. Aortic dissection is initiated by a ruptured aortic intimal tear that, under the high pressure aortic blood flow, rapidly involves the medial aortic wall layers and further extends longitudinally down the aortic wall, separating the aortic lumen into true and false lumens [2]. In a very variable period of time, the adventitia can rupture which is potentially a lethal event. Patients with traumatic aortic dissection often suffer multiple associated injuries, which are easily missed or misdiagnosed [3], and may have serious consequences. Therefore, timely diagnosis and prioritized effective treatments are the essentials for successful outcomes. Here, we report a rare case of multiorgan trauma with aortic dissection caused by a fall from height.

2. Case report

A 43-year-old male was brought to our emergency orthopedics department by ambulance due to a "fall from height a half hour previously" at 17:18 on December 21, 2020. The patient was immediately resuscitated in the rescue room with the following initial findings: temperature 36.1℃, pulse 122 beats/min, respiratory rate 31 breaths/min, blood pressure 78/40 mmHg, SpO_2 91%, comatose with inability to cooperate; GCS score [4]: 7 points, pupils unresponsive to light, ECG monitoring showed sinus tachycardia, open injury of the right lower leg dressed with an elastic bandage; a forehead abrasion of 3 × 2 cm, an elastic bandage of the left upper limb; and multiple other abrasions over the body. The patient's wife reported that the patient was previously healthy and had no concerning medical history. The patient was endotracheally intubated and transferred to the ICU. A right subclavian central venous catheter was placed, vasoactive drugs and blood transfusions were administered to maintain the blood pressure at 90 ~ 100/40 ~ 50 mmHg, heart rate fluctuated at 100 ~ 120 beats/min, and the vital signs stabilized. CT showed slightly increased density of the tentorium cerebelli; thickened wall of the aortic arch and part of the thoracic aorta, slight high density arc around the tube (Figure 1a); multiple fractures throughout the body; traumatic wet lung (acute respiratory distress syndrome-ARDS); and pleural effusion. The Department of Cardiovascular Surgery recommended aortic CT angiogram. The

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Department of Orthopedics debrided and sutured the right elbow and left lower leg, plaster external fixation of the right upper limb, immobilization of the right shoulder, plaster external fixation of the left lower limb, and pelvic pocket fixation. The Department of Neurosurgery considered the possibility of a traumatic arachnoid hemorrhage but did not recommend immediate intervention. The Department of Cardiothoracic Surgery provided chest immobilization, and chest CTA at 21:11 on December 21 revealed the presence of aortic dissection (Figure 1b, c).

The working diagnoses included: 1) aortic dissection; 2) hemorrhagic shock; 3) multiple fractures; 4) traumatic ARDS; and 5) pleural effusion. Clearly, the highest priority was the risk of aortic rupture, so emergency surgery was performed, during which localized hematomas of the ascending aorta and aortic arch were observed. Because the ascending aortic hematoma was not thick and the valve was intact, the procedure performed was individualized combined stent total arch replacement + elephant trunk stenting alone (Figure 1d). The operation proceeded smoothly. The patient was transferred to the ICU for postoperative monitoring and further management. A portable bedside chest X-ray showed inflammation. The patient was given antibiotic cefuroxime sodium 1.5g q12h for anti-infection treatment. Nevertheless, the high fever persisted postoperatively with a peak temperature of 39.7℃. The antibiotic was switched to cefoperazone sulbactam 3g q8h. Sputum and blood cultures were obtained and were positive for gram negative bacilli and gram-positive cocci. The antibiotic treatment was switched to continuous iv vancomycin 1500 mg and minocycline. With this regimen, the inflammatory indicators decreased, the temperature returned to normal and stabilized, and the infection was controlled. The patient was eventually transferred to the orthopedics department. The right clavicle and pelvic fractures were managed conservatively (Figure 2a ~ d), but the right humerus, left tibia and left carpal scaphoid fractures (Figure 3a ~ i) required surgical fixation. With further recovery and graduated functional exercise, the patient had achieved clear consciousness with a GCS of 15 points, the muscle strength of the lower limbs was given a grade IV, and he was discharged from the hospital. During the follow-up period of nearly six months after discharge, the patient had returned to a normal living status.

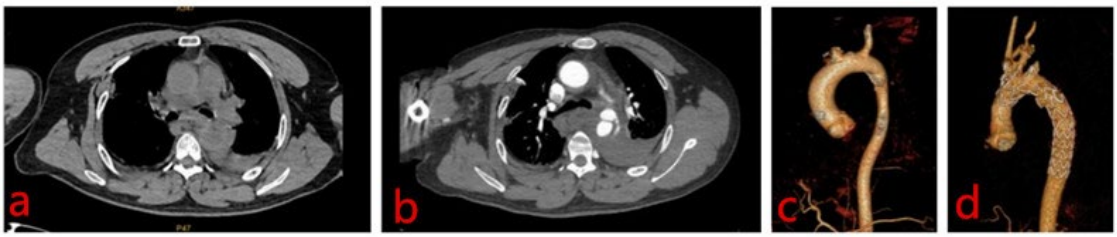

Figure 1: a. CT showed a widened aortic shadow with unclear boundary; b. Contrast-enhanced CT scan showed aortic dissection; c. CTA showed that the rupture was located adjacent to the aortic arch near the descending aorta; d. CTA at one month following the operation showed that the metal stent was unobstructed and in proper position, with no significant contrast agent exudation, and a few atherosclerotic plaques in the aorta and iliac artery.

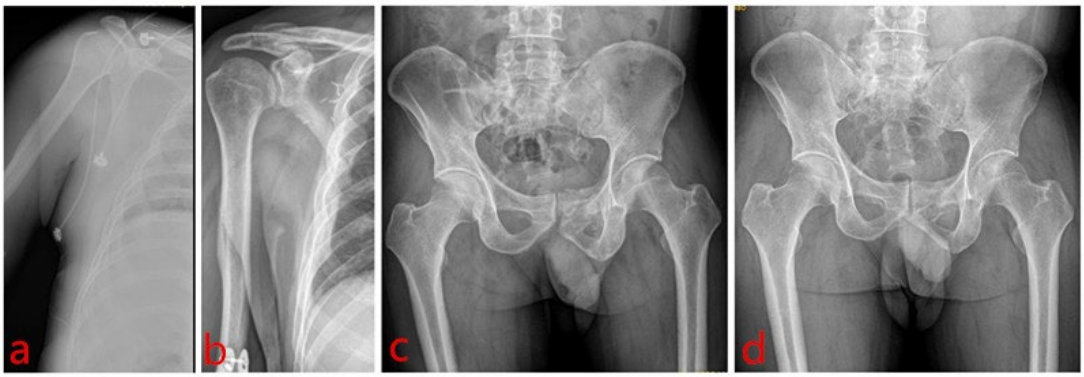

Figure 2: a. X-ray showed discontinuity of bone cortex in the shoulder peak segment of the right clavicle; b. X-ray reexamination 3 months after discharge showed callus formation at the fracture end; c. X-ray showed interruption of bone cortex continuity in the superior and inferior left pubic rami, surrounded by multiple free fragments; d. X-ray reexamination 3 months after discharge showed improvement of the left pubic bone, with intact bone structure.

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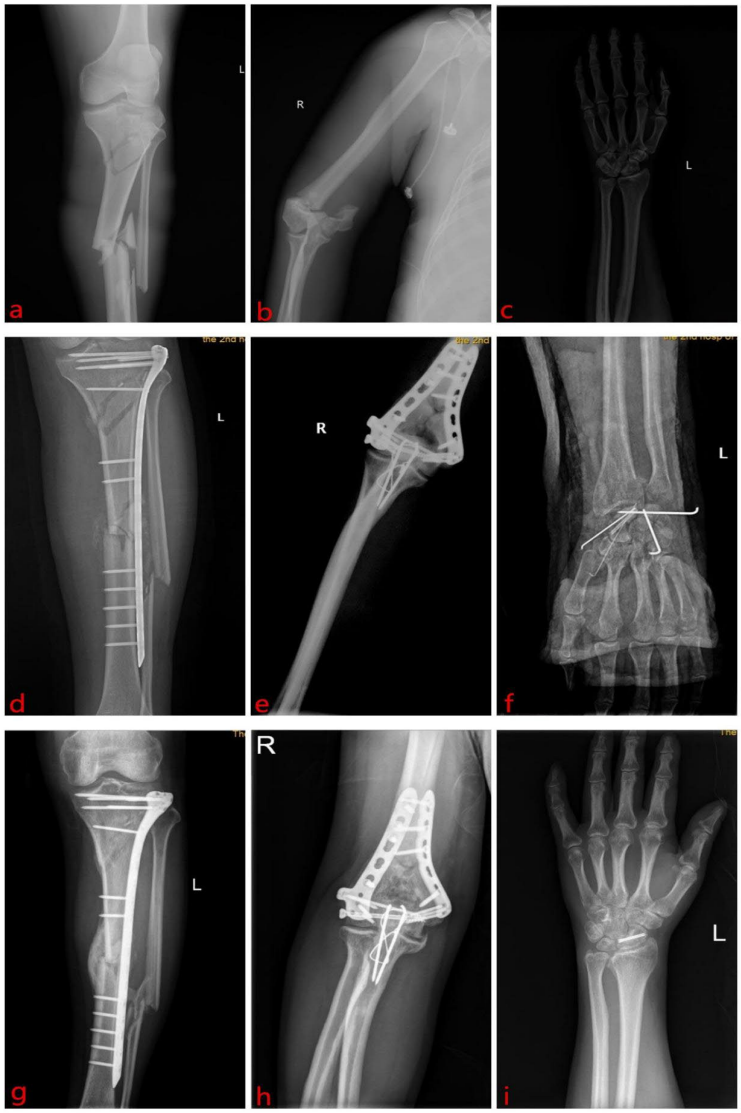

Figure 3: a. X-ray showed: left middle and upper tibial and fibular fractures, involving the tibial plateau; b. X-ray showed: right humerus and ulna comminuted fractures, poor elbow alignment; c. X-ray showed left scaphoid, capitate and hamate tearing fractures; d. Postoperative X-ray showed: metal instrumentation in place with well aligned tibial fracture ends; e. Postoperative X-ray showed: metallic internal fixation in place, fracture ends well aligned, and the elbow relationship returned to normal; f. Postoperative X-ray showed: metal internal fixation in place, the fracture ends well aligned, and the wrist relationship did not show significant abnormalities; g. three months after discharge X-ray showed: the original fracture showed callus formation, metal internal fixation without loosening or displacement; h. three months after discharge X-ray showed: the original fracture healed well, normal joint relationship, metal internal fixation without loosening or displacement; i. three months after discharge X-ray showed: left carpal fracture recovered well, joint relationship with no abnormalities, retain scaphoid internal fixation, the remaining hardware removed.

3. Discussion

This case represents a rather extreme composite of multiorgan trauma that included the rare but dangerous, life-threatening aortic dissection caused by fall from height. The entire sequence of management from the time the patient entered the emergency department to his hospital recovery was retrospectively analyzed. There were several key management algorithms to be noted: (1) the patient was resuscitated in strict accordance with the priority of ABCDE (airway, breathing, circulation, neurological examination, systemic examination and body temperature protection); (2) the multidisciplinary trauma group was activated immediately upon admission [5, 6] to optimize diagnostic efficiency and accuracy; (3)

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enhanced CT and CTA were immediately requested when the aortic shadow by CXR was noted to be widened, facilitating the diagnosis of aortic dissection at the earliest possible time to proceed with emergency treatment. For patients with severe multiorgan trauma, a missed diagnosis of any important injury could be responsible for a patient death; furthermore, prolonged or inefficient delays in diagnosis, in this type of emergency, for even a few minutes might result in a missed opportunity to save a patient's life. Therefore, timely, rapid, and accurate diagnosis is of critical importance in assessing the patient's condition and guiding treatment [7].

Patients sustaining multiple injuries characteristically are complex and present in critical clinical condition. Multiple organ systems are typically involved, often presenting in shock, the urgency of which can lead to missed diagnoses, and high mortality. The fatality rate accounts for 12% of global deaths, making it the most important cause of death in people under 44 years of age [8, 9]. Studies have shown [10] that a GCS score < 8, head and neck fracture, and abnormal pulse are independent risk factors associated with death in patients with multiorgan trauma. Aortic dissection, as one of the most common arterial emergencies, has an average annual incidence of 0.03 per 1,000 [11, 12, 13], and 20% to 30% of patients have died before admission [14], and the in-hospital mortality rate ranges from 10% to 18% [15, 16, 17]. Multiorgan trauma with DeBakey type III aortic dissection is the most common [18], with intimal breaks often located in the descending aorta and aortic isthmus[19], and their mechanism is associated with the descending aortic anatomy and hemodynamics [20]. In the present case, the aortic rupture was located adjacent to the aortic arch near the descending aorta, which was consistent with the report and suggested that the aortic dissection in this case was caused by trauma. Some scholars believe that traumatic aortic dissection is due to the impact of external force caused by sharp deceleration when the patient is injured, resulting in a sharp increase in blood pressure and severe pulsation causing intimal damage to form a break and tear downward [21].

Multiorgan trauma with aortic dissection was not easily diagnosed because the patient presented in coma, precluding any history or symptoms that might have given clues to the diagnosis. Through a review of the literature, for patients with multiorgan trauma, the following recommendations should be undertaken to establish an early diagnosis of aortic dissection. (1) Mechanism of injury: studies have shown that 90% of traumatic aortic dissections are caused by closed blunt trauma, and the mechanism is deceleration injury [22]. Therefore, the possibility of aortic dissection should be highly suspected in patients who experience deceleration or high-energy injuries. (2) Clinical manifestations and symptoms: aortic dissection is characterized by severe symptoms but few signs; patients often present with persistent, severe, tearing-like pain in the chest and especially the back [23, 24]. Additionally, patients with abnormally increased blood pressure associated with multiple injuries should alert the clinician to the possibility of an aortic dissection, especially male patients. Significant differences in limb blood pressure and pulse are key, specific manifestations of aortic dissection [25]. Incredibly, aortic dissection can be highly suspected by the simple routine measurement of blood pressure in both upper limbs. (3) D-dimer level: when time is urgent, or imaging conditions are lacking, D-dimer detection can reflect early aortic wall injury in the diagnosis of acute aortic dissection. Previous studies have shown that when D-dimer reaches a cut-off value of 500 ug/L within 24 h of onset, the sensitivity of diagnosing acute aortic dissection is 51.7% and the specificity ranges from 32.8% to 89.2% [26]; compellingly, such an increase in D-dimer is associated with increased in-hospital mortality [27]. Other biomarkers useful in the diagnosis and evaluation of aortic dissection are soluble growth-stimulating gene-2 protein which is associated with cardiovascular injury [28], C-reactive protein reflecting inflammatory activity, certain microRNAs (miRNAs) in plasma, such as miR-15a [29], and calmodulin reflecting vascular interstitial damage. Studies have shown that plasma C-reactive protein is an indicator of poor prognosis in patients with aortic dissection [30]. (4) Imaging examination: chest radiography, aortography, CT and MRI can be used to diagnose aortic dissection. Chest radiography can show aortic widening and shape change, but it only raises suspicion of a potential dissecting hematoma. Aortography is the primary, most accurate and reliable diagnostic method for the diagnosis of aortic dissection, but it is invasive, has potential risk, and the preparation prior to examination plus the length of the procedure is time-consuming—it has only rarely been used for emergency examination. MRI examination has high sensitivity and specificity for the diagnosis of aortic dissection and is the gold standard for the diagnosis of aortic dissection, but the time required for imaging is prohibitive for patients with severe symptoms, aside from the issue of metal interference in the body. At present, the sensitivity of CT in the diagnosis of aortic dissection can reach 99.1%. Moreover, with enhanced scanning, CT angiography and three-dimensional image reconstruction, CT classification of dissection can be accurately determined, the full range of dissection and the precise location of the rupture can be captured, both the true and false lumen can be identified including the diameter of each and the supply of the true and false lumen can be imaged. Therefore, multi-slice spiral CT angiography is recognized as the most effective examination method for rapid, safe, accurate

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diagnosis of aortic dissection. Advanced trauma life support (ATLS) of the American Academy of Surgery proposed that all patients who experience high-energy injuries with associated fractures should routinely undergo enhanced CT scanning to determine whether there are life-threatening injuries, such as aortic dissection.

Multiple injuries require multidisciplinary participation, optimally comprised of a multidisciplinary trauma team; effective and complete evaluation can shorten trauma resuscitation time and save lives. Treatment of traumatic aortic dissection should be based on comprehensive management of systemic trauma, recognizing its life-threatening potential. The medical aspects include emergency resuscitation, sedation, and pain relief. The surgical treatment includes vascular repair or graft replacement, endovascular exclusion, or hybrid surgery. For most of the multiorgan trauma patients, they arrive in the emergency department with unstable vital signs, necessitating rapid resuscitation, and appropriate imaging. Traumatic aortic dissection is principally Stanford type B. Therefore, when the conditions and techniques can be met, and the indications are clear, endovascular graft exclusion therapy should be preferred [22]. Compared with traditional thoracotomy, the advantages of endovascular treatment include avoidance of complications such as bleeding related to cardiopulmonary bypass, especially for patients with severe trauma at other sites; the operation time is shortened, and the overall additional surgical trauma is minimized; there are few postoperative complications, and the recovery is hastened. For type A aortic dissection or complex type B aortic dissection, when the patient cannot tolerate a thoracotomy, treatment can incorporate the "chimney" technique, "fenestration" technique, and hybrid technique.

4. Conclusion

In summary, patients with multiorgan trauma have variable clinical manifestations, often with impaired consciousness, and in overall critical condition. If aortic dissection is part of the complex presentation, it would be easy to overlook the diagnosis, which could lead to a fatal outcome. Therefore, emergency physicians should be vigilant in evaluating for aortic dissection if the mechanism of injury, physical examination, or imaging examination raises any consideration of the diagnosis, as early diagnosis and treatment are critical for patient survival.

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