Case Report

Cardiopulmonary resuscitation causing thoracolumbar hyperextension with severe spinal cord injury: A case report✩,✩✩

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ABSTRACT

Thoracic vertebral fractures are extremely rare complications of cardiopulmonary resuscitation (CPR). A morbidly obese 79-year-old female positive for COVID-19 suffered cardiac arrest and received CPR for 18 minutes with return of spontaneous circulation. Post cardiac arrest the patient was unable to be weaned from the ventilator and had decreased lower extremity movement. A computed tomography scan of the chest/abdomen/pelvis demonstrated a widely diastatic spinal separation at the T12/L1 intervertebral disc space with L1 spinous process fracture. The patient ultimately expired from the severe spinal cord injury combined with older age, COVID-19 pneumonia, and morbid obesity. CPR can be an important life-saving procedure, but strict attention to proper technique is of paramount importance as it can have many possible complications.

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Introduction

Cardiopulmonary resuscitation (CPR) was developed in 1960 when the American Heart Association started a program to familiarize physicians with closed chest cardiac resuscitation as well as educating the general public. While CPR can be potentially life-saving, it can lead to unanticipated traumatic complications. Bony injuries, in particular fractures of the ribs and sternum, are the most frequently reported complications of chest compressions. Vertebral body fractures can also occur, but they are seldom diagnosed and rarely reported in the literature [1]. We describe an extremely rare case of a COVID-19 positive, 79-year-old female who had a cardiac arrest with CPR, resulting in a widely diastatic spinal separation at the T12-L1 intervertebral disc space with L1 spinous process fracture.

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A 79-year-old female with a history of diabetes, hypertension, osteoarthritis, morbid obesity, and chronic lymphedema arrived to her local community hospital for multiple episodes of coffee ground emesis. She was complaining of nausea, vomiting, abdominal pain, and had multiple abdominal hernia repairs in the past. The patient was diagnosed with a small bowel obstruction and taken for exploratory laparotomy by general surgery. Postoperatively the patient required continued mechanical ventilation and was unable to be weaned off the ventilator for 7 days.

A computed tomography (CT) scan of the chest/abdomen/pelvis (C/A/P) was done that showed a small right pleural effusion with associated passive atelectasis and possible right lower lobe pneumonia. Severe degenerative changes were present throughout the spine consistent with diffuse idiopathic skeletal hyperostosis (DISH) and also demonstrated a significant kyphosis (Figs. 1a and b, Fig. 2).

She was initially successfully extubated to bilevel positive airway pressure (BiPAP), but 3 days later the patient became hypoxic and had a pulseless electrical activity cardiac arrest. The patient underwent 18 minutes of CPR with return of spontaneous circulation.

After the patient's cardiac arrest, she was again unable to be weaned from the ventilator. A Covid-19 swab was sent that resulted positive, and a repeat CT of the C/A/P was ordered. CT now demonstrated a widely diastatic spinal separation at the T12/L1 intervertebral disc space with L1 spinous process.

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![Fig. 1(a) – CT abdomen/pelvis soft tissue window without contrast prior to cardiac arrest showing significant diffuse idiopathic skeletal hyperostosis (DISH) of the spine with intact thoracic and lumbar vertebrae and thoracic kyphosis.](image1)

![Fig. 1(b) – CT abdomen/pelvis bony window without contrast prior to cardiac arrest showing significant diffuse idiopathic skeletal hyperostosis (DISH) of the spine with intact thoracic and lumbar vertebrae and thoracic kyphosis.](image2)

![Fig. 2 – CT abdomen/pelvis coronal plane bony window demonstrating no involvement or fusion of the sacroiliac synovial joints.](image3)
Fig. 3 – CT of the abdomen/pelvis without contrast post cardiac arrest demonstrating a widely diastatic spinal separation at the T12/L1 intervertebral disc space with L1 spinous process fracture.

...fracture in the context of multilevel vertebral fusion, reflecting diffuse idiopathic skeletal hyperostosis (Fig. 3). Multiple bilateral rib fractures compatible with sequelae of chest compressions were also demonstrated. The patient's initial hospital was not equipped to perform magnetic resonance imaging (MRI) for an intubated patient and did not have neurosurgical specialty consultation available. After discussion with the patient’s family, she was subsequently transferred to our tertiary care facility for both neurosurgical evaluation and advanced imaging to include MRI.

On arrival, the patient’s neurologic exam showed pupils were equal, round, and briskly reactive to light bilaterally, eye opening to voice, nonverbal secondary to intubation, and withdrawal to pain of all 4 extremities. The bilateral upper extremities briskly withdrew to painful stimulation, with the bilateral lower extremities only withdrawing minimally to painful stimulation. The patient was diffusely hyporeflexic in all 4 extremities. Her exam was consistent with an ASIA C spinal cord injury.

MRI of the lumbar spine was performed and showed severe cord compression at the level of the conus medullaris at T12-L1 secondary to displacement of the superior articular facets of L1 with a small ventral epidural hematoma, and abnormal soft tissue in the ventral epidural space at L2 suggesting some additional epidural hemorrhage. Rupture of the anterior longitudinal ligament at T12-L1, and rupture of the T12-L1 disc with macerated disc tissue and extensive edema in the disc space were also manifested (Fig. 4).

One day after the MRI was obtained, the patient was still requiring high levels of oxygen and positive end expiratory pressure with mechanical ventilation. She became hypotensive despite aggressive pressor support and suffered yet another cardiac arrest with the patient ultimately expiring.

Discussion

The CPR guidelines released in 2010 and 2015 by the American Heart Association endorsed performing chest compressions at a speed of at least 100-120 compressions per minute and to a depth of at least 5 cm for adult patients with cardiac arrest [2,3]. Compared with the 2005 guidelines, which stated a rate of approximately 100 compressions per minute and a depth of approximately 1.5-2 inches (4-5 cm), the 2010 and 2015 guidelines recommended increases in both parameters [4]. The faster and deeper chest compressions intend to augment the survival rate.

Despite CPR being potentially life-saving, it is a traumatic procedure which may result in unforeseen complications. Skeletal injuries, particularly fractures of the ribs and sternum, are common complications of chest compressions [1]. Spinal fractures as a complication of CPR are exceedingly rare and have been minimally reported in the literature. Of cases
that have been described, the fractures are mid-thoracic vertebral compression fractures [5–9]. The most common fracture location is at the mid-thoracic level because compressive forces during CPR are focused along the anterior and middle columns of the mid-thoracic curve [10]. To our knowledge, a T12-L1 spinal injury with wide diastasis has not been published.

Previous cases speculate that some degree of skeletal susceptibility such as osteoporosis, osteopenia, or kyphosis could be culpable for spinal fractures during CPR. Osteopenia is an important major risk factor for all different types of fractures. Dorsal kyphosis can increase the lumbar lordosis, therefore, exposing the spine to greater shearing forces during active chest compressions [6,8]. Although our patient was morbidly obese, her initial CT of the C/A/P demonstrated an almost fusion of her thoracolumbar spine from severe DISH, as well as a significant thoracic kyphosis. The patient’s underlying spine disease of severe DISH is a major contributing factor for this type of fracture as it functionally creates a long lever arm of the spine.

We hypothesize that older age with decreased bone density, DISH, severe kyphosis, and forceful chest compressions during prolonged CPR all contributed to the T12-L1 separation. As the patient’s initial CT of the C/A/P did not show any injury to the thoracic or lumbar vertebrae, we feel confident the T12/L1 spinal separation did in fact result from cardiopulmonary resuscitative efforts. Because the patient was transferred to our facility, it is unknown if CPR was performed on a hospital bed mattress or if the patient was placed on a backboard. Much of the research about the performance of CPR on various support surfaces has been performed on manikins and it is unclear how the results could be translated to the CPR performed on humans. Limited manikin studies have demonstrated a small benefit of increased chest compression depth when using a backboard. The benefit was not enough to make a recommendation to routinely use a harder surface such as a backboard over the standard hospital bed mattress [11].

The lumbar-sacral spinal cord starts at T9 and continues to L2. Therefore, the patient did suffer significant motor and sensory loss to her bilateral lower extremities. She was classified on The American Spinal Injury Association/International Spinal Cord Society Neurological Standard Scale (ASIA Impairment Scale) as ASIA C; motor function preserved but with more than half of the muscles in the lower extremities having a muscle grade of less than 3 [12]. The severe spinal cord injury, combined with older age, preexisting DISH, Covid-19, bilateral pneumonia, and morbid obesity all contributed to the patient’s death.

**Conclusion**

CPR can be an important life-saving procedure, but strict attention to proper technique is of paramount importance as it can have many possible complications. While injuries to the spine seem to rarely occur following cardiopulmonary resuscitative efforts, they can be easily missed and a high index of suspicion by providers is necessary.

**Patient consent statement**

The patient’s family was able to see her over FaceTime prior to withdrawing care. They gave consent to publish a case report. All information in the case report is anonymous with no personal identifiers throughout the manuscript or figures.

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