Delayed Diagnosis of Upper Cervical Spine Injury Presenting with Cardiopulmonary Arrest in Elderly Patients—A Case Report and Review of Literature—

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Abstract
The incidence of cervical spine injuries (CSIs) among elderly patients is increasing in an aging society. An accurate diagnosis in the acute phase is important to avoid adverse clinical and sociolegal consequences. We present case reports of 2 elderly women who presented with cardiopulmonary arrest (CPA) with a delayed diagnosis of CSI. They presented with CPA of unclear etiology, and after successful cardiopulmonary resuscitation, a medical emergency team concluded that CPA in these patients was not trauma-related but was attributable to cardiovascular or endogenous pathology, because both patients showed only a few facial scars (which would rule out trauma). In both cases, cervical computed tomography performed after admission revealed atlantoaxial dislocation accompanied by type II odontoid fractures, confirming the diagnosis of upper CSI secondary to falls after CPA. Factors contributing to the diagnostic delay included lack of awareness regarding the following: (I) bone fragility in elderly patients can cause serious CSIs even with low-energy trauma, (II) CPA-related falls can cause CSIs, and (III) superficial facial bruising can be the only external manifestation of CSIs. Upper CSIs should be considered as a complication of CPA, particularly in elderly patients presenting with even minor facial trauma.

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Key words
cervical spine injury, cardiopulmonary arrest, diagnosis, osteoporosis, elderly

Introduction
Although upper cervical spine injury (CSI) is known to cause cardiopulmonary arrest (CPA), the possibility of significant CSI following minor trauma after CPA is rare. Awareness regarding this condition is important particularly in the elderly population, because even low-energy trauma can cause disproportionately serious CSIs secondary to vulnerability of osteoporotic bones observed in this group.1,2 In patients with CPA, it is difficult to identify CSIs when there is no suspicion of or reported traumatic etiology but endogenous pathology is suspected. We describe the cases of 2 elderly women who presented with CPA with a delayed diagnosis of CSI. Additionally, we have discussed the diagnostic pitfalls associated with CSI in aging populations, both from clinical and sociolegal perspectives, with useful guidelines for clinicians.

Case reports

[Case 1]
A 70-year-old Japanese woman without any relevant history was discovered outdoors in a state of CPA soon after she had walked away from her family. Return of spontaneous circulation was observed after a few minutes of cardiopulmonary resuscitation (CPR) performed by an
ambulance team. She was transported to our hospital where she was examined by the medical emergency teams, including staff from the Departments of Neurosurgery, Surgery, Internal Medicine, and Cardiovascular Medicine. Physical examination showed slight contusions on the lips with the loss of a tooth. Her blood pressure (BP) was 205/99 mmHg, and the heart rate (HR) was 120 beats per minute (bpm) at a regular rhythm. No other evidence of trauma was observed.

Neurological examination revealed a disturbance of consciousness with respiratory distress necessitating oral intubation. The emergency team evaluated the results of her blood tests, electrocardiography (ECG), ultrasonic cardiology (UCG), chest and abdominal computed tomography (CT), and head CT and cerebral CT angiography. They concluded that her CPA was not trauma-related but was attributable to some endogenous pathology based on the observation of only minor facial scars, which were considered secondary to the CPA.

After admission to our hospital, a neurosurgeon happened to recognize irregularity of the anterior arch of the atlas on the most caudal view of the initial head CT (Fig. 1 a). Cervical CT was performed and revealed atlantoaxial dislocation (AAD) accompanied by a type II odontoid fracture with posterior displacement and an anterior arch fracture of the atlas (Fig. 1 b, e). Based on magnetic resonance imaging (MRI), she was diagnosed with upper CSI at the C1–2 level (Fig. 1 d). The patient was not in a state of neurogenic shock; thus, CPA-induced CSI was presumed rather than CSI-induced CPA.

The patient was managed conservatively using external immobilization (Philadelphia collar initially, followed by a soft collar), which subsequently caused pressure ulcers requiring dermatological treatment. She was extubated 2 weeks later, although her apallic state persisted, and she required tube feeding. Bony fusion was observed 2 months after the onset of this condition (Fig. 1 e, f), and she was transferred to general care (modified Rankin Scale [mRS] 5).

Fig. 1
a : Head computed tomography (CT) scan (the most caudal axial image) shows an irregularity of the atlas.
b, c : Axial (b) and sagittal (c) images of cervical CT scans show an anterior arch fracture of the atlas (b), a type II odontoid fracture with posterior displacement and an atlantoaxial dislocation (c).
d : Sagittal T2-weighted magnetic resonance image confirms a spinal cord hyperintensity secondary to a contusion at the C1–2 level.
e, f : Sagittal (e) and axial (f) images of cervical CT scans 2 months after the onset of the condition show bony fusion of the type II odontoid fracture and the fracture of the anterior arch of the atlas, respectively.
**Case 2**

A 91-year-old Japanese woman with a history of paroxysmal atrial fibrillation, vasospastic angina, and bradycardia–tachycardia syndrome was hospitalized for the adjustment of her cardiac pacemaker. At midnight she fainted after voiding and struck her forehead and developed CPA. Spontaneous return of circulation was observed after a few minutes of CPR administered by an emergency team. Physical examination showed BP of 80/40 mmHg, HR 70 bpm at the pacemaker’s rhythm, and a slight contusion on her forehead.

Neurological examination revealed a disturbance of consciousness and no voluntary movements of the extremities in addition to respiratory distress, necessitating oral intubation. The emergency team evaluated the results of her blood tests, ECG, UCG, and CT (chest, abdomen, and head) and concluded that the patient’s CPA could be a type of cardiovascular disease. The traumatic scars were considered secondary to the CPA. Follow-up head CT scan was obtained 3 days later, and the most caudal image incidentally included the C1–2 level, and the radiologist identified the abnormality at that level (Fig. 2 a). Cervical CT revealed AAD associated with a type II odontoid fracture with posterior dislocation, leading to the diagnosis of upper CSI (Fig. 2 b, c). Considering her medical history, CPA–induced CSI was presumed rather than CSI–induced CPA. The patient was managed conservatively using external immobilization (Philadelphia collar initially, followed by a soft collar), which thereafter caused pressure ulcers requiring dermatological therapy. She needed tube feeding and underwent a tracheostomy for respiratory support. Bony fusion was observed 3 months later (Fig. 2 d, e), and she was transferred for systemic control (mRS 5).

**Discussion**

The incidence of CSIs among elderly patients is increasing in an aging society. Reportedly, 54–60% of CSIs are attributable to low–energy trauma including that caused by simple ground–level falls (GLFs) despite the seemingly innocuous causes of CSIs. Notably, 7% of elderly patients who experience GLFs sustain CSIs, of which 60% are C1–2 level fractures. Upper CSIs account for approximately 30–40% of fatal CSIs. Miyata et al. report that in most patients (11/14, 79%, mean age 74 years) fatal CSIs...
were caused by minor or low-energy trauma.  

In contrast to younger individuals (<60 years) in whom fatal CSIs are more often caused by high-energy trauma with >90% of deaths occurring within 24 hours of the CSI, a significant number of elderly individuals who experience fatal CSIs die approximately a week post-injury of respiratory and circulatory system disturbance, which might be potentially preventable or treatable conditions if they are identified early. Neurological deficits associated with upper CSIs are fatal in patients with a serious presentation: therefore, an accurate diagnosis at the initial evaluation and appropriate management in the acute phase is important to prevent deterioration secondary to CSIs after admission and to avoid medicolegal issues (as was observed in the 2 cases presented here).

Among the upper CSIs observed in the elderly population, Anderson and D’Alonzo type II odontoid fractures (often accompanied by complex atlantoaxial fractures) are the most common variety, and neurological deficits are primarily caused by the posterior displacement of the odontoid process. Treatment options for these fractures include traction, semirigid immobilization (collar), rigid immobilization (halo, sterno-occipital-mandibular immobilizer), surgical stabilization and fusion (posterior fusion, anterior odontoid screw fixation), among other options. Indices and measurement criteria for management are as follows (Fig. 3): fracture type of the odontoid process of the axis with dislocation measuring ≥6.0 mm, classification of atlas fractures, a 3-mm limit for a normal atlanto-dental interval, integrity of the transverse atlantal ligament to determine the stability of the atlas assessed by the rule of Spence, Dickman classification, MRI evaluation, and type of complex fractures, among other such criteria.

However, the optimal management in elderly patients with osteoporotic bones, medical comorbidities, and impaired physiological reserves remains controversial. Our patients were treated conservatively using external immobilization because of their serious neurological and physical condition after CPA. External immobilization, particularly in elderly patients requires close attention to prevent device-related pressure ulcers.

In survivors, upper CSIs are often overlooked at the initial evaluation owing to the patient’s clouded consciousness caused by the associated head injury or circulatory failure and/or a lack of characteristic clinical symptoms. In elderly individuals, particularly those with a history of cardiovascular disease (as was observed in Case 2), it may be difficult for even a medical team that includes cardiovascular and neurosurgical specialists to differentiate between CSI-induced CPA and CPA-induced CSI. We diagnosed our patients with CPA-induced CSIs, although we could not completely exclude the possibility of CSI-induced CPA. Advanced age, upper CSIs, and tetraplegia are reported to be associated with CPA, and it is important for clinicians to be aware of these factors to ensure prompt and appropriate diagnosis.

Factors contributing to the delayed diagnosis were a lack of awareness regarding the following: that bone fragility and vulnerability in elderly patients could cause serious CSIs following even low-energy trauma, CPA-related falls could cause CSIs and superficial bruises on the face might be the only external manifestations of CSIs. Thus, we did not consider a traumatic mechanism following CPA, which explains our incomplete examination of the cervical spine.

Based on our experience, we emphasize that upper CSIs should be considered a serious complication of CPA, particularly in elderly patients presenting with even minor

Fig. 3  Treatment algorithm for complex atlantoaxial fractures. TAL: transverse atlantal ligament, O: occiput
scars, and cervical spine CT and/or MRI should be performed in these patients. This condition is rare, and the diagnosis can easily be missed. Therefore, the possibility of missed injuries in elderly patients should always be considered to avoid adverse clinical and sociolegal consequences. Whole-body CT might be useful as a standard diagnostic method for CPA because it would help in the identification of a CSI or other latent injury in patients with CPA without obvious evidence of trauma.

**Conflicts of Interest Disclosure**

The authors have declared no conflicts of interest regarding this article.

**References**