Clinical Decision Making Associated With an Undetected Odontoid Fracture in an Older Individual Referred to Physical Therapy for the Treatment of Neck Pain

A pproximately 25% to 35% of individuals aged 65 years and older fall each year.13,15,17,21,22 The consequences of falls among older individuals are increased health care costs and decreased quality of life. Traumatic injuries to the cervical spine are of particular concern, as they can be difficult to detect and are associated with substantial morbidity and mortality.13,18 Fractures of the odontoid process are some of the more common cervical spine injuries in individuals aged 65 years and older, accounting for 20% of all cervical spine fractures.24

When evaluating older individuals with neck pain caused by trauma, physical therapists should be especially alert for the presence of cervical spine fractures and should understand the clinical findings associated with cervical spine fractures. A clinical decision rule has been developed to determine when radiographs of the cervical spine are indicated in individuals with neck pain following trauma (FIGURE 1).19 This clinical decision rule is highly sensitive (100%), suggesting that a negative finding on this rule essentially rules out the presence of a fracture and that radiographs are not indicated.19 However, this clinical decision rule lacks specificity (43%), suggesting that while a positive finding on the rule mandates radiography, it is not necessarily indicative of a fracture.

Conventional radiography is often the initial imaging completed when evaluating for acute fractures in patients with a history of trauma. However, radiographs may not always detect the presence of cervical spine fractures.4,12 Therefore, additional diagnostic imaging may be necessary for some individuals with neck pain; even if initial conventional radiographs of the cervical spine are negative for a fracture, these individuals may have undetected injuries that require medical referral and are not appropriate for physical therapy intervention.

The purpose of this paper is to pro-
 Provide a description of a patient referred to physical therapy for the treatment of neck pain following trauma. Prior to physical therapy, the patient had cervical spine radiographs that were read as negative for a fracture; however, magnetic resonance imaging revealed that the patient had an underlying odontoid fracture that precluded physical therapy intervention.

**DIAGNOSIS**

**History**

The patient was a 73-year-old retired woman who reported a sudden onset of neck and left upper extremity pain after a fall 15 days prior to her initial physical therapy visit. The patient reported that she tripped over a rug in her home and fell from her standing height of 160 cm. The patient landed by striking her forehead on the floor and bracing herself with her left upper extremity. The patient was seen by her primary care physician 1 day prior to her initial physical therapy visit. The patient’s physician prescribed Lortab for pain, ordered conventional radiographs of her cervical spine (anterior-posterior, lateral, and open-mouth views), and referred her to physical therapy. The radiology report described the presence of C4 to C6 degenerative disc disease and torticollis, and that the C7 vertebra could not be visualized on the lateral view (Figure 2).

The patient complained of a constant diffuse ache that varied in intensity through the cervical region and left upper extremity down to her hand, and intermittent sharp pain in the upper cervical region (Figure 3), with all of her symptoms progressively worsening since her fall. While the symptoms in her cervical region were the worst, the patient reported that her symptom intensity decreased as it moved distally down the left upper extremity. The patient also reported that her cervical and left upper extremity symptoms began immediately after her fall and that her left upper extremity symptoms began the day after her fall. Her cervical and left upper extremity symptoms were aggravated by any neck

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RESIDENT’S CASE PROBLEM

movements and left upper extremity use. All of the patient’s symptoms were temporarily eased with Lortab, as prescribed by her physician, and by resting her left arm on a pillow in her lap while in a sitting position. Since her fall, the patient stated that she had extreme difficulty sleeping and she had not been able to find a comfortable sleeping position. The patient stated that the pain she experienced at night was the worst pain that she experienced over a 24-hour period.

Prior to the episode, the patient had experienced intermittent neck pain for the past several years and was diagnosed with cervical osteoarthritis 5 years earlier. However, this episode of neck pain was the worst that she had ever experienced. Her past medical history was significant for hypertension, osteoporosis, and breast cancer 8 years prior, for which she was successfully treated. She was also previously treated for a right humeral head fracture, sustained after falling on her shoulder 2 years prior. The fall that caused her right humeral head fracture was also the result of tripping on a rug at home. This injury was treated with sling immobilization and physical therapy. The patient denied having difficulty maintaining her balance with walking or other activities of daily living, and she had not seen a physician specifically for her 2 reported falls. She did not report any changes in her weight or bowel and bladder function since the injury and she was not experiencing dizziness or lightheadedness. The medications the patient reported taking were Lopressor for hypertension, Fosamax for osteoporosis, and the Lortab that was recently prescribed by her physician.

Physical Examination

The patient demonstrated a nonantalgic gait without gross balance deficits. But, while walking, her head was tilted slightly to the left and she held her left arm at her side in a position of 90° of elbow flexion, with her right hand supporting her left arm under her left elbow.

The patient stated that her current resting level of pain for the cervical spine was 9 on a scale of 0 to 10, with 0 being no pain and 10 the worst imaginable pain. Active cervical range of motion was assessed after correcting the patient’s resting cervical spine position to neutral for each measurement. Active cervical range of motion, as measured with an inclinometer, was as follows: forward flexion to 22°, extension to 10°, left rotation to 12°, and right rotation to 43°. Cervical lateral flexion was not assessed. All cervical movements were limited by sharp upper cervical pain and caused a significant increase in the patient’s diffuse aching sensation in the mid to lower cervical spine regions and left upper extremity.

Shoulder active range of motion was measured with a standard long-arm goniometer. Her right shoulder active range-of-motion measurements were as follows: flexion to 163°, internal rotation to 68°, and external rotation to 83°. Her left shoulder active range-of-motion measurements were as follows: flexion to 61°, internal rotation to 67°, and external rotation to 33°. And her left shoulder passive range-of-motion measurements were as follows: flexion to 162°, internal rotation to 72°, and external rotation to 74°. The patient’s left shoulder active range-of-motion measurements were limited by increased complaints of diffuse aching in the cervical and left shoulder region and a sharp painful sensation in her upper cervical region. Elbow, wrist, and hand
shoulder pain. It was noted by the physical therapist during midline palpation of the cervical spine. A significant midline palpatory tenderness throughout the cervical and thoracic regions indicated cervical spine fracture.19 Therefore, the decision was made to contact the referring physician to discuss the patient’s history, physical examination, and radiographic findings. The physician requested immediate cervical spine magnetic resonance imaging. The patient was placed in a rigid cervical collar, provided with a transcutaneous electrical nerve stimulation unit for pain control, educated on home safety measures to decrease the risk of falling and other serious pathology. However, upon review of the radiographs by the physical therapist (J.M.C.), it was noted that the radiographic images were generally underexposed, which may not allow for adequate interpretation (FIGURE 2).11

Interpretation of the History, Physical Examination, and Conventional Radiographic Findings
Several components of this patient’s history and physical examination were consistent with a condition for which physical therapy intervention would not be indicated until more definitive cervical spine diagnostic imaging had been completed (TABLE 1); more specifically, the physical therapist was primarily concerned about the possibility of an undetected fracture. The patient was an older woman who had been previously diagnosed with osteoporosis. She reported trauma to her cervical spine region 15 days prior, which continued to cause significant pain in the cervical region and left upper extremity. It has been recommended that there should be concern for serious cervical spine injuries in any older patient who presents with a history of minor trauma or a fall, and that C2 injuries, especially odontoid fractures, should be ruled out in older patients with neck pain after even a minor injury.18 The patient complained that pain was constant in nature and worst at night, which caused significant difficulty sleeping; pain that is constant and worst at night may indicate serious pathology.6,16 The patient also had significantly limited active cervical spine range of motion and significant midline palpatory tenderness throughout the cervical spine, which may indicate cervical spine fracture.18 Therefore, the decision was made to contact the referring physician to discuss the patient’s history, physical examination, and radiographic findings and the possibility of an undetected serious cervical spine injury. The physician requested immediate cervical spine magnetic resonance imaging. The patient was placed in a rigid cervical collar, provided with a transcutaneous electrical nerve stimulation unit for pain control, educated on home safety measures to decrease the risk of falling and
proper postures to minimize pain, and instructed to obtain cervical spine magnetic resonance imaging, as requested by her physician.

**Intervention and Outcome**

Cervical spine magnetic resonance imaging revealed a type II fracture of the odontoid and moderate disc degeneration from C4 to C7, with small spondylotic ridges that did not deform the spinal cord. Odontoid fractures are commonly classified into 3 types, using the classification system devised by Anderson and D’Alonzo: a type I fracture is an oblique fracture in the upper portion of the odontoid; a type II fracture, which is most common, is a fracture occurring at the base of the odontoid as it attaches to the body of C2; a type III fracture occurs when the fracture line extends through the body of the axis.

Based upon the cervical spine magnetic resonance imaging results, the patient was referred to an orthopaedic surgeon. Thirty-four days after her fall, the patient underwent a C1-C2 fusion. At 6 months following her surgery, the patient had pain-free cervical range of motion that was within functional limits and no limitations in her activities of daily living.

**DISCUSSION**

For the patient described in this case, radiographs were taken at the first medical visit after she sustained her fall. Using the radiography clinical decision rule, radiographs would have indeed been indicated based upon a positive response to the first question of the clinical decision rule (ie, aged 65 years or more) (FIGURE 1). Initial radiographic reports were negative for a fracture and the patient was referred to physical therapy. Magnetic resonance imaging, which was completed based upon the findings of the initial physical therapy evaluation, revealed an odontoid fracture that precluded physical therapy intervention. Although the 6-month outcome from this patient was favorable, despite the patient’s odontoid fracture not being detected on initial radiographs, this report demonstrates the importance of screening for underlying cervical spine fractures in patients with neck pain following trauma.

Recently, Mower et al assessed the diagnostic accuracy of cervical spine radiographs in patients following blunt trauma in an effort to categorize the frequencies and types of injuries missed by conventional radiographic screening. They studied 1496 distinct cervical spine injuries in 818 patients. Conventional radiographs revealed 932 injuries but failed to identify 564 injuries. While 128 of those unidentified injuries were not visualized on adequate conventional radiographs, the remaining 436 unidentified injuries occurred in patients in which conventional radiographs were inadequate (eg, impossible to complete adequate radiographic imaging, complete radiographic series not obtained, radiographs technically inadequate, incomplete visualization of cervical anatomy). The patient described in this case is an example of a patient with a history of blunt trauma whose initial radiographs did not allow for adequate interpretation due to general underexposure. Further diagnostic imaging was necessary to accurately identify her cervical spine fracture. We recommend that physical therapists routinely review radiographs with radiologists or other trained physicians, especially in patients with a history of cervical spine trauma. If there is a question regarding radiographic quality that may not allow for adequate interpretation, the radiographs should be repeated or, if warranted, more sophisticated diagnostic imaging should be performed.

Although Mower et al did not describe the clinical characteristics of the patients who had cervical spine injuries that were missed on initial radiographs, Blackmore et al studied the clinical predictors of cervical spine fractures. They determined that cause of injury (a high-speed motor vehicle accident greater than 48 km/h or pedestrian struck by motor vehicle), the patient’s age (greater than 50 years), the presence of a severe head injury (intracranial hematoma, brain parenchymal contusion, skull fracture, or loss of consciousness) or focal neurological deficit (focal neurological deficit that could be in a spinal cord or spinal nerve distribution) are important predictors of cervical spine fractures. Furthermore, Stiell et al described the clinical variables from the history and physical examination seen in patients with cervical spine injuries caused by blunt trauma to the head and neck (TABLE 2). Compared to patients with blunt trauma to the head and neck but without serious cervical spine injuries, patients with cervical spine injuries were older, less likely to be ambulatory at any time after injury, and had significantly higher rates of midline posterior neck pain and numbness and tingling in the extremities. Patients with cervical spine injuries also were generally unable to actively flex or ro-
tate their neck to 45° in either direction. We recommend that the clinical predictors described by Blackmore et al² and the clinical characteristics described by Stiell et al† (TABLE 2) be considered by physical therapists with patients who have a history of cervical spine trauma and no fractures evident on adequate initial screening radiographs. Specifically, these factors can help guide the use of repeat radiography, advanced cervical spine diagnostic imaging recommendations, and medical referral prior to implementing physical therapy interventions.

As noted by Blackmore et al,² focal neurological deficits are important predictors of cervical spine fractures. Although a full neurological examination was not completed with our patient prior to contacting the patient’s physician, it is recommended that physical therapists utilize neurological screening questions in patients with neck pain following trauma (ie, changes in sensation, strength, gait, and bowel and bladder function).³,16 Additionally, physical therapists should perform upper and lower motor neuron testing to include testing of deep tendon reflexes, strength, and sensation, as well as assessment of clonus, Babinski sign, Hoffman sign, balance, and gait.³,16 Because the clinical tests and measures for upper motor neuron disorders generally display low sensitivity, indicating that a negative finding may falsely suggest the absence of a neurological disorder that actually is present, screening should include a thorough patient history and physical examination to counter the low levels of sensitivity.³ Because the clinical tests and measures for upper motor neuron disorders generally display higher levels of specificity, any positive or unclear finding from the neurological examination should prompt medical referral and advanced diagnostic imaging.³

In the patient described in this case, upper extremity manual muscle testing of the C4 (shoulder girdle elevation) and C5 (shoulder abduction) innervated muscle groups revealed a 3/5 grade on the left side and a 4/5 grade on the right side. Muscle weakness has been associated with several different conditions, including neurological disorders.¹⁴ However, because the patient described in this case reported significant cervical spine pain with manual muscle testing bilaterally and left shoulder pain with manual muscle testing on the left side, we believe that this finding of muscle weakness should be interpreted with caution, as it could have been related to pain inhibition rather than a frank neurological deficit or other condition. Nonetheless, this finding of proximal muscle weakness, in addition to the other findings for this patient (TABLE 1), suggested a serious cervical injury that warranted communication with the patient’s physician.

The patient in this case had an odontoid fracture that was presumably caused by a fall from standing height, which involved striking her forehead on the floor. It has been reported that cervical fractures in the elderly are more likely to occur from falls, while cervical fractures in younger patients are more likely to occur from higher energy impact activities, such as high-speed motor vehicle accidents.²⁴ There also is a disproportionate increase in the prevalence of C2 fractures in the elderly, including an 8-fold increase in the prevalence of odontoid fractures in patients greater than 65 years of age compared to younger patients.²² While the reason for the increase in odontoid fractures and the precise mechanism of odontoid fractures in the elderly is not known, it has been hypothesized that it may be due to several factors, including the pattern of mechanical stress placed on the cervical spine in falls commonly seen in the elderly population, the weakening effects of osteopenia on the narrow odontoid, and the pattern of progressive degenerative changes in the cervical spine.¹⁰,²⁴ Nonetheless, it has been recommended that there should be concern for serious cervical spine injuries in any older patient who presents with a history of minor trauma or a fall, and that C2 in-

### TABLE 2

<table>
<thead>
<tr>
<th>Variables</th>
<th>Cervical Spine Injury (n = 151)¹</th>
<th>No Cervical Spine Injury (n = 8773)</th>
<th>χ²²</th>
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</thead>
<tbody>
<tr>
<td>Patient history</td>
<td></td>
<td></td>
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<tr>
<td>Age ≥65 y</td>
<td>22.5</td>
<td>7.0</td>
<td>53.4</td>
</tr>
<tr>
<td>Men</td>
<td>66.9</td>
<td>51.3</td>
<td>14.5</td>
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<tr>
<td>Ambulatory at any time since injury</td>
<td>44.4</td>
<td>68.0</td>
<td>37.8</td>
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<tr>
<td>Midline posterior neck pain</td>
<td>89.7</td>
<td>60.1</td>
<td>49.0</td>
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<tr>
<td>Time to neck pain (mean min)</td>
<td>16</td>
<td>38</td>
<td>NA</td>
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<tr>
<td>Immediate neck pain</td>
<td>79.0</td>
<td>52.9</td>
<td>35.7</td>
</tr>
<tr>
<td>Numbness or tingling in extremities</td>
<td>24.0</td>
<td>9.4</td>
<td>35.9</td>
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<td>Weakness in extremities</td>
<td>8.0</td>
<td>3.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Physical examination</td>
<td></td>
<td></td>
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<tr>
<td>Sitting position during examination</td>
<td>6.0</td>
<td>37.9</td>
<td>70.5</td>
</tr>
<tr>
<td>Sensory deficit in extremities</td>
<td>6.0</td>
<td>1.9</td>
<td>12.2</td>
</tr>
<tr>
<td>Motor deficit in extremities</td>
<td>4.6</td>
<td>1.2</td>
<td>14.6</td>
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<tr>
<td>Neck tenderness (midline)</td>
<td>86.1</td>
<td>57.3</td>
<td>50.6</td>
</tr>
<tr>
<td>Able to actively rotate neck 45°</td>
<td>4.0</td>
<td>56.4</td>
<td>17.01</td>
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<tr>
<td>Able to actively flex neck</td>
<td>1.3</td>
<td>53.8</td>
<td>180.0</td>
</tr>
</tbody>
</table>

Abbreviation: NA, not applicable.

* Adapted from Stiell et al.¹⁹ Values are percentages unless otherwise indicated.
† Cervical spine injury indicates any fracture, dislocation, or ligamentous injury demonstrated by diagnostic imaging.
‡ Significant difference between groups (P<.05) for all variables; higher χ² values indicate a stronger statistical association with the presence of a cervical spine injury.

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Injuries, especially odontoid fractures, must be ruled out in older patients with neck pain after even a minor injury.18 Cervical fractures in older individuals are most likely to occur from falls. Falls in older individuals are commonly multifactorial,17,23 and a complex interaction among different factors (medical, neuromuscular, cognitive, and psychosocial impairments) determines whether a person is at risk for falls.2,23 Evidence suggests that interventions that address multiple risk factors result in a significant reduction in the risk of falling among older individuals.3,20 It is recommended that physical therapists routinely screen patients for fall risk and ensure that relevant impairments and risk factors are addressed through a multidisciplinary approach.

**CONCLUSION**

When evaluating patients with neck pain who have a history of cervical spine trauma, it is important that physical therapists understand the clinical findings associated with cervical spine fractures, as these findings provide guidance for the use of cervical spine diagnostic imaging and medical referral prior to implementing physical therapy interventions. In this patient, a history of a fall, age greater than 65 years, severe neck pain that was worst at night, and significant pain with midline cervical spine palpation led to the suspicion of an undetected fracture, despite a negative initial radiographic report. This suspicion led to the physical therapist contacting the referring physician to suggest the need for additional diagnostic imaging studies that confirmed a fracture of the odontoid.

**REFERENCES**

This article has been cited by:


