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Evidence-Based Practice: Best Imaging Practice in Musculoskeletal Disorders

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ABSTRACT

As musculoskeletal disorders are a common cause of emergency department visits in the United States, it is vital for nurses and nurse practitioners to understand the decision rules for ordering imaging tests when triaging patients with musculoskeletal complaints. Proper knowledge and command of selecting the most appropriate imaging for these frequent emergency department presentations will help reduce costs, decrease ionizing radiation exposure, and increase patient throughput. This article reviews the current evidence-based literature for musculoskeletal imaging in the emergency department and discusses the epidemiology, etiology, management, and prevention of the most common musculoskeletal disorders.

Key Words

Emergency department, Imaging, Musculoskeletal disorders, Nurse practitioners, Nurses

Musculoskeletal disorders, the most common cause of pain and disability in the United States, result in 30 million emergency department (ED) visits annually, a number that is projected to rise.[1,2] Increased ED census levels have led to a national crisis of ED overcrowding, with subsequent excessive wait times and lengthy patient stays.[3] In an effort to increase throughput, advanced nurse practitioners may initiate and interpret diagnostic imaging studies.[4,5] Benefits associated with nurse-initiated imaging orders include increased patient satisfaction, increased ED efficiency, and shorter ED lengths of stay.[4] Studies also demonstrate high concordance in ordering appropriate musculoskeletal imaging studies when comparing protocol-driven nurse-initiated orders with those of physicians.[6]

Limiting unnecessary imaging not only improves patient flow and reduces costs but also increases patient safety by reducing exposure to unnecessary ionizing radiation.[7] Therefore, nurses need to understand decision rules for ordering imaging studies, as well as become familiar with the American College of Radiology Appropriateness criteria to guide decision making when triaging or caring for patients with musculoskeletal complaints.[8] This article reviews the current evidence-based literature for musculoskeletal imaging in the ED and reviews the epidemiology, etiology, management, and prevention of the most common musculoskeletal disorders encountered in the ED. These disorders are categorized into the following: (1) upper extremities, (2) spine, and (3) lower extremities. At the end of the article, we present 3 case studies for an interactive readership experience.

UPPER EXTREMITIES

Wrist Pain

Wrist injuries can range from simple strains to fractures and dislocations. Upon arrival in the ED, acute suspected fractures of the radius and ulna should be evaluated by ordering posteroanterior (PA), lateral, and medial oblique views of the wrist.[9,10] All patients with wrist injuries should be examined for navicular tenderness on palpation. The navicular or scaphoid bone is the most frequently fractured carpal bone. Patients with scaphoid or navicular bone fractures normally describe a history of blunt blow or a fall onto the wrist with subsequent focal pain in the navicular region of the wrist. Any patient with tenderness or appropriate mechanism of injury for a suspected scaphoid fracture should be imaged using the PA ulnar deviation or navicular view in addition to the PA, lateral, and medial oblique views (Figure 1) of the wrist.[11] These fractures can be easily missed on initial radiographic evaluation because of the overlapping anatomy of the wrist. If scaphoid tenderness is present and radiographs are negative for fracture, then the patient should be splinted in

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Figure 1. Oblique view of an acute scaphoid fracture (*arrow*).

a thumb spica splint and an urgent magnetic resonance image (MRI) should be obtained to evaluate for an occult scaphoid fracture. Occult scaphoid fractures can disrupt the tenuous blood supply of the scaphoid, resulting in avascular necrosis (Figure 2), poor healing, and poor functional outcomes. Magnetic Resonance Imaging is the most accurate test with high specificity and sensitivity for both scaphoid fractures and scapholunate instability.[12]

Rotator Cuff Disorders

As one of the most common causes of shoulder pain secondary to upper extremity trauma or repetitive motion, rotator cuff disorders can result in significant disability among laborers, athletes, and older adults.[13] Previous studies have shown that about 10% of athletic injuries involve the shoulder and account for 3.9% of new ED visits[14]; therefore, nurses should understand the appropriate imaging guidelines for shoulder complaints. The best initial imaging study for patients with suspected rotator cuff disorders is a musculoskeletal ultrasound of

Figure 2. Scaphoid collapse from avascular necrosis.

the affected shoulder, though its utility is limited by operator expertise and availability.[15] Ultrasound enables the clinician to assess the tendons while they are in motion and to compare the affected with the unaffected shoulder. Major advantages of ultrasound include low cost and ionizing radiation. However, MRI is the most accurate test for confirming a diagnosis of rotator cuff tear while also evaluating other pertinent structures of the shoulder, such as the biceps tendon and labrum. In the ED setting, routine shoulder radiographs should not be ordered, in a patient with suspected rotator cuff injury, unless the patient has a history of recurrent tendinopathy or is nonresponsive to conservative therapy.[12] Patients should be instructed that the best prevention against rotator cuff disorders is daily exercises to keep the shoulder muscles strong and flexible. The best initial management consists of cryotherapy and nonsteroidal anti-inflammatory drugs (NSAIDs), despite the lack of strong scientific evidence.[16]

Adhesive Capsulitis (Frozen Shoulder)

With a prevalence of about 3% in the general population and 20% diabetics, frozen shoulder is the most common musculoskeletal problem seen in orthopedics.[17] This disorder occurs more commonly in middle-aged adults. Symptoms include unilateral nocturnal pain with impaired range of motion.[18] Patients with diabetes

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having unilateral shoulder pain and stiffness without any underlying cause should be suspected for this disorder. Diagnosis is generally based on the history and physical examination demonstrating limited shoulder range of motion, particularly movements that stretch the capsule (eg, abduction and external rotation).[12] Plain radiographs have limited diagnostic value and should only be used to rule out comorbidities.[19] MR arthrography is useful in challenging cases. For severe symptoms that fail conservative therapy, intra-articular glucocorticoid injections are recommended; however, oral corticosteroids are not beneficial.[20] Intra-articular dilation is another treatment option with similar efficacy to intra-articular glucocorticoid injections.[21]

Shoulder Dislocation

Glenohumeral dislocation, the most frequent type of joint dislocation, is a common reason for ED visits.[22] Anterior dislocations are more common than posterior dislocations, and any patient with a posterior dislocation should be assessed for antecedent seizure or electrocution injury. Shoulder dislocation typically occurs after a high-velocity fall or shoulder stress and is associated with shoulder deformity and severe pain. Patients with a history of dislocated shoulder joints are also at risk for future dislocations because of ligamentous injury, so care must be taken to avoid recurrence. Prevention includes shoulder-strengthening exercises, wearing protective gear while playing sports, and avoiding falls. Evaluation for shoulder dislocation requires and axillary view (Figures 3A and 3B), of the shoulder in addition to the routine anteroposterior (AP) views in the external and internal rotation.[12-23] Except in the case of suspected axillary artery injury, computed tomography (CT) scans are not routinely used as a diagnostic test. Emergency treatment of acute dislocation includes reduction followed by shoulder immobilization.[12]

Clavicular Fractures

These common fractures normally occur as a result of blunt trauma to the shoulder region. The typical presentation includes localized pain and deformity along the clavicle because of hematoma and bony disruption. The preferred imaging study for diagnosing clavicular fractures is an isolated AP view radiograph (Figure 4). When the AP view does not reveal a fracture despite a high clinical suspicion, a 30-degree cephalic view should then be ordered.[24] Because of the associated risk of pneumothorax or neurovascular impingement injuries, the physical assessment should also include chest auscultation and distal extremity neurovascular examination. Treatment of clavicular fractures includes ice application, rest, and NSAIDs.

Acute Epicondylitis (No Trauma)

Medial and lateral epicondylitis, more commonly known as golfer's and tennis elbow, respectively, have a prevalence of about 1% in the general population.[25] Epicondylitis results from inflammation along the flexor and extensor tendons of the elbow joint from repetitive or overuse injury. Patients may also complain of neck and shoulder pain; therefore, a complete upper extremity examination including the cervical spine should be performed.[26] Imaging studies are not indicated initially, and patients should be managed with conservative therapy including counterforce splints and topical or oral NSAIDs. However, if

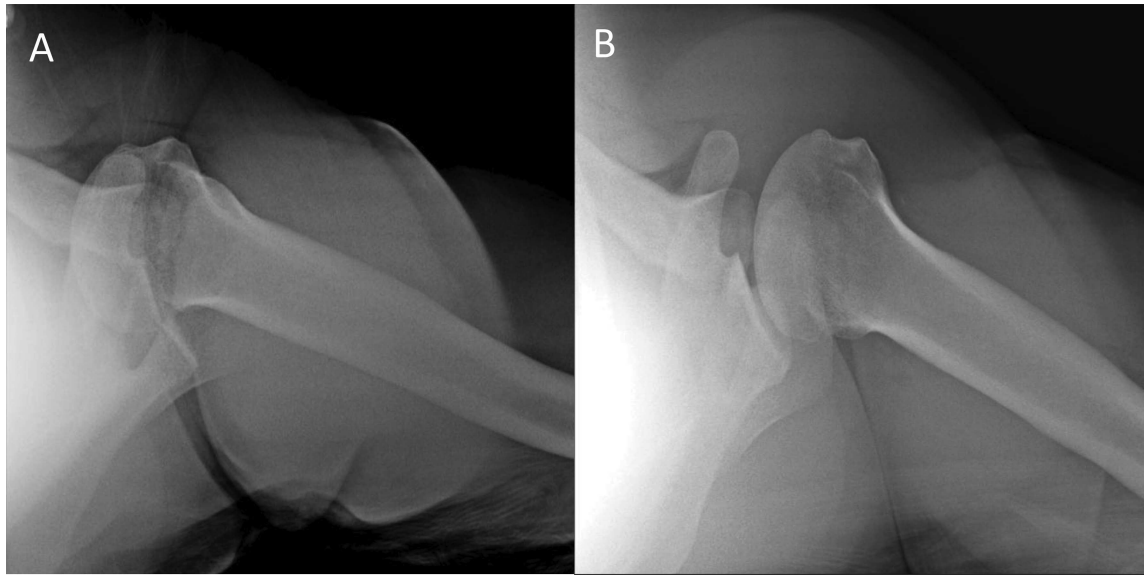

Figure 3. (A) Anterior dislocation (axillary view). (B) Shoulder positioning postreduction.

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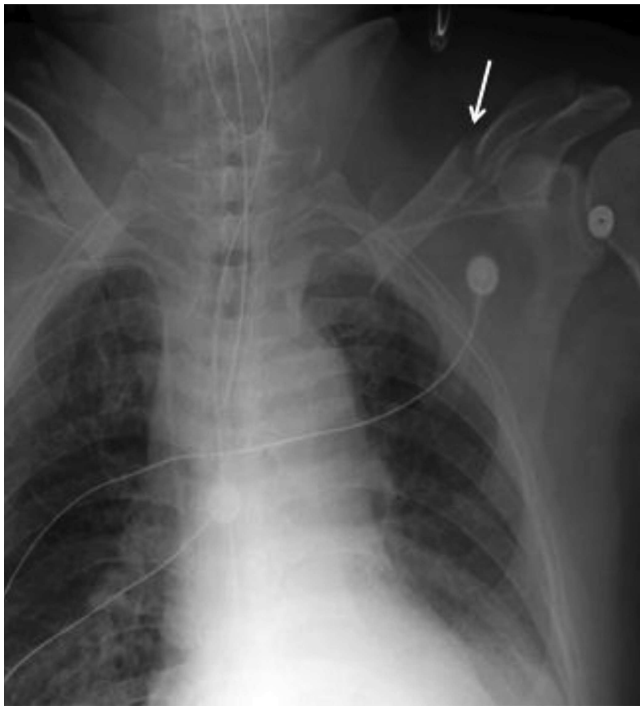

Figure 4. Left comminuted mid/distal clavicular fracture (*arrow*).

symptoms worsen or do not improve with conservative therapy, AP, oblique, and lateral radiographs of the elbow should be performed including AP in full extension, lateral at 90 degrees and medial oblique views. Magnetic resonance imaging and CT are only used to confirm refractory cases, to plan for surgical correction, or to rule out associated tendon or ligamentous tears.[27] Patients should be instructed that the best way to prevent acute epicondylitis is to strengthen the muscles of the forearm and to use sports equipment appropriate for body size and muscle strength.

Elbow Pain After Trauma

Three-view radiographs as described above should be performed for any patient with a history of elbow trauma to reduce poor functional outcomes.[28] Additional views, including lateral stress and axial views, may be ordered to further identify fracture/dislocation or joint effusions. If a visible posterior fat pad is seen, then occult radial head fracture and joint effusion should be suspected. Magnetic resonance imaging can be used to identify any injuries to lateral and medial collateral ligaments.[10,29] Radial head fractures can be treated with a sling, and a double-sugar-tong splint should be used to stabilize fractures of the distal humerus or olecranon.

Forearm Pain After Trauma

Hand and forearm fractures have been reported to account for up to 1.5% of all ED visits in the United States.[30] Suspected Injury to the radius or ulna, which are the most common fractures, should prompt imaging of the forearm. Conventional radiographs including AP and lateral views can identify Colles, Smith, Galeazzi, and Monteggia fractures.[29-31] Emergent reduction is indicated for cases of neurovascular compromise or fracture instability. If reduction must be delayed, then fractures should be immobilized and patients should receive narcotic analgesics.[30] Stable fractures can be treated with a double-sugar-tong splint or a well-molded sugar tong instead of circumferential casting.[32] Proper positioning within the splint should be maintained, and frequent icing along with range of motion exercises for the fingers should be recommended.

Trauma to Hands and Fingers

Radiographic imaging for traumatic hand and finger injuries includes PA, lateral, and pronation-oblique views to identify fractures and possible foreign bodies. For thumb views, an AP view should be ordered.[33,34] Open fractures, especially of the distal phalanx, will require antibiotics, debridement, and thorough inspection for foreign bodies. Focused ultrasound with a high-frequency transducer is recommended for nonmetal or bony foreign bodies such as wood splinters.

SPINAL DISORDERS

Cervical Spine Trauma

Motor vehicle and sporting accidents are major causes of acute neck injuries presenting to the ED.[35] Patients with acute neck trauma should be evaluated according to Advanced Trauma Life Support guidelines. Nurses should anticipate potential airway involvement and prepare accordingly.[36] Using the Canadian Cervical Spine Rule (CCSR), any individual who meets one of the following criteria should undergo emergent spinal imaging: (1) age greater than 65 years, (2) extremity paresthesias, or (3) dangerous mechanisms of injury such as a fall from greater than 3 ft, axial cranial force, road accident at greater than 100 km/hr or accidents from motorized recreational vehicle such as all-terrain vehicles. For patients who do not meet these criteria, screening should include range of motion testing and a thorough spinal and neurological examination before radiographs are excluded.[37] Adult patients meeting one of the CCSR criteria should undergo noncontrast CT of the cervical spine, which is faster and more accurate than plain radiographs for assessing spinal fractures.[38] Plain radiographs should not be ordered after CT spinal evaluation.[39] Wearing seatbelts, protective gear, and modifying the home environment to minimize the risk of falling should be discussed with all patients to reduce the chances or severity of traumatic injuries.

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Thoracolumbar, Lumbar, or Thoracic Spine Blunt Trauma

It is estimated that the incidence of thoracolumbar fractures in patients presenting at major trauma centers ranges from 8% to 15%.[40] Injuries of the thoracolumbar spine can be devastating and are often associated with other major injuries. Therefore, spinal immobilization must be maintained until spinal column or cord injury has been excluded while addressing immediate life-threatening conditions.[41] Under the National Emergency X-Radiography Utilization Study criteria, for patients presenting at the ED after trauma, spinal injury cannot be excluded if any one of the following symptoms is present: subjective back pain, evidence of drug or alcohol intoxication, focal spinal tenderness on palpation, neurological deficits, and altered mental status.[40] AP and lateral radiographic views of lumbar and thoracic spine must be ordered if any one of the above-mentioned symptoms is present. If the radiograph reveals a fracture or is difficult to interpret, a noncontrast CT or MRI should be performed.[42] Moreover, in the presence of neural and complex injuries, advanced imaging such as CT and MRI should also be considered. The most accurate imaging modality is MRI, which provides a detailed evaluation of soft tissue and osseous pathology. It is normally used when conventional radiographs are inconclusive or a more occult injury such as an epidural hematoma is suspected.[43] Thoracolumbar fractures normally occur because of compressive forces, older age, female sex, and osteoporosis being major risk factors. Older adults with a history of minor injury but who are symptomatic are at high risk for traumatic injury and should be imaged. For healthy adults with a history of mild blunt trauma and no evidence of risk factors, such as intoxication, or symptoms, diagnostic imaging is not necessary.[44]

Acute Back Pain

As one of the most common reasons for seeking medical care, acute back pain accounts for 3.2% of all emergency visits in the United States.[45] In 2006, more than 44.4 million patients visited a physician with a complaint of back pain.[46] Back pain is also costly. It is predicted that about $50 billion of the health care cost is expended on the treatment of low back pain.[45,47] Chronic back pain is also associated with psychosocial costs including reduced quality of life and costs to employers because of the loss of productivity. Risk factors for back pain include smoking, obesity, age, sex, race, sedentary work, and low educational level.[45,48] The differential diagnosis for back pain is diverse. Radiographs are usually not recommended when patients present with nontraumatic acute back pain without neurological deficits or indicators of serious injury because the overuse of imaging is associated with increased back pain costs of care.[49]

Radiographs are also not indicated for back pain associated with sciatica, sharp leg pain associated with extremity paresthesias, because acute sciatica typically resolves after conservative treatment with analgesics and NSAIDs.[50] Sciatica can result from lumbar disc herniation (LDH), spinal stenosis, and degenerative spondylothesis. Lumbar disc herniation that causes sciatica typically involves L4-L5 and L5-S1 nerve roots. Physical examination of the patient with suspected LDH includes level-specific neurologic testing including patellar and ankle reflexes, strength testing including toe and heel walking, and straight-leg raising. Although the straight-leg raise test is sensitive for LDH, it is not specific. Middle-aged, obese male smokers who perform repetitive heavy lifting are particularly susceptible to LDH.[51,52] Patients presenting with neurological deficits, extreme pain despite conservative care, or lack of resolution of symptoms after 6 weeks of usual care should be referred for an MRI to visualize the intervertebral discs.[51,52] Lumbar disc herniation cannot be identified with conventional radiographs. Treatment for LDH includes physical therapy, gradual return to work, and conservative treatment. Clinical practice guidelines for the management of acute back pain guide treatment and reduce costs of care and unnecessary imaging.[49] Patients who do not improve with conservative care should be referred for multidisciplinary rehabilitation or for possible surgical intervention.[53] Patients with back pain should be counseled that the single best way to prevent LDH is to maintain a normal body mass index, exercise regularly, maintain good posture, and stop smoking.

Cauda Equina Syndrome

Although generally rare with only 2 to 4 cases per 10 000 patients, cauda equina syndrome (CES) is an emergent condition that, if untreated, can lead to permanent spinal disability.[54] Symptoms associated with CES include severe back pain, saddle anesthesia, incontinence of bowel/bladder, and sexual dysfunction. Tumors, trauma, inflammatory conditions, and spinal stenosis in the region of L4-S4 can all trigger CES. Although there is no particular set of risk factors, it is believed that individuals who are at risk of LDH are the most susceptible.[55,56] Clinical diagnosis of CES can yield false positives; therefore, confirmatory MRI in patients suspected of CES is indicated.[57] Treatment for confirmed cases requires urgent spinal decompression to prevent poor functional outcomes and disability.[58]

Musculoskeletal Chest Wall Pain

Chest pain is the second most common reason for visits to the ED, and chest pain of musculoskeletal origin results in a significant number of ED visits.[59] The most common causes of musculoskeletal chest wall pain are costochondritis and lower rib pain syndromes. Although radiographs are not indicated to diagnose costochondritis

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and lower rib pain syndromes, they are indicated to evaluate for serious causes of chest pain such as pneumothorax or pericardial effusion. Treatment for musculoskeletal chest pain includes NSAIDs and rest.[60,61]

Rib Fractures

It has been reported that up to 66% of blunt chest wall trauma results in rib fractures.[62] Although rib fractures are rarely life threatening, imaging can help to detect or exclude more serious pathological injuries, such as pneumothorax, flail chest, or pulmonary contusion.[63] AP and lateral chest radiographs are considered the best initial imaging test to diagnose lung injuries associated with rib trauma, although these images can miss up to 50% of fractures.[63] CT scan is the most accurate (both high sensitivity and specificity) imaging test in assessing rib fractures but is not routinely performed because of cost and radiation exposure.[64] Treatment is usually limited to pain management as ribs normally heal after a few weeks. In patients with persistent focal rib/chest pain, a bone scan of the chest (high sensitivity but low specificity) can be useful in detecting occult rib fractures that may be missed on CT.[65]

LOWER EXTREMITY

Femoral Neck Fractures

Hip fractures account for 316 000 inpatient hospitalizations annually in the United States, with aggregated costs estimated at $4.9 billion.[66] Hip fractures are associated with significant disability and rates are anticipated to increase along with a growing aging population.[67] Risk factors for hip fractures include older age, osteoporosis, sedentary lifestyle, diabetes mellitus, early menopause, high intake of phosphorus, metabolic bone diseases, bisphosphonate therapy, and metastatic cancer.[68] Hip fractures are most common in older adults after a ground-level fall. Physical examination findings typically include localized hip pain, extreme difficulty in walking, and external rotation, and leg shortening of the affected extremity.[69] Hip radiographs including AP and (surgical) lateral views should be urgently ordered (Figure 5). Because 20% of hip fractures can be fatal,[70] advanced imaging such as MRI should be ordered for patients with negative radiographs but high clinical suspicion. CT scans should only be considered if MRI is not readily available as MRI has a greater sensitivity.[71,72] Definitive treatment for hip fractures requires orthopedic surgery. Preventing hip fractures by reducing hazards within the home such as installing nongrip rugs and eliminating extension cords in walkways to prevent falls are important modifications.[73] Menopausal women should be counseled to obtain bone density/osteoporosis screening and to maintain an adequate dietary intake of calcium and vitamin D.[74]

Figure 5. Subcapital fracture—sclerotic line suggests impaction (*arrow*).

Septic Arthritis

Risk factors for septic arthritis include prosthetic joints, skin infection, human immunodeficiency virus type 1 infection, age greater than 80 years, diabetes mellitus, intravenous drug abuse, and rheumatoid arthritis.[75] Septic arthritis results when organisms are introduced and spread hematogenously to extremity joints.[76] Patients typically present with sudden onset of severe joint pain associated with movement, fever, and malaise. If untreated, septic arthritis can be life threatening in 5% of the cases.[77] Definitive diagnosis of septic arthritis includes synovial fluid aspiration and analysis. Treatment is based on culture and sensitivity of the joint aspirate. Although radiographs are neither sensitive nor specific, they should be ordered to develop a baseline and to rule out osteomyelitis. Magnetic resonance imaging has a specificity of 98% to detect joint effusions and inflammation.[78] Patients who receive joint surgeries should be counseled to follow up for symptoms of systemic infection.

Knee Pain

As the largest joint in the body in terms of volume and surface area of cartilage, the knee joint is extremely susceptible to injury, repetitive stress, and arthritis.[79] It is reported that 1.3 million ED visits occur annually in the United States for knee pain at an annual cost of $1 billion.[80,81] The Ottawa knee rule criteria, along with a history and physical examination, should

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be followed to reduce unnecessary imaging. According to the Ottawa knee rules, AP and lateral radiographs of the knee should be obtained on the basis of the following findings[82,83]:

1. Isolated tenderness of patella or at the head of fibula
2. Age 55 years or more
3. Inability to flex the knee to 90 degrees
4. Inability to bear weight for 4 steps

Patients who meet none of the aforementioned criteria do not require imaging, but should be advised to return for follow-up if their pain does not improve within 7 days.[77] If radiographs are negative for fracture or dislocation and the patient has persistent symptoms suspicious for soft tissue trauma or occult fracture, an MRI should be ordered to evaluate for ligamentous, cartilaginous, and meniscal injuries, which cannot be seen on plain radiographs. Meniscal injuries commonly occur during joint twisting while weight bearing, and patients may report joint locking when walking. Patients presenting with ligamentous injuries, such as anterior cruciate ligament, may report a history of a direct blow to the knee followed by swelling and joint instability.[84,85]

Ankle Sprain

It is estimated that more than 23 000 people per day are treated for ankle sprains in the United States, making them one of the most common musculoskeletal injuries.[86] Athletes performing excessive side-to-side motion are the most vulnerable. Patients normally present to the ED after inversion or eversion stress complaining of swelling, decreased mobility, and throbbing pain exacerbated by weight bearing. To reduce unnecessary imaging, evaluate the patients using Ottawa ankle rules (which have 100% sensitivity for ankle or mid foot fractures).[87] According to Ottawa ankle rules, patients meeting the following criteria should receive AP, 20-degree medial oblique, and lateral ankle radiographs:

1. Inability to bear weight immediately after the injury and in the ED for 4 steps
2. Point tenderness along the distal 6 cm of the posterior margin of tibia or at the fibula

Point tenderness at the base of the fifth metatarsal or at the navicular tarsal bone along with the inability to bear weight warrants an AP, 20-degree medial oblique, and lateral foot radiograph. Advanced imaging, such as MRI or CT, should only be considered in patients with negative radiographs of the foot or ankle with functional disability and in patients with a history of recurrent ankle sprains. Magnetic resonance imaging is the most accurate test for detecting tears of ankle ligaments.[77] Any patient with difficulty walking, heel pain, and loss of dorsiflexion should be evaluated for acute Achilles tendon rupture. Conservative treatment of ankle sprains includes rest, ice, compression, elevation, and NSAIDs for pain and swelling. Patients with Achilles rupture and tears may require surgical intervention. Athletes with a history of recurring ankle sprains require prophylactic ankle support and physical therapy for proprioceptive retraining.[88]

CASE STUDIES

Study 1

A 25-year- old generally healthy male construction worker presents to the ED with complaints of shoulder pain for the past 2 weeks. He denies any significant medical history or acute shoulder trauma. What will be the most appropriate imaging test?

A. Radiography of the shoulder
B. Computed tomography of the shoulder
C. Magnetic resonance imaging of the shoulder
D. No imaging needed

Considering he is a laborer, rotator cuff disorder because of repetitive motion is the most likely cause of his shoulder pain. The best initial management includes NSAIDs and conservative therapy including rest, ice, and heat applications. Hence, the correct choice is D. Radiographs should be ordered only if there is a history of trauma, recurrent shoulder pain, or no response to conservative therapy.

Study 2

A 45-year-old man presents to the ED complaining of knee pain after tripping and twisting his leg. There is no focal tenderness or effusion on examination. He is able to walk and has full range of motion of the knee joint. What type of imaging study is indicated in this case?

A. Radiographs of the knee
B. Ultrasound of the knee
C. Computed tomography of the knee
D. Magnetic resonance imaging of the knee
E. No imaging needed

According to the Ottawa knee rule, the patient does not need knee radiographs; hence, the correct choice is E. If the patient meets the criteria for imaging according to the Ottawa rules, knee radiographs are the best initial test. CT scans are indicated in the presences of negative radiographs but persistent clinical signs. Magnetic resonance imaging is indicated for suspected cases of meniscal or ligamentous injury.

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Study 3

A 67-year-old man presents to the ED complaining of neck pain after a high-speed motor vehicle accident. There is point tenderness over the C4 spinous process on examination. What will be the most appropriate imaging test to exclude a cervical spine fracture?

A. X-ray of the cervical spine—lateral view only
B. X-ray of the cervical spine—AP, lateral, and open-mouth views
C. Computed tomography of the cervical spine
D. Magnetic resonance imaging of the cervical spine
E. No ideal imaging examination
F. No imaging needed

The correct answer is C. When a patient presents with cervical spine trauma, the CCSR should be used as a criterion to determine whether imaging is needed. The CCSR specifies that any individual who is older than 65 years or has undergone dangerous injury should be scanned. Although radiographs might be appropriate, the better answer will be CT of the cervical spine especially in cases of suspected fractures as CT is more accurate.

CONCLUSIONS

As nurses are increasingly responsible for ordering diagnostic imaging studies, it is important to understand radiologic modalities, imaging appropriateness criteria, and radiological decision rules. This article has presented the most common musculoskeletal disorders seen in the ED, along with a discussion of what the most appropriate imaging studies are and why. Proper knowledge and command of selecting the most appropriate imaging for the frequent presentations in the ED will help reduce costs, decrease ionizing radiation exposure, and increase patient throughput without compromising the quality of care. Nurses and nurse practitioners play an increasingly vital role in achieving these outcomes.

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