**Supplemental Table 1.** Case reports of shoulder injury related to vaccine administration

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Study | Number of patients | Age, gender | BMIa | Vaccine | Injection site | Country | Reporter | Onset | Symptoms | Imaging | Diagnosis | Management and outcome |
| Bodor et al.[5] | 2 | 71, oman | NR | PPV | High into right deltoid | USA | Physical medicine and rehabilitation physician | Within 2 days | Shoulder pain and difficulty moving arm | None | Adhesive capsulitis | NSAIDs, PT, steroid injection to subacromial space, glenohumeral joint, and bicipital tendon sheath; complete resolution by <6 months maintained at 1 year  |
|  |  | 89,Man | NR | Influenza | High into right deltoid | Shoulder pain and loss of ROM within 2 days, forearm numbness in 2 months | Severe shoulder pain and loss of ROM, forearm numbness | Radiographs: mild degenerative changes | Bicipital tendonitis, subacromial bursitis, and a mild C6 sensory radiculopathy  | NSAIDS, acetaminophen, PT, separate steroid injections into the subacromial space, bicipital groove, and glenohumeral joint; complete resolution by <6 months |
| McColgan and Borschke [32] | 1 | 73, woman | NR | PPV | Quite proximal on the arm and over the glenohumeral joint  | USA | Emergency medicine physician | 2 hours | Acute shoulder pain, swelling, and decreased ROM | None | Pseudoseptic arthritis with rotator cuff tear | Antibiotics, incision and drainage of deltoid region, arthroscopy: chronic rotator cuff tear and a proximal biceps tendon rupture of undetermined age; limited mobility of arm at 2 weeks |
| Shafer and Burroughs [39] | 1 | 25, woman | NR | Influenza | NR | USA | Primary care and sports medicine physician | Immediate | Moderate shoulder pain, inability to lift arm beyond shoulder height without severe pain | Radiographs: normal findingsMRI: localized non-specific humeral edema of the greater tuberosity | Periosteal reaction secondary to influenza vaccination  | Meloxicam and tramadol; mild pain at 5 months |
| Kuether et al. [27] | 1 | 48, woman | NR | Influenza | Anterolateral portion of the deltoid muscle  | Germany | Rehabilitation medicine physician | 2.5 hours | Painful local swelling with redness and hardening of the skin and deeper tissue layers at the injection site, continuous shoulder pain at rest and with activity | MRI: pronounced osteonecrosis of the humeral head with beginning bone collapse; minor effusions in the bursa subacromialis and bursa subdeltoid | Atraumatic osteonecrosis of the humeral head | NSAIDs, acetaminophen, steroid injections, opioids (Tramadol and Valoron), bisphosphonates, PT; at 12 months, some pain after strong exertion in arms, improved ROM, MRI showed slight reduction of the necrosis area with signs of regeneration in the necrotic region |
| Barnes et al. [3] | 1 | 22, woman | NR | Influenza | Three fingerbreadths inferior to edge of acromion | USA | Family medicine physician | Within 2 hours | Acute shoulder pain with limited ROM | MRI and US: partial supraspinatus tear, humeral head cortical irregularity with underlying contusion, subacromial bursa effusion | NR | PT; complete resolution at 16 months  |
| Degreef and Debeer [14] | 3 | 36, woman | NR | Hepatitis A | NR | Belgium | Orthopaedic surgeon | Several days | Painful loss of mobility in shoulder | Radiographs: unremarkableUS: unremarkable | Adhesive capsulitis | Distention arthrography, PT; at 3 months, good pain relief and improved shoulder ROM |
|  |  | 54, man | NR | Influenza | Deltoid muscle | NR | Progressively increasing shoulder pain | Radiographs: unremarkableUS: subacromial bursitis | Adhesive capsulitis | Immediate pain relief and improved mobility with distension arthrography, PT; at 3 months, pain free and mobility almost normal |
|  |  | 73, woman | NR | Tetanus | NR | NR | Sudden onset of severe shoulder pain | Radiographs and US: some minor calcifications around the great tubercle | Adhesive capsulitis | Distension arthrography and PT for 4 weeks; regained full ROM and pain relief |
| Floyd et al. [17] | 1 | 59, woman | NR | PPV | Deltoid | USA | Orthopaedic surgeon | 2 hours | Severe pain and decreased mobility of shoulder, swelling and redness of the soft tissue overlying the anterior aspect of the shoulder | MRI: full-thickness tear of the anterior supraspinatus tendon with 1.2-cm proximal retraction, fluid in the subacromial and subdeltoid bursa, and a small amount of subcutaneous edema | Pseudoseptic arthritis with rotator cuff tear | Arthroscopic irrigation and debridement, antibiotics, PT; at 12 weeks, ROM of affected shoulder nearly equal to that of contralateral shoulderArthroscopy: substantial inflammation throughout the shoulder, small partial-thickness tear involving the anterior aspect of the rotator cuff |
| Messerschmitt et al. [33] | 1 | 46, man | NR | Influenza | Deltoid muscle in a lateral and proximal position, approximately 2 cm distal to the lateral aspect of the acromion  | USA | Orthopaedic surgeon | A few days | Progressively worsening anterior shoulder pain exacerbated with overhead activities | Radiograohs: small lytic area involving the greater tuberosity of the humeral head and surgical changes relating to Bankart repairMRI: abnormal uptake and cystic changes involving the greater tuberosity of the humeral headBone scan: isolated increased signal intensity involving the lateral aspect of the humeral head | Chrondrolysis and osteolysis of the proximal humerus  | NSAIDS, OT, arthroscopic irrigation and debridement, open biopsy, proximal humerus resurfacing, biceps tenodesis, PT; at >3 years postoperatively, pain-free ROM of shoulder, excellent alignment, and return to all activitiesArthroscopy: hyperemic joint capsule and extensive chondrolysis involving approximately 50% of the articular surface of the humeral head with a central, full- thickness defect, hyperemia of the exposed subchondral bone, minimal chondral fraying of the glenoid, hyperemic biceps tendon consistent with tenosynovitis |
| Uchida et al. [47] | 1 | 45, woman | NR | HPV | Superior portion of deltoid muscle, in proximity to the acromion | Japan | Orthopaedic surgeon | 3 hours | Intense pain throughout the arm | MRI: high-intensity area at the subacromial bursa suggestive of acute subacromial bursitis | Subacromial bursitis | Corticosteroid injections, PT, arthroscopic synovectomy and subacromial decompression; 1 year later, no pain and complete ROMArthroscopy: adhesive and inflammatory tissue at subacromial bursa, several small particles at alleged site of injection |
| Cook [12] | 1 | 76, man | NR | Influenza | Too high, roughly 3 cm below midacromion | Australia | General practitioner | Immediate | Severe pain and loss of movement in upper arm | US: subacromial bursitis | Subacromial and /subdeltoid bursitis  | Subacromial steroid injection; complete resolution at 1 month  |
| Okur et al.[36] | 4 | 66, woman | 25.7 | Influenza | NR | United States | Radiologist | Immediate | Arm pain exacerbated by motion, cool, numb, heavy sensation in hand with radiation down the arm, neck, and scapular region | MRI: fluid within subacromial and subdeltoid bursa, undersurface tears in the posterior margin of supraspinatus and anterior margin of infraspinatus tendons | NR | No medical or surgical intervention; normal musculoskeletal exam at 2.5 years' followup |
|  |  | 59, woman | 37.2 | Influenza | NR | NR | Worsening left upper arm and neck pain  | MRI: minimal increased T2-weighted signal in deltoid muscle and subcutaneous fat tissue, which might suggest focal inflammatory changes | NR | NSAIDS; complete resolution at 33 days |
|  |  | 39, man | 25.7 | Influenza | NR | NR | Prolonged, increasing shoulder pain  | MRI: Focal subcortical bone marrow edema-like signal within the greater tuberosity without associated obvious cortical destruction; periosseous soft tissue inflammatory changes and small subacromial or subdeltoid bursal fluid | NR | NSAIDs; complete resolution at 5.5 months |
|  |  | 36, man | 22 | Influenza | NR | NR | Severe pain localized to the injection site  | MRI: Subcortical bone marrow edema involving the greater tuberosity without associated cortical destruction, periosseous inflammatory changes, and small fluid within the subdeltoid bursa | NR | NSAIDs; complete resolution of symptoms at 2 months, normal clinical exam at 2 years |
| Hexter et al. [21] | 1 | 50, woman | NR | Influenza | Too high in deltoid muscle | United Kingdom | Orthopaedic surgeon | Immediate | Severe pain in shoulder radiating to arm | Radiography: no bone or joint abnormalityMRI: considerable subacromial and subdeltoid bursitis, with a significant amount of fluid in the subacromial space, supraspinatus tendinopathy with intrasubstance tearing, focal bone marrow edema-like signal changes within the humeral head | Glenohumeral synovitis | Arthroscopic arthrolysis of the contracted ligaments and joint washout, subacromial decompression with bursectomy and anterior third acromioplasty with steroid and local anesthetic injections at end of procedure, arthroscopy: thickening of the middle glenohumeral and coracohumeral ligaments, a partial-thickness tear of the supraspinatus and extensive synovitis throughout the glenohumeral joint; complete pain resolution and restoration of ROM at 6 weeks |
| Saleh et al. [37] | 3 | 67, man | NR | PPV | Lateral deltoid region | United States | Orthopaedic surgeon | Next day | Severe arm pain with markedly decreased ROM, decreased ability to perform overhead activities, sense of weakness in arm | MRI: mild acromioclavicular joint arthropathy and rotator cuff tendinopathyRadiographs: some degenerative changes of the acromioclavicular and glenohumeral joints | Adhesive capsulitis | Steroid injections, PT, NSAIDs; regained full ROM after 50 days, no limitation 20 months post-injection |
|  |  | 30, man | NR | Influenza | NR | NR | Sharp pain in the posterior subacromial region whenever he brought his arm up behind his head and tried to relax his elbow back, decreased ROM | Radiographs: Type II acromion with no joint abnormalities | Adhesive capsulitis | NSAIDs, PT; at NR follow-up, no limitations with activities of daily living except for very low grade pain with activity |
|  |  | 69, woman | NR | Influenza | NR | Same day | Shoulder pain, swelling, and stiffness | Radiographs: well-preserved glenohumeral joint with mild degenerative changes | Adhesive capsulitis | NSAIDs, PT; outcome NR |
| Salmon et al. [38] | 1 | 26, woman | NR | dT-IPV | 2 cm distal to lateral aspect of acromion | France | Orthopaedic surgeon | Immediate | Shoulder pain | MRI and US: glenohumeral effusion; subacromial-subdeltoid, subscapular, axillary recess bursitis; humeral head cortical edema with subsequent erosion | Bone erosion and subacromial bursitis  | NSAIDS, corticosteroid injection; favorable outcome at 5 months |
| Cross et al. [13] | 2 | 82, woman | NR | PPV | 1 cm inferior to acromion | Australia | Internist | 2 hours | Severe shoulder pain and reduced ROM | US: complete supraspinatus tear, subdeltoid fluid collection | NR | Subacromial aspiration, glenohumeral washout and IV antibiotics; complete resolution at 1 month |
|  |  | 23, woman | NR | Tdap | NR | 24 hours | Severe shoulder pain and reduced ROM | US: subacromial bursitis | NR | NSAIDs and subacromial steroid injection; complete resolution by 3 months  |
| DeRogatis et al. [15] | 1 | 90, woman | 21.9 | PPSV23 | NR | United States | Orthopaedic surgeon | Within 24 hours | Shoulder pain, inability to move arm, decreased appetite, decreased ambulation, generalized weakness | US: hypoechoic fluid collection anterior to the proximal humerus, measuring 2.2 × 0.6 × 1.8 cm, with peripheral vascularity, suggestive of abscess, hematoma, or encapsulated complex joint fluidMRI: large shoulder joint effusion with a large component anterior to the shoulder joint Operative cultures: MRSA | Septic shoulder joint | Irrigation and debridement (purulent material and fibrinous tissue found in shoulder joint), antibiotics; at 3 months, in good spirits, good appetite, walking with a cane, no pain with active shoulder elevation or external rotation |
| Erickson et al. [16] | 1 | 51, woman | NR | Influenza | Distal and slightly anterior to the posterolateral border of the acromion | United States | Orthopaedic surgeon | 1 day | Anterior and lateral shoulder pain, pain with shoulder flexion and abduction, and night pain | MRI: partial-thickness rotator cuff tear, proximal humerus lytic lesion | Humeral head lytic lesion | NSAIDs, PT, US-guided intraarticular corticosteroid injections, shoulder arthroscopy with bone and soft-tissue biopsy and debridement; complete resolution at 1 year |
| Jotwani and Narducci [26] | 1 | 61, woman | NR | Influenza | Proximal-most aspect of lateral right upper arm  | United States | Orthopaedic surgeon | NR | Shoulder pain worse with abduction, forward flexion, and reaching movements  | Radiogrphs: unremarkable | Rotator cuff tendinitis secondary to an immune response to an influenza vaccination that infiltrated the supraspinatus tendon  | NR |
| Shahbaz et al. [40] | 1 | 35, woman | NR | Influenza | Too high | United States | Occupational and environmental medicine physician | Immediate | Pressure and intense pain in anterior aspect of shoulder, stiffness | MRI: glenohumeral joint effusion and synovitis, glenohumeral effusion, infraspinatus tendinitis, reactive bone marrow edema | NR | NSAIDs, lidocaine patch, PT; incomplete resolution at 8 months |
| Szari et al.[45] | 1 | 31, man | NR | Influenza | > 3 cm below top of shoulder | United States | Allergist | Immediate | Intense shoulder pain and decreased ROM | MRI: small partial-thickness tear of the supraspinatus, possible calcific tendinopathy of the distal teres minor, underlying humeral head edema | NR | NSAIDS, corticosteroid injection; incomplete resolution at 6 months  |
| Wright et al. [51] | 1 | 72, woman | NR | Influenza | NR | United States | Radiologist | Immediate | Upper arm pain extending from the injection site to the mid upper arm, shoulder pain, decreased ROM | MRI and US: subacromial bursitis, small partial-thickness, intra-substance tear noted in subscapularis tendon, small articular-sided partial-thickness tear of infraspinatus footprint, bicipital tenosynovitis | Subacromial and subdeltoid bursitis  | NSAIDs, subacromial steroid injection; near complete resolution by 3 months  |
| Jenkins et al. [25] | 1 | 61, woman | NR | Influenza | NR | United States | Internist | Immediate | Shoulder pain | MRI: subdeltoid bursitis | Subdeltoid bursitis | Oral prednisone, PT; complete resolution by 6 months |
| Macomb et al. [30] | 2 | 69, woman | NR | PPV | NR | United States | Allergist | 1 day | Shoulder pain, difficulty raising arm | None | NR | NSAIDs, PT, and subdeltoid steroid injection; complete resolution by 1 month |
|  |  | 84, man | NR | Zoster | NR | 12 hours | Shoulder pain and stiffness | None | NR | Acetaminophen, PT, and subacromial steroid injection; complete resolution by 1 month  |
| Natanzi et al. [35] | 2 | 38, woman | NR | Influenza | NR | United States | Physical medicine and rehabilitation surgeon | Immediate | Shoulder pain | MRI: edema at underlying teres minor insertion and underlying humerus | NR | NR |
|  |  | 42, woman | NR | Influenza | Perhaps higher than patient was accustomed to in the past | Immediate | Shoulder pain | MRI: edema at underlying teres minor insertion and underlying humerus | NR | NR |
| Smith et al. [43] | 1  | 15, girl | NR (weight: 54.9 kg) | HPV | NR | United States | Pharmacist | Seconds | Pain in arm and tingling in fingers | MRI (Day 12): focal edema involving the deltoid muscle, fluid and edema tracking along the posterolateral aspect of the proximal humeral diaphysis with mild associated periostitis MRI (Day 21): osteomyelitis of the left proximal humeral diametaphysis with associated periosteal elevation, adjacent suppurative phlegmon formation, and myofasciitis involving the deltoid and triceps musculature Radiography (Day 21): periosteal new bone formation along the posterolateral left proximal humeral metadiphysis, with adjacent stippled density probably reflecting heterotrophic bone formation in the setting of prior soft tissue traumaBone biopsy: findings suggestive of acute osteomyelitis with a low degree of acute inflammation Cultures: negative for growth  | Osteomyelitis with proximal humerus abscess | Glenohumeral joint steroid injection, prednisone, gabapentin, incision and drainage of abscess with bone biopsy and wound cultures, antibiotics, PT; improved arm pain, range of motion, and full recovery of function at several months |
| Thompson and Ensrud [46] | 1 | 64, man | NR  | Influenza | High up on the left shoulder | United States | Physiatrist/neurologist | A few days | Left shoulder soreness followed by right shoulder soreness a couple days later; bilateral shoulder pain with active ROM  | Radiographs: unremarkableMRI: bilateral thickening and edema of the inferior glenohumeral ligaments with loss of fat in the rotator interval | Adhesive capsulitis | PT, fluoroscopic-guided glenohumeral corticosteroid injections; marked improvements in shoulder ROM and strength at 3 months |
| Veera et al. [48] | 1 | 58, woman | NR | Influenza | 2 inches below deltoid insertion | United States | Primary care physician | Within 24 hours | Shoulder pain, hand paresthesia, decreased shoulder ROM | MRI: mild rotator cuff tendinopathy with a partial thickness rotator cuff tear, moderate bicipital tenosynovitis, and glenohumeral joint effusion | Cervical spine strain and shoulder tendonitis | PT, subacromial steroid injections, NSAIDs, oral methylprednisilone dose pack, acupuncture, osteopathic manipulation, MUA; resolution of pain and near normal ROM at 4 months |
| Batra and Page [4] | 5 | 36, woman | 24 | Influenza | Higher than normal in the arm | United States | Occupational and environmental medicine physician | Within hours | Pain at rest and difficulty moving arm because of pain and stiffness with movement | None | NR | Medrol Dosepak, NSAIDs; all complaints resolved at 2 weeks |
|  |  | 29, woman | 23 | Influenza | NR | Immediate | Shoulder pain and restricted ROM | None | NR | NSAIDs, Medrol Dosepak, PT; no complaints at 3 weeks |
|  |  | 38, woman | 21 | Influenza | High in the shoulder | Immediate | Increasing pain and limited ROM with abduction or flexion above shoulder height | None | NR | Medrol Dosepak, PT; at 3 weeks, released to full duty without permanent impairment or disability |
|  |  | 34, woman | 25 | Influenza | High in the shoulder, < 1 inch from the acromion | Immediate | Shoulder pain | None | NR | Steroid injection, PT; no complaints after 4 weeks |
|  |  | 32, woman | 23 | Influenza | NR | Within 48 hours | Severe shoulder pain and limited ROM | None | NR | Medrol Dosepak, PT; no further complaints at 3 weeks |
| Boonsri and Chuaychoosakoon [6] | 1 | 51, woman | NR | Oxford-AstraZeneca coronavirus-19 | One finger breadth below the midlateral border of the acromial process | Thailand  | Orthopaedic surgeon | 3 hours | Shoulder pain and limited ROM | Radiographs: soft tissue swelling without fractureUS: subacromial-subdeltoid bursitis with synovial wall thickening, internal septa with small full-thickness tear at the posterior fiber of supraspinatus  | Combined subacromial-subdeltoid bursitis and supraspinatus tear | NSAIDs; gradual improvement of clinical symptoms over next few days |
| Cantarelli et al. [8] | 1  | 61, woman | NR | Oxford-AstraZeneca coronavirus-19 | Two finger breadths of the lateral border of the acromion,  | Brazil | Radiologist | 30 minutes | Shoulder pain, swelling, decreased ROM | Radiogrphs: soft tissue density of fat pad adjacent to the subacromial-subdeltoid bursa MRI: lateral to medial extension of fluid in the subacromial-subdeltoid bursa with synovial hypertrophyUS: hypoechoic fluid accumulation within the subacromial-subdeltoid bursa > 3.0 mm; thickening of bursal walls | Subacromial-subdeltoid bursitis and rotator cuff tendinopathy  | Oral prednisone, vitamin D supplementation, and PT; outcome NR |
| Chuaychoosakoon et al. [10] | 1  | 52, man | NR | Sinovac coronavirus-19 | Three finger breadths below the midlateral edge of the acromial process | Thailand | Orthopaedic surgery | 3 days | Shoulder pain, limited ROM, fever, swelling | Radiographs: degenerative change US: subacromial-subcoracoid-subdeltoid bursitis Shoulder aspirate: 45,500 WBCs, 99% PMNs, no growth in gram stain or culture | Subacromial-subcoracoid-subdeltoid bursitis | IV cefazolin for 3 days then oral cefalexin for 7 days; afebrile after 1 day; could slowly increase movement in his shoulder and tolerate passive motion of his right shoulder after 3 days  |
| Littrell et al. [29] | 1 | 51, man | 21 | Influenza | 1 cm distal to the lateral edge of the acromion | United States | Radiologist | Within 2 hours | Shoulder pain and stiffness with decreased internal and external rotation | MRI: progressive erosive changes of the greater tuberosity, rotator cuff injury, and extensive enhancing synovitis of the glenohumeral joint and subacromial/subdeltoid bursa | Adhesive capsulitis related to vaccine administration | Ice, NSAIDs, PT, and US-guided glenohumeral joint corticosteroid injection; improved pain and near full range of motion at 1.5 years  |
| Waninger and Slenker [49] | 1 | 46, woman | 32.5 | Influenza | NR | United States | Orthopaedic surgeon | Within hours | Shoulder pain; limited ROM and functional ability | Radiographs: unremarkableMRI: mild subacromial bursitis with significant inflammation and thickening of the joint capsule and obliteration of the axillary recess, consistent with adhesive capsulitis  | Adhesive capsulitis related to SIRVA | Fluoroscopy-guided glenohumeral joint steroid injection, PT, shoulder MUA; at 9 months, ROM improved to allow desired daily activities  |
| Wong et al. [50] | 1 | 51, woman | NR | Influenza | Deltoid | United States | Orthopaedic surgeon | NR | Shoulder pain worst with attempted shoulder elevation, limited ROM | MRI: evidence of severe shoulder bursitis with a large volume of fluid and solid-appearing heterogeneous bodies that extended throughout the subacromial space Histology of loose bodies from intraoperative biopsy: reactive changes with area of tissue necrosis | Rotator cuff bursitis and impingement syndrome | NSAIDs, cortisone subacromial injection, PT, arthroscopic shoulder debridement and subacromial bursectomy; improved ROM and no pain at 3 months  |

aValues reported in kg/m2. NR = not reported; PT = physical therapy; IV = intravenous; WBCs = white blood cells; PMNs = polymorphonuclear neutrophils; MUA = manipulation under anesthesia.