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CASE REPORT

MIDSHAFT HUMERAL FRACTURE FOLLOWING A PROXIMAL HUMERAL FRACTURE: A CASE REPORT

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ABSTRACT

Background and Purpose: Proximal humeral fractures are relatively uncommon injuries. While previous research has led to effective clinical and diagnostic evaluation and treatment of proximal fractures, less is currently known regarding the typical evaluation and treatment of midshaft humeral fractures. The purpose of this case is to describe the clinical reasoning and utilization of diagnostic imaging in the physical therapy management of a midshaft humeral fracture, sustained during the course of rehabilitation of a proximal humerus fracture.

Case Description: A 63-year-old female recreational tennis player presented to physical therapy, progressing well following a proximal humeral fracture, sustained 18 weeks prior. During the course of care, the patient had a significant regression in range of motion and function, with increased pain, following a seemingly trivial injury. Based on a cluster of subjective and objective flags, the therapist was concerned about a new fracture. The therapist communicated findings with a physician and recommended plain film radiographs before continuing therapy.

Outcomes: Radiographs showed an oblique displaced fracture extending through the midshaft of the humerus. The patient ultimately underwent surgical plating. At one-year post injury e-mail follow up, she had functional mobility of her left arm, and was playing tennis recreationally three times a week.

Discussion: In this case, a patient who was progressing well following a proximal humeral fracture sustained a separate displaced fracture of the midshaft of the humerus, not associated with therapy. Her reported mechanism was not consistent with a typical injury. This highlights the need for clinicians, specifically physical therapists, to cluster subjective information, objective data, and the patient's medical history when interpreting patient appropriateness for therapy, and to optimize outcomes.

Key Words: clinical reasoning, humeral fracture, radiograph, tennis

Level of Evidence: 5 (single case report)

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BACKGROUND/PURPOSE

Proximal humeral fractures are relatively uncommon fractures, accounting for 5% of all fractures at an incidence of 66/100,000 person-years.[1] As with any fracture, numerous fracture types and classifications exist, such as displaced or non-displaced fractures, in addition to simple or complex. Proximal humeral fractures are typically treated successfully using conservative interventions, however in some cases surgical management may be indicated (usually when head-to-shaft displacement exceeds 50% of the diaphyseal diameter or in the presence of varus/valgus deviations of more than 20°).[2]

While proximal humeral fractures are not common, and recurrence is less common,[3] midshaft humeral fractures are even less commonly reported. These injuries typically occur following a direct blow or bending force applied to the middle humerus, but may also be caused by a fall onto an outstretched hand (FOOSH) or elbow, or by violent muscle contraction such as in weight lifting.[4] Risk of non-union and instability in diaphyseal fractures with conservative bracing increases by up to 40% per millimeter of gap, smoking increases risk by six times, and being female increases risk by five times[5] indicating the need for early recognition, appropriate imaging, and management.

The first step in fracture management is fracture recognition. Clinicians should consistently utilize sensitive subjective questioning and thorough objective examination techniques, in order to prevent overutilization of diagnostic examinations. The Ottawa Ankle Rules, for example, have been shown to prevent excessive imaging for individuals, based on a series of questions and palpation.[6] A change in status such as increased pain, limited function, particularly following trauma, should raise suspicion. The purpose of this case report is to describe the clinical reasoning and utilization of diagnostic imaging in the physical therapy management of a midshaft humeral fracture, sustained during the course of rehabilitation of a proximal humerus fracture.

CASE DESCRIPTION

The subject of this case report was a 63 year-old female college professor presenting to a university outpatient physical therapy clinic, with complaints of decreased left shoulder strength and range of motion. Eighteen weeks prior, the patient reported falling onto an outstretched left arm, after slipping while playing tennis. At that time, she was diagnosed with a non-displaced left proximal humeral fracture, which was treated conservatively with bracing and physical therapy at another clinic in her home state. She was out of her home state visiting her daughter for two months, and wanted to continue with physical therapy in order to maximize progress. She stated her arm was getting much better, but had remaining limitations, most notably left shoulder weakness, decreased mobility, low-grade pain, and the inability to play tennis. Pain was described as a dull ache at the left anterolateral shoulder. Pain intensity, measured using the Numeric Pain Rating Scale (NPRS) was classified as 0/10 at rest and 6/10 at worst. Pain was aggravated by carrying groceries, combing her hair and showering. Pain was quickly alleviated with cessation of aggravating activities. She denied pain or parasthesias in her neck or distal to the deltoid tuberosity. She reported consistency with a home exercise program (HEP) primarily focused on pain free stretching of her involved upper extremity (UE). Her primary goal was to continue to improve her left shoulder function, in order to return to playing tennis. Prior to injury, she reported playing tennis between three and five times a week, in both singles and doubles matches. She had been playing tennis for over 20 years, and found it to be her main form of stress relief.

The patient had a past medical history of left breast cancer four years prior, successfully treated with surgical removal and radiation therapy. She was cancer free for three years and was following up with her oncologist annually. She was also diagnosed as being osteoporotic, but otherwise her past medical history was unremarkable. Medications included ibuprofen as needed, calcium and vitamin D supplements, and a daily multivitamin. Because the patient was presenting from out of state, the treating therapist talked to her referring orthopedic physician through telephone contact. Her physician was pleased with her progress to date, and stated that plain film radiographs taken at 16 weeks demonstrated good proximal humeral fracture site healing. The fracture, at the surgical neck, was non-displaced and there was no greater or lesser tuberosity involvement. He

stated that there were no precautions at the time, outside of avoiding heavy resistance training.

CLINICAL IMPRESSION I

Based on the patient's presenting symptoms and communication with her referring physician, the primary therapist believed she was properly progressing following a left proximal humeral fracture. Given her pain location, rotator cuff pathology, adhesive capsulitis, biceps brachii tendinopathy, left glenohumeral (GH) joint osteoarthritis (OA), lower cervical facet dysfunction, avascular necrosis, and acromioclavicular (AC) joint OA were other competing diagnoses. However, given the patient's specific mechanism of injury, age, radiographic findings, and communication with her referring physician, proximal humeral fracture was the most likely pathology. Given the positive correlation between duration and improved function with previous therapy, it was expected that continued skilled physical therapy services would facilitate improved functional use of her arm.

Examination of the cervicothoracic spine, shoulder and elbow complexes was planned. A neurological screen was also planned secondary to pain distal to the acromioclavicular joint and complaints of weakness. While the patient reported functional progression since the onset of symptoms, given her age and history of breast cancer, a prolonged recovery was expected. Continued mobility and strength based impairments were anticipated 18 weeks after initial fracture.

EXAMINATION

The examination was initiated with postural examination. In sitting and standing, a mild forward head position was noted. The left scapula was slightly elevated and internally rotated as compared to the right. A cervical screen including active range of motion (AROM) and overpressure in all planes was negative for reproduction of symptoms. Shoulder complex examination included AROM, passive range of motion (PROM), strength, joint mobility assessment, and palpation. Actively, the left shoulder was limited in all planes, with pain (3/10) noted into abduction and functional external rotation (ER). Early scapular elevation was noted on the left with elevation. Left shoulder PROM was also limited in all planes, most notably internal rotation (IR) and ER. While left shoulder AROM was limited, strength was measured in the patient's available ROM. Deficits were present in all planes, primarily shoulder ER, with pain reported at 3/10. Anterior-posterior (AP) and inferior glides were restricted at the GH and AC joints on the left. Mild tenderness (4/10) was noted at the left greater tuberosity, but not at the deltoid or rotator cuff tendon insertions. The right shoulder was unimpaired. Specific shoulder examination findings, including range of motion and strength measurements, can be seen in Table 1. An elbow screen including AROM and overpressure was also negative for symptom reproduction.

While the patient's subjective history appeared to be consistent with a healing fracture, considering her complaints of arm weakness, mechanism of injury, and symptoms distal to the AC joint, a neurological screen was also conducted. Sensation was intact to light touch through bilateral UE dermatomes. Deep tendon reflexes of C5, C6, and C7 were 2+ (normal) bilaterally. Myotomal assessment was limited secondary to her shoulder pathology; however C6 through T1 was grossly unimpaired bilaterally. Neurodynamic assessment of the median nerve did not recreate pain.

INTERVENTION

After the initial evaluation, it seemed likely that the patient's symptoms were musculoskeletal in nature, and ongoing impairments of left shoulder weakness, limited A/PROM, decreased joint mobility, and tenderness were related to her proximal humeral fracture. She demonstrated functional arm elevation, which was consistently improving since the initial injury, and primary expected interventions would be manual therapy for joint and soft tissue mobilization, therapeutic exercises for stretching and strengthening, neuromuscular re-education for rotator cuff and scapular mechanics, with a progression towards return to sport.

Based on time constraints, no manual therapy was performed at the evaluation. Her current HEP, including active assisted ROM and PROM for shoulder elevation and abduction, and scapular retraction was examined for proper technique. Rather than adding new exercises, the patient was instructed to continue

with her previous HEP in pain free ROM until the next visit, at which point manual therapy and new exercises would be initiated. The patient was also educated on anatomy, pathology, rehabilitation progression and expectations. The patient agreed with the plan of care, and all questions were answered.

At the first follow up visit, four days later, the patient reported a worsening in her shoulder function. Over the weekend, she reported that while greeting her, a family member grabbed and patted her arm. She noted immediate sharp pain (8/10), and was unable to move her arm as much as she could previously. The pain subsided slightly, however she had more pain at rest (4/10), and found activities of daily living and sleeping more challenging secondary to pain. As a result, she did not perform her HEP as frequently, although she tried occasionally. Despite the increased pain and limited motion, the patient stated that she wanted to continue with therapy. She believed the low impact mechanism of increased symptoms to be only a temporary setback.

Given the change in functional status and increased pain, re-evaluation was performed, with specific findings presented in Table 1. A significant limitation in left shoulder active and PROM as compared to initial evaluation was noted, with guarding present throughout. Palpation revealed a protrusion near the deltoid tuberosity with exquisite tenderness reported. Midshaft humerus fractures increase the risk of radial nerve injury,[7] however wrist extension was intact and no sensory loss was noted, making nerve involvement less likely. Despite the patient's desire to continue with therapy, the examination findings, coupled with the patient's complaints of functional regression, and risk factors for fracture (age, gender, osteoporosis, and history of cancer) prompted the therapist to consult with a physician prior to continuation of therapy.

CLINICAL IMPRESSION II

After initial evaluation, the patient reported minimal pain and had functional AROM. However, at first follow up visit, despite no change in activity level and continuation of her HEP which she had been performing consistently prior to evaluation, she had increased resting pain, limited AROM and PROM, and exquisite tenderness at the deltoid tuberosity, following mild trauma, which was not present before. Given the patient's change in status, the therapist's differential diagnosis expanded to include humeral fracture,

Table 1. *Examination findings.*

	Initial Evaluation		Re-Evaluation (Day 2)	
AROM/PROM*	Left	Right	Left	Right
- Flexion	120/141	175/180	82†/91†	175/180
- Abduction	113†/120	173/179	63†/74†	174/179
- ER	54†/60	79/83	48†/57†	80/84
- IR	30/42	68/72	32†/38†	70/72
Strength‡	Left	Right	Left	Right
- Flexion	4	5	NT	5
- Abduction	3+	5	NT	5
- ER	3	4	NT	4
- IR	5	5	NT	5
Palpation	Tenderness at greater tuberosity	None	Tenderness at greater and deltoid tuberosity; protrusion at deltoid tuberosity	None

*Active range of motion/Passive range of motion, in degrees
†Denotes pain
‡Manual muscle testing (0-5, higher score indicates greater strength), in available range of motion
§Not tested due to change in available range of motion and pain

whether it could be a reinjury or a new fracture. While less likely, the therapist also considered the patient's new complaints may potentially be related to overuse or a muscular strain. The therapist was also concerned of a potential metastasis, given her cancer history. While the reported mechanism of injury appeared to be unremarkable and low-impact, the likelihood of fracture increases after mild trauma in osteoporotic patients, and post-menopausal women, specifically those with breast cancer,[8] leading the therapist to consider obtaining more imaging. Prior to further imaging ruling out related pathologies however, the therapist did not believe it would be appropriate to continue with physical therapy.

The therapist contacted a physician next door to the clinic, and explained the new patient findings. Again, while the trauma seemed to be minimal, given her co-morbidities and the association between fracture risk and osteoporosis, the therapist was primarily concerned about a potential fracture. The therapist suggested the physician order plain film radiographs of the left shoulder to determine appropriateness of the patient for therapy, but also to determine if other referrals were necessary. Plain film radiographs are commonly the first imaging modality used when considering fracture, given reliability in detecting overt fractures, ease, and minimal time requirements. In this case, plain film radiographs were preferred because they provide valuable information on bone structure, could determine the need for further imaging such as computed topography (CT) or a bone scan if necessary, and would be easiest to schedule.

OUTCOMES

X-ray imaging was obtained with multiple views of the left humerus. Radiographs showed an oblique displaced fracture extending through the midshaft of the humerus with mild apex lateral angulation (Figure 1). A 6 mm lucency involving the distal aspect of the fracture between the two major fracture fragments was concerning for non-union (Figure 2). The midshaft fracture appeared separate from the healing proximal humeral fracture, which remained intact. While cancer metastasis was initially a concern, it was less likely given her duration of being cancer free, a specific mechanism of injury, and no evidence of cancerous growth present on the radiographs.

Figure 1. *Plain film radiographs (anterior-posterior view) demonstrating a 6 mm wide lucency involving the distal aspect of the fracture between the 2 major fracture fragments indicating non-union. Interval healing can be noted at the proximal humeral fracture site.*

When made aware of these findings, the therapist contacted the patient's referring orthopedic physician to discuss the patient's status. The referring physician recommended surgical intervention, likely to include plating of the midshaft of the humerus. After receiving advice from the physical therapist on local physicians, a referral was made to a local orthopedic surgeon for expedited consultation. The new orthopedic physician agreed that surgical plating of the midshaft of the humerus would be ideal; however the patient preferred a trial of conservative management, which included bracing,

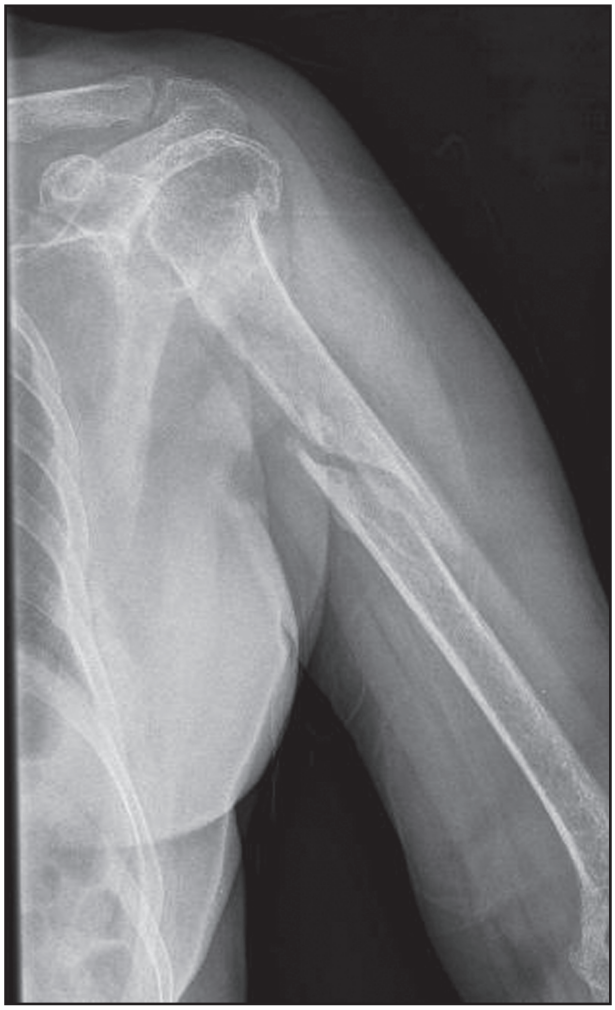

Figure 2. *Anterior-posterior radiograph with humeral internal rotation exposing the lateral aspect of the left humeral midshaft. Complete displacement can be seen.*

until she returned to her primary orthopedic physician back home. After an unsuccessful six week trial of bracing, and per her referring physician's recommendation, the patient opted for surgical intervention, and surgical plating of the humeral midshaft was performed. An email received from the patient one year after surgery revealed that the patient had functional (yet not full) ROM, and was back to playing tennis recreationally, which was her initial goal. She remained cancer free.

DISCUSSION

Proximal humeral fractures while uncommon, and typically seen in an elderly population, often occur following a fall from a standing height.[3] Conservative care utilizing physical therapy within the first three weeks is often successful in those with non-displaced and stable proximal humeral fractures.[9] While less common, midshaft humeral fractures also may occur following a FOOSH, but more often are sustained after a direct blow.[4] Midshaft fractures tend to respond well to conservative management, however, displaced fractures increase the risk of non-union, requiring surgical intervention. The use of diagnostic imaging in proximal and midshaft humeral fractures can detect the fracture itself, but may also guide and expedite proper management.

In the case presented here, a 63 year-old woman presented initially with a stable and healing proximal humeral fracture, following a FOOSH injury. Unfortunately, during the course of care, she sustained a midshaft humeral fracture, during a seemingly harmless event, not associated with therapy. While she believed it to be a minimal setback, based on her risk factors including osteoporosis, female gender, postmenopausal status, age, and history of cancer, the therapist had increased suspicion of fracture. The use of diagnostic imaging confirmed this suspicion, which led to a significant change in her course of care. Without imaging, the therapist could have further exacerbated her injury, and her outcomes may have been worsened. However, with early imaging, and coordination of care between multiple practitioners, the patient was able to undergo proper treatment without worsening of her condition, ultimately returning to tennis.

A limitation within this report is the absence of pre-injury radiographs, making comparison to her altered status more challenging. Unfortunately, the treating therapist was unable to obtain radiographic reports, and had to rely on the referring physician's report that the patient was progressing well after the proximal humeral fracture. Ideally, previous reports and images should be obtained when possible, particularly in patients at a higher risk of injury.

This case, while appearing straight forward, highlights the need for therapists to recognize the benefit of diagnostic imaging in coordinating proper care. With physical therapists acting more as direct access care practitioners, it becomes imperative that they not only understand risk factors for fractures, but also consistently utilize excellent clinical reasoning with a moderate index of suspicion during seemingly unrelated events, in order to optimize patient care. However, it

should also be noted that in most jurisdictions, physical therapists do not currently have the capabilities of ordering diagnostic tests or evaluations. Despite this, clinicians should be aware of the capabilities of each diagnostic modality, including indications, contraindications, benefits, and drawbacks, if therapists are expected to be utilized as direct access practitioners. This should include open and frequent communication with other members of the healthcare team. Future research may benefit from the development of clinical prediction rules for the detection of humeral fractures, such as those that exist for the ankle and cervical spine. It is the authors' hope that this report will facilitate an increased suspicion of red flags, regardless of degree of trauma, in order to optimize patient safety and outcomes.

CONCLUSION

Proximal humeral fractures are not common, especially in conjunction with midshaft humeral fractures. Early recognition with the use of sensitive subjective questioning is essential for efficient diagnosis and management. The consequences of missing such a diagnosis may include medical complications and functional loss. This case report demonstrates successful recognition, screening, and physician referral that resulted in appropriate imaging and intervention. As physical therapists continue to function in the direct access environment, it is essential to recognize and properly screen for such an injury and then work in conjunction with other healthcare professionals in order to optimize patient care.

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