Review Article

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Differential Diagnosis of Elbow Pain

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Elbow pain is a common symptom encountered in clinical practice. Pathology can arise from any component of the joint, including the bone, tendons, ligament, bursa, or nerves. This paper discusses how elbow pain can be differentiated according to its anatomic location and presents the corresponding causes, diagnosis, and treatment options.

Introduction

The elbow is a complex joint with a wide range of motion and many functions. Its bony structure, composed of the humerus, radius, and ulna, and various muscles and ligaments work as a functional unit. One or multiple elbow joint components can cause pain and functional deficits; therefore, determining the underlying etiology of elbow pain can be difficult. Accordingly, this paper discusses the causes of common conditions that can lead to elbow pain and their respective diagnosis and treatment options.

Main Text

The location and quality of elbow pain can generally localize the injury to one of the four anatomic regions: anterior, medial, lateral, or posterior [1]. Table 1 presents the differential diagnosis of elbow pain by anatomic location [1].

1. Anterior elbow pain

1) Primary osteoarthritis

Osteoarthritis of the elbow joint, also known as degenerative or primary osteoarthritis, is distinct from secondary arthritis, which is caused by trauma or underlying disease. The incidence of elbow osteoarthritis is lower than that of knee joint osteoarthritis, a typical type of degenerative arthritis, and the pain is often less severe as the elbow is a non-weight bearing joint. However,

Table 1. Differential diagnosis of elbow pain based on anatomic location

Diagnosis	
Anterior	Medial
Anterior capsule strain	Cubital tunnel syndrome
Biceps tendinopathy	Medial epicondylitis
Gout	Medial collateral ligament injury
Intra-articular loose body	Valgus extension overload syndrome
Osteoarthritis	
Pronator syndrome	
Rheumatoid arthritis	
Lateral	Posterior
Lateral epicondylitis	Olecranon bursitis
Osteochondral defect	Olecranon stress fracture
Plica	Osteoarthritis
Posterolateral rotatory instability	Posterior impingement
Radial tunnel syndrome	Triceps tendinopathy
Posterior interosseous nerve syndrome	

Data from Kane et al. [1].

the elbow does bear a dynamic load due to gravity and muscle contraction during dynamic arm swing motion. This can lead to severe disabling symptoms such as pain, locking, and stiffness [2,3].

The elbow joint can be subdivided into the ulnohumeral joint, the radiocapitellar joint, and the proximal radioulnar joint. Arthritis mainly affects the radiocapitellar and ulnohumeral joints from an anatomical perspective. Cadaveric studies and biomechanical experiments have reported that the radiocapitellar joint bears a greater load, leading to more severe joint wear [4,5]. This can be attributed to the fact that the radiocapitellar joint—unlike the ulnohumeral joint, which only performs a hinge function—facilitates both hinge and rotational movements. This dual functionality increases the load on the articular cartilage.

The main pathology of degenerative arthritis involves degeneration of the articular cartilage. However, the lesions that lead to clinical symptoms are the formation of osteophytes around the joint and the contraction of the joint capsule. Osteophytes primarily occur in the apex of the coronoid process, the radial fossa, and the coronoid fossa on the anterior aspect, as well as in the apex of the olecranon and the olecranon fossa on the posterior aspect. It is also common for an osteophyte to fracture, forming a loose body. Osteoarthritis often involves posteromedial and anterior capsule contractures, which are significant contributors to the restriction of joint motion. A posteromedial capsule contracture can limit elbow flexion and compress the ulnar nerve, while an anterior capsule contracture can result in a flexion contracture of 10°–20°.

The main symptoms are pain and limited range of motion in the elbow joint, which gradually intensify as arthritis advances. Until the disease reaches its end-stage, pain typically manifests at the point of maximum extension (posterior pain) or flexion (anterior pain), and is often absent in the mid-range of motion. Pain during extension is a symptom triggered by the mechanical impingement of the olecranon apex and the olecranon fossa. In severe instances, this may hinder the ability to extend the arm in daily activities. Accompanied by ulnar neuropathy [6], progression of the condition may result in numbness of the fourth and fifth fingers, or even atrophy of the intrinsic finger muscles.

Plain radiographs and CT are helpful in the diagnosis. On lateral radiographs, anterior and posterior osteophytes and loose bodies can be observed. The joint space is generally preserved, except in instances of advanced arthritis. CT scans are particularly useful for preoperative

planning, as they allow for a more precise and straightforward observation of the location and size of osteophytes and loose bodies.

Conservative treatments for osteoarthritis of the elbow joint include NSAIDs, rest, lifestyle modification, physical therapy, and intra-articular steroid injection therapy. However, steroid injections should be used with caution due to the potential for systemic disorders and further soft tissue damage [7]. It is important to note that many patients' symptoms are related to occupational causes and often persist. If conservative treatments fail, surgical intervention is considered based on the patient's symptoms, functional needs, and the progression of the disease.

Representative surgical treatments for elbow joint osteoarthritis include arthroplasty and total elbow replacement. Arthroplasty is generally recommended for younger patients who experience pain only at the maximum range of extension and flexion, and do not report pain during mid-range joint motion. Open debridement is a conventional surgical approach. A notable example of this is the Outerbridge-Kashiwagi procedure, which involves a posterior approach to penetrate and enlarge the olecranon fossa and coronoid fossa, thereby expanding the space and eliminating bony impingement [8]. Ulnohumeral arthroplasty is a variation of this method, where the expansion of the olecranon fossa is performed concurrently with the removal of surrounding osteophytes and a capsulectomy. However, this method has limitations in identifying anterior structures and lesions in the ulnohumeral joint.

Total elbow replacement is a viable procedure for elderly patients suffering from severe osteoarthritis, but it is typically reserved for those with a limited range of motion. Generally, total elbow replacement for degenerative osteoarthritis is less common than for rheumatoid arthritis.

2) Gout

Gout is a condition characterized by the excessive production of monosodium urate, which is then deposited as crystals in joints or surrounding tissues, leading to inflammation. Acute gout primarily affects the first metatarsophalangeal joint, although it can also occur in the elbow joint. In fact, the elbow joint is affected in 20%–30% of all patients with this condition.

The primary complaint is often severe pain in a single joint, accompanied by swelling and redness around the joint. This necessitates differentiation from infectious diseases such as cellulitis, bursitis, and septic arthritis. Gout can be categorized into acute and chronic types, based on the nature of clinical manifestations. Acute gout is characterized by episodic symptoms in a single joint, which, over a period of intermittent symptoms, gradually progresses to chronic gout.

The diagnosis is confirmed when needle-shaped crystals, exhibiting negative birefringence, are observed under a polarizing microscope following joint fluid aspiration.

Acute gout is typically managed with conservative treatments such as immobilizing the affected joint with a splint, in conjunction with drug therapy. Common drug treatments involve the oral administration of colchicine, NSAIDs, and febuxostat, with steroids used sparingly. Surgical intervention may be considered when it is challenging to distinguish the condition from bacterial arthritis, or when the condition fails to respond to medical treatment. With the aid of an arthroscope, joint lesions can be readily observed, and accumulated urate and inflammatory synovium can be extracted. For chronic gout, it is advisable to implement ongoing drug treatment to regulate uric acid levels and prevent arthritis progression. Key medications include probenecid, which facilitates the excretion of uric acid, and allopurinol, which inhibits its production. These should be prescribed with consideration for the patient's kidney function and potential side effects.

2. Medial elbow pain

1) Medial epicondylitis

Medial epicondylitis, also known as golfer's elbow, is the predominant cause of medial elbow pain. However, it is relatively uncommon, with an incidence rate of approximately 0.5%, and it occurs 15%–20% as often as lateral epicondylitis. This condition occurs twice as frequently in males as it does in females.

The key areas implicated in medial epicondylitis are the medial conjoint tendon and its associated pronator teres and the origin of the flexor carpi radialis.

A standard physical examination for medial epicondylitis employs the golfer's elbow test. This test involves supinating the arm while the elbow is bent and the affected arm is clenched into a fist. Subsequently, the elbow and wrist joints are extended against resistance. This action may induce pain on the medial side of the elbow joint and the medial epicondyle. If pain is experienced, the test is considered positive.

Pain in the medial epicondyle could be attributed to structural damage to the ulnar nerve or ulnar collateral ligament. Therefore, it is crucial to evaluate these structures for any abnormalities prior to making a definitive diagnosis.

In 50% of patients with medial epicondylitis, symptoms of ulnar nerve involvement are also present, necessitating their differentiation. Conditions such as cervical or upper thoracic radiculopathy, or ulnar nerve compression, can produce similar symptoms. These neurogenic pains, often described as being pricked by several small needles or experiencing numbness, can serve as distinguishing factors in a patient's medical history. However, patients often struggle to accurately describe these sensations, which can lead to confusion. To differentiate cervical lesions, Spurling's test is required. In cases involving the posterior interosseous nerve or ulnar nerve, the area of entrapment and compression differs from the area of maximum tenderness in medial epicondylitis. If the Tinel sign is positive, this can provide a relatively clear distinction.

The treatment of epicondylitis can be divided into conservative and surgical approaches. The goal of these treatments is to reduce inflammation, distribute excessive load that is concentrated in one area by improving biomechanics, and ultimately regenerate tendons where tendinosis has occurred. Conservative treatment for epicondylitis boasts a success rate of approximately 90%. If epicondylitis remains unimproved after 3 to 6 months of treatment, it is considered refractory and surgical intervention may be indicated. Conservative treatment encompasses exercise therapy, physical therapy, drug therapy, bracing, extracorporeal shock wave therapy, percutaneous pie crusting of the tendon origin [9] polydeoxyribonucleotide injections [10], platelet-rich plasma (PRP) injections [11], autologous blood injections [12], and local corticosteroid injection therapy.

Various stretching methods serve as exercise therapy for the prevention and treatment of epicondylitis. For medial epicondylitis, maintaining a posture where the forearm is supinated, the wrist joint is extended, and the elbow joint is extended for 30 seconds to 1 minute proves effective. In the acute stage, a cold pack application and massage are followed by light stretching. As pain subsides, eccentric contraction exercises are then introduced.

Physical therapy encompasses techniques that utilize both superficial and deep heat. These methods are recognized as beneficial for managing acute or chronic refractory pain. However, the effectiveness of strong deep heat increases proportionally with the chronicity and refractoriness of the pain.

Injection therapy can be broadly categorized into trigger point injections, local steroid

injections, and PRP injections. Trigger point injection therapy, which involves injecting a local anesthetic into the palpated painful area, has long been in use. However, the results vary significantly depending on the operator, and it generally only provides short-term relief compared to other treatments. Local steroid injections are highly effective in the short term for treating refractory elbow pain. However, after 6 weeks, the therapeutic effect is typically less than that of other treatments, or the recurrence rate increases. Therefore, steroid injections should be used judiciously [13]. PRP injection therapy is designed to promote tissue healing and prevent the progression of tendinosis. Notably, it has been reported that various growth factors are concentrated at the injection site, which increases blood flow and promotes healing by attracting platelets to the damaged area.

Surgical treatment for medial epicondylitis should only be considered after ruling out diseases affecting other structures in the medial epicondyle region. It is typically reserved for patients who show no improvement after 3 to 6 months of non-surgical treatment. Furthermore, the presence of ulnar neuropathy also indicates the need for surgical intervention. Due to the potential risk of nerve damage, the primary approach to surgical treatment for medial epicondylitis is typically an open technique.

2) Medial collateral ligament injuries

Clinically, we often encounter medial collateral ligament injuries in individuals who are occupationally exposed to valgus overload, such as throwing athletes and gymnasts. From a biomechanical perspective, the stability of the elbow joint against valgus force is influenced by the degree of elbow joint flexion. Notably, the medial collateral ligament plays a crucial role in the flexion range of 20° to 120° [14].

Most patients with medial collateral ligament injuries report a gradual onset of pain in the medial elbow joint, a decrease in ball speed compared to previous performance, and difficulty in control [15]. Pain is most severe during the late cocking phase and early acceleration phase, with medial elbow pain followed by a "popping" sensation and medial collateral ligament rupture [15]. If mechanical symptoms such as elbow flexion contracture or catching are present, conditions like posteromedial impingement syndrome, radiocapitellar joint lesions, or an intra-articular loose body should be considered.

Generally, the elbow joint's range of motion is restricted in extension. If pain is present during terminal extension and is accompanied by a hard-end feeling, it may indicate posteromedial impingement syndrome. The carrying angle of the elbow joint is typically increased beyond the normal 11°–13°, often exceeding 15°. If tenderness is detected at the attachment site of the medial collateral ligament in the anteroinferior aspect of the medial epicondyle, it could suggest a medial collateral ligament injury. Similarly, if there is tenderness along the posteromedial side of the ulnohumeral joint and pain during terminal extension, posteromedial impingement syndrome should be considered.

On plain radiographs, it is essential to examine for bony avulsion or calcification of the medial collateral ligament, osteophyte of the olecranon, arthritic changes, and loose bodies. Calcification and olecranon osteophytes are the most frequently observed findings, appearing in more than 50% of cases [16]. A discrepancy of more than 0.5 mm compared to the unaffected side on the valgus stress view may suggest a complete or severe partial tear of the medial collateral ligament [17]. However, it has been noted that the medial joint gap is approximately 0.32 mm wider than the valgus stress test in the dominant arm of pitchers [18]. Therefore, caution is required, as many athletes exhibit valgus laxity without any specific symptoms. Currently, MRI

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is acknowledged as an exceptional diagnostic tool for medial collateral ligament injuries, with its sensitivity increasing to 92% and specificity to 100% when combined with an intraarticular arthrogram [19]. Although it is possible to identify medial collateral ligament injuries through ultrasonography, the interpretation may vary depending on the expertise of the examiner.

In young athletes who have experienced a partial tear due to an acute injury, and who do not exhibit severe valgus instability, a systematic rehabilitation treatment that includes pronation-flexor strengthening exercises is recommended, provided symptoms improve after a minimum of 6 weeks of rest [20]. Steroid injections are not advised as they can potentially cause further damage to ligaments and tendons [21]. Surgical treatment may be an option for patients with chronic attritional tears that have not responded to at least 3 months of conservative treatment, as well as for pitching athletes who wish to return to their pre-injury exercise capacity in the event of carbuncle tears or highly partial tears [22]. Ensuring elbow stability in young throwing athletes is a crucial measure for preventing future injuries throughout their careers [23].

3. Lateral elbow pain

1) Lateral epicondylitis

Lateral epicondylitis, also known as tennis elbow, is characterized by tendinosis at the origin of the lateral epicondyle of the carpal joint extensors. This condition is one of the most common causes of elbow pain.

In cases of lateral epicondylitis, lesions are reported to occur 1 to 2 cm proximal to the attachment point of the extensor carpi radialis brevis (ECRB) tendon. However, lesions can also be found in the extensor digitorum communis, and are commonly known to occur in the proximal portion of the common extensor tendon.

Tenderness at the origin of the ECRB on the lateral epicondyle is typically present. Cozen's test, a standard physical examination, is conducted by passively flexing the wrist joint while the elbow joint is extended, or when the examiner strongly resists the patient's wrist extension. If this action induces pain, the test is considered positive.

Diagnoses that can be differentiated from lateral epicondylitis include radial canal entrapment syndrome, abnormal lesions within the lateral elbow joint, posterolateral instability of elbow, lateral triceps dislocation, lateral forearm cutaneous neuropathy, and radiculopathy caused by cervical arthritis.

In radial canal entrapment syndrome, the pain is typically more distal than that experienced in lateral epicondylitis. While Cozen's test may yield negative results, pain can be induced when resistance is applied during the extension of the thumb or index finger. To alleviate symptoms, the elbow joint can be bent at a 90° angle and the forearm placed in a neutral position. A splint can be used to secure this position, and movements such as supination or wrist extension against resistance can be performed. Generally, it has been reported that approximately 5% of cases involve both lateral epicondylitis and radial canal entrapment syndrome.

In cases of intra-articular lesions, such as an intra-articular loose body or radiocapitellar arthritis, the forearm is supinated, producing a painful sound at the end of extension. The point of maximum tenderness is typically located in the posterior part of the radiocapitellar joint, which helps distinguish it from lateral epicondylitis. Posterolateral instability may present similar symptoms, but it can be differentiated by the sensation of "giving way" or the presence of accompanying varus instability.

The treatment of lateral epicondylitis is similar to that of medial epicondylitis. This section

provides information specifically pertaining to lateral epicondylitis. For a broader understanding of lateral epicondylitis treatment, please refer to the section on medial epicondylitis treatment. Exercise therapy for lateral epicondylitis proves effective when a specific posture is maintained: the forearm is pronated, the wrist joint is flexed, and the elbow joint is extended. This position aids in lengthening the ECRB and extensor digitorum communis.

Surgical treatment for lateral epicondylitis is performed when there is no meaningful improvement even after about 6 to 9 months of non-surgical treatment. Surgical treatment for lateral epicondylitis is mainly performed through arthroscopic and open techniques.

2) Posterolateral rotatory instability

Posterolateral rotatory instability is a condition that arises when the ulna and the radial head rotate externally in unison, while the proximal radioulnar joint remains intact, leading to subluxation. This typically results from an injury to the lateral collateral ligament complex, which includes the lateral ulnar collateral ligament, radial collateral ligament, and annular ligament. This instability can also occur in the presence of a defect in the radial head or coronoid process.

In most patients, the symptoms are vague and there is almost no limitation of joint motion; thus, the diagnosis can be challenging unless it is suspected from the outset. A history of elbow dislocation, previous elbow joint surgery, and multiple steroid injections can be important clues to the diagnosis. Patients often complain of pain on the lateral side of the elbow joint, locking, catching, snapping, and instability, which most often occur around 40° of elbow flexion.

Screening tests for the stability of the lateral collateral ligament complex include the table-top relocation test [24] and the chair push-up test [25]. The table-top relocation test is performed by having the patient stand in front of a table, grasp the side edge, and execute a push-up with the forearm in a supinated position. When the elbow joint flexes to approximately 40°, the patient may experience pain and a sensation of elbow joint dislocation. The chair push-up test is considered positive if the patient shows hesitation in fully extending the arm or if subluxation occurs during extension. This is observed when the patient attempts to rise from a chair with the forearm supinated and arms spread wider than shoulder width.

The posterolateral pivot-shift test [26] is frequently utilized as a confirmatory test for posterolateral rotatory instability. During this test, the patient lies on their back with their arms extended overhead. The examiner, standing at the patient's head, flexes the patient's elbow joint while holding the upper arm with one hand and applying a valgus-supination force with the other, before slowly extending the elbow joint. Around 40° of flexion, the radial head subluxes posterolaterally, and a depression between the radial head and the capitellum can be palpated. However, confirming posterolateral rotatory instability in conscious patients using the posterolateral pivot-shift test is challenging. Most cases are initially suspected through other screening tests. Once surgical treatment is determined, posterolateral pivot-shift tests are typically performed under anesthesia in the operating room.

Most findings on plain radiographs are normal. However, in rare instances, a slightly widened humeral joint space or a posterior displacement of the radial head relative to the capitellum may be observed on lateral radiographs [27]. Although MRI is not essential for diagnosis, it is useful as a preoperative examination because it enables relatively accurate diagnoses in cases of severe injury to the lateral collateral ligament complex, and it can help differentiate other diseases that cause elbow joint pain.

While conservative treatments have been explored for posterolateral rotatory instability, they often prove unsuccessful, making surgical intervention the primary treatment option.

Conservative treatment may be considered when symptoms like pain or anxiety are mild. This could involve wearing an orthosis to limit forearm supination, elbow joint extension, and valgus force. Additionally, patient education to avoid actions or movements that induce pain, along with physical therapy that includes strengthening of the extensor muscles, may be attempted.

3) Osteochondritis dissecans

Osteochondritis dissecans of the elbow joint is a condition that often affects throwing athletes or gymnasts, and is one of the causes of lateral elbow joint pain [28]. This condition results from repetitive compression on the lateral side of the elbow joint, which damages the cartilage and subchondral bone of the radiocapitellar joint, leading to fragmentation and separation. It predominantly occurs in adolescent males and is frequently overlooked in diagnoses, which can lead to severe disability as they age.

The active radiocapitellar compression test serves as the provocative maneuver for the radiocapitellar joint. The test is deemed positive if it elicits pain in the elbow's lateral compartment when the patient rotates their forearm in both pronation and supination, while keeping their arm extended [29].

On plain radiographs, one can observe an irregular articular surface, local destructive lesions, or cystic changes of the capitellum, as well as a relative enlargement of the radial head in the late stages of the disease. Both ultrasonography and MRI play crucial roles in a prompt diagnosis.

The treatment method is determined based on the symptoms, radiologic findings, and the state of the bone fragment. If no loose body is present in the joint cavity, conservative treatments such as activity restriction, splinting, and NSAID administration may be implemented. Surgical intervention is considered when symptoms continue despite sufficient conservative treatment, or when osteochondral fragments are dislocated or detached.

4. Posterior elbow pain

1) Primary osteoarthritis

Refer to the section on primary osteoarthritis related to anterior elbow pain.

2) Olecranon bursitis

Olecranon bursitis is the most common type of superficial bursitis and is a common cause of posterior elbow pain and swelling [30]. This condition can also develop following an injury, due to crystal deposition such as gout, or as a consequence of systemic diseases such as rheumatoid arthritis, systemic lupus erythematosus, or uremia [31].

Olecranon bursitis can be categorized as either septic or aseptic. Patients with septic olecranon bursitis may report symptoms such as pain, swelling, and redness over the olecranon, and fever is observed in 20% to 86% of cases [32]. The diagnosis is confirmed by identifying the pathogen in the bursal fluid culture. Ultrasonography can be beneficial in detecting fluid retention in the early stages and in guiding needle aspiration. MRI is useful for distinguishing this condition from osteomyelitis or septic elbow arthritis. Septic olecranon bursitis can generally be effectively managed with antibiotics, and surgical treatment may be considered for cases that are resistant to other treatments.

Conversely, patients with aseptic olecranon bursitis may exhibit swelling over the olecranon, absent any signs of infection [31]. Aspiration of the bursa, while potentially leading to complications such as infection, is only undertaken when the diagnosis is unclear or to alleviate

symptoms in cases that are resistant to treatment [30].

3) Distal triceps tendon injuries

Distal triceps tendon injuries are very rare. In the early stages of such an injury, pain and swelling around the elbow joint often occur, complicating the process of making an accurate diagnosis. As time progresses, this injury can lead to a limited range of motion in the elbow joint or weakness in the extensor muscle [33]. Therefore, if this type of injury is suspected, a cautious approach is necessary. The most common cause of these injuries is the eccentric contraction of the triceps, which typically happens during a fall on an outstretched hand. This type of injury is particularly prevalent among males and soccer players.

A physical examination should assess the active extension of the elbow joint and inspect for any palpable defects in the proximal olecranon. The modified Campbell Thompson test is a useful diagnostic tool. In this test, the elbow joint is flexed to 90° in the prone position, with the forearm and hand relaxed. The examiner then compresses the triceps while the muscles are in a relaxed state. If the elbow joint extends, this indicates either normal function or incomplete damage. Conversely, a lack of movement in the elbow joint suggests a complete tear.

A plain radiograph should be used to check for any accompanying injuries or fractures. The flake sign, characterized by the observation of a small avulsion bone fragment on the posterior side of the olecranon, is useful for diagnosis [34]. A CT scan can verify the presence and location of small avulsion bone fragments and any other accompanying fractures. MRI is very useful for diagnosing a triceps tear, as well as confirming the location and extent of the damage.

Conservative treatment is an option for patients with a partial tear who do not have limitations on active extension, as well as for inactive elderly patients. In these cases, the elbow joint is stabilized using a brace or splint. Typically, pain subsides approximately 3 months post-injury, at which point all daily activities become feasible. However, if conservative treatment proves ineffective, or in the event of a complete rupture, operative treatment becomes necessary.

Conclusion

The elbow joint, with its wide range of motion, plays a crucial role in performing various movements in our daily lives. Consequently, elbow pain can significantly disrupt everyday activities. Given the diverse causes of elbow pain, it is essential to have a precise understanding of the structures that trigger this discomfort.

The patient's medical history plays a pivotal role in diagnosing elbow pain, as it aids in revealing the mechanism of injury. It also supplies crucial information necessary for achieving an accurate diagnosis through a comprehensive physical examination, supplemented by imaging studies. A systematic approach to assessing the characteristics, onset, and duration of pain, as well as associated symptoms, is essential for making a diagnosis.

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