

Examination of the Elbow Region

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LEARNING OUTCOMES

After studying this chapter, you should be able to:

- Outline the key anatomical structures and biomechanical functions of the elbow joint complex.
- Discuss common pathological presentations for this region.
- Identify how clinical reasoning guides history taking in the subjective examination of people with elbow complex pain and/or dysfunction, informed by the location, behaviour and nature of symptoms, and the value of screening questions.
- Discuss the multifactorial nature of elbow pain and the role psychosocial factors may play in how people with elbow dysfunction may present.
- Identify how subjective data will guide the physical examination of the elbow complex.
- Using clinical reasoning, justify selection of tests and interpretation of findings related to common pathological presentations of the elbow complex.
- List the key constituents of a comprehensive physical examination of the elbow complex with considerations of the sensitivity and specificity of key physical tests for the elbow joint region.
- Explain how physical examination findings contribute to reasoning of common pathologies of the elbow joint.

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INTRODUCTION TO THE ELBOW REGION

The elbow complex is composed of three bones, the humerus, ulna and radius, which together form three separate articulations: the humeroulnar joint, the humeroradial joint and the superior radioulnar joint. The joint capsule is continuous for all three joints and is reinforced by the collateral ligaments, which contribute to elbow stability. The humeroulnar joint provides most structural stability due to the tight fit between the trochlea and the trochlear notch. It is primarily involved in flexion and extension. The humeroradial joint allows flexion and extension movements as well as pronation and supination (Hengeveld & Banks, 2014). The elbow is not considered a weight-bearing joint; however, activities such as pushing and press-ups do subject the humeroradial joint to compression forces and should be considered. The superior and inferior radioulnar joints are considered as one joint; however, in this text the inferior radioulnar joint is discussed in Chapter 12. They are primarily involved in supination and pronation movements and therefore are essential in fine-tuning wrist and hand spatial positioning.

The muscles associated primarily with the elbow include three flexors (brachialis, biceps brachii and brachioradialis) and two extensors (triceps and anconeus). The role these muscles have in elbow movement depends on many factors, including functional elbow and forearm positions, type of muscle contraction and associated load. In addition, the humerus provides a stable base of attachment for many of the wrist and hand muscles via the common flexor/pronator and extensor tendon origins, which are the medial and lateral dynamic stabilizers of the elbow joint, respectively (O'Driscoll et al., 2005). These tendon origins are susceptible to overload and degenerative changes.

Anatomically the elbow forms part of the kinetic chain for the upper limb, sitting between the mobile shoulder, wrist and hand joints. The elbow's primary role is to optimize hand function by enabling an individual to place the hand in a variety of positions to perform functional activities. Normal elbow physiological ranges for flexion and extension range between -5 degrees hypertension and 145 degrees flexion, although most functional activities usually occur between 30 and 140 degrees of flexion (Sardelli et al., 2011), meaning one does not need to have full elbow range to be fully functional.

The superior radioulnar joint has on average 75 degrees of forearm pronation and 85 degrees of supination (Neumann, 2010). These physiological ranges enable a wide variety of activities. For example, elbow flexion and supination are used to bring the hand to the face and body in activities of daily living, such as eating, dressing and carrying. Similarly, elbow extension and pronation together enable the hand to be used in reaching, pushing, throwing and weight bearing, (e.g. through a walking stick). The elbow joints therefore allow transmission of forces to or from the hand such as torque as a result of twisting (e.g. using a screwdriver) or compression (e.g. pushing a heavy door). Any gross loss of flexion or extension range may significantly limit the level of functional independence for an individual (Lockard, 2006), with Søjbjerg (1996) describing a 50% loss of range, resulting in an 80% functional loss. In contrast, compensations at the elbow may arise when there are dysfunctions at the wrist or shoulder, reminding us of the importance of screening these regions too.

Elbow injuries affect people of all ages and activity levels and result in significant pain and disability (Aviles et al., 2008). Elbow pain potentially may be described as arthrogenic, myogenic, neurogenic or a combination of these, depending on the structures involved. Sports involving overhead throwing, repeated use of power grips (golf and tennis) and compression (divers, gymnasts and weightlifters) are particularly associated with acute and chronic elbow pathologies.

Particular symptoms may be indicative of certain conditions. For example, numbness and tingling in the little finger while talking on the phone may suggest ulnar neuropathy, twinges of pain on turning a key may be related to the superior radioulnar joint and an inability to extend the elbow fully may suggest synovitis or osteoarthritis (MacDermid & Michlovitz, 2006). See Table 11.1 for possible causes of pain and/or limitation of movement. Limitation of cervical or glenohumeral joint range, along with glenohumeral joint weakness, has also been linked to elbow joint pathology (Alizadehkhayat et al., 2007).

KNOWLEDGE CHECK

1. Which muscles are the medial and lateral dynamic stabilizers of the elbow?
2. What is the range of motion needed for function at the elbow?

TABLE 11.1 Possible Causes of Pain and/or Limitation of Movement

Trauma/defined mechanism of injury	• Fracture of humerus, radius or ulna—fall on outstretched hand • Dislocation of the head of the radius/pulled elbow (most commonly seen in young children) • Ligamentous sprain—'pop' may suggest collateral ligament injury • Elbow joint dislocation • Distal biceps rupture • Muscular strain
Inflammatory	• Inflammatory disorders: rheumatoid arthritis • Bursitis (of subcutaneous olecranon, subtendinous olecranon, radioulnar or bicipitoradial bursa)
Degenerative/repetitive conditions	• Common extensor origin dysfunction/lateral elbow tendinopathy/tennis elbow • Common flexor origin dysfunction/medial epicondylalgia/golfer's elbow • Degenerative conditions: osteoarthritis and loose bodies • Calcification of tendons or muscles (e.g. myositis ossificans)
Peripheral nerve sensitization/neuropathy entrapment	• Compression of, or injury to, the median, radial and ulnar nerve
Sinister pathologies	• Infection (e.g. tuberculosis) • Primary bone tumours
Other	• Hypermobility syndrome • Haemophilia • Referral of symptoms from the cervical spine, thoracic spine, shoulder, wrist or hand • Volkmann ischaemic contracture (e.g. supracondylar fracture of humerus)

SUBJECTIVE EXAMINATION/TAKING THE PATIENT'S HISTORY

Further details of the questions asked during the subjective examination and the tests carried out in the physical examination can be found in Chapters 3 and 4. The order of the subjective questioning and the physical tests described later should be justified through sound clinical reasoning and may depend on the type of presenting symptoms as well as the patient's expectations.

Patient's Perspective on Their Experience

To treat the patient appropriately, it is important that the condition is managed within the context of the patient's social and work environment. Social history that is relevant to the onset and progression of the patient's problem is recorded. This includes age, employment, home situation, including sleep postures, and details of any leisure and sporting activities (MacDermid & Michlovitz, 2006). It is essential to gain an understanding of the functional demands on the elbow because it may indicate direct and/or indirect mechanical influences on structures. For example, occupational activities involve sustained or repetitive activities, such as production line work, implicating the common flexor/extensor origins at the elbow. Ask specifically about details of work status and job satisfaction. In cases of athletes, ask about changes in training regimes or loads.

Identifying the patient's expectations and possible presence of unhelpful thoughts/beliefs and psychosocial factors will help to effectively plan both the subjective and physical examinations and help to guide future treatment. Following elbow fractures, fear avoidance beliefs at 2 weeks post injury predict functional outcome at 6 months, regardless of fracture severity and treatment (Jayakumar et al., 2019). Identifying psychosocial factors will also alert the perceptive clinician to investigate them early on and can impact upon outcomes of treatment (Linton et al., 2011). Patients with lateral elbow tendinopathy can exhibit psychosocial risk factors for poor treatment outcomes, such as anxiety and fear avoidance along with feelings of low job satisfaction (Alizadeh-khaiyat et al., 2007; van Rijn et al., 2009). Helpful psychosocial screening questions are as follows:

- What is your main problem?
- What do you think physiotherapy can do for you?
- How do you feel about physical activity?

Patient-reported outcome measures are also recommended to measure the impact of the dysfunction on the patient's perceptions and functional limitations. Useful outcome measures include the Oxford Elbow Score (Joint-specific), Mayo Elbow Performance Score (Joint-specific), Patient-Rated Tennis Elbow Evaluation (Condition-specific) and Disabilities of the Arm, Shoulder and Hand (DASH) (The et al., 2013).

Body Chart

Information concerning the type and area of current symptoms can be recorded on a body chart (see Fig. 3.2), including hand dominance. This helps to determine the impact that symptoms in the upper limb may have on normal function. Handedness and frequency of activity may well produce physical adaptations, such as reduced range of motion and increased strength of the dominant elbow, wrist and hand, in throwing athletes (Ellenbecker et al., 2012; Wilk et al., 2012). This means comparing the left and right arm of a throwing athlete may not be adequate when restoring him or her to the preinjury status.

Area of Current Symptoms

Precisely map out the area of the symptoms. Elbow symptoms can be felt locally or may refer to the forearm and hand. Localized pain may be felt over the joint lines, including the humeroradial joint, the olecranon process, ulnar notch and medial and lateral epicondyles. Ascertain which is the worst symptom, and record where the patient feels the symptoms are coming from.

Areas Relevant to the Region Being Examined

Symptoms around the elbow complex may be referred from more proximal and distal structures, including the cervical and thoracic spine, shoulder, wrist and hand. For example, lateral elbow pain radiating symptoms distally to the forearm may arise from the common extensor tendon or more proximally from the cervical spine (C5–C6) (Neumann, 2010). Be sure to negate all possible areas that might refer or contribute to the area of pain. Mark unaffected areas with ticks (✓) on the body chart.

Quality of Pain

Establish the quality of the pain to assist in determining possible pain mechanisms; for example, sharp, catching pain may indicate an intraarticular dysfunction, whereas a

deep ache localized to the lateral epicondyle with or without distal referral may be indicative of a lateral elbow tendinopathy.

Intensity of Pain

The intensity of pain can be measured as shown in Chapter 3 (see Fig. 3.4) and informs clinical reasoning of symptom severity, which may guide the extent and vigour of the physical examination.

Abnormal Sensations

Check for sensory changes such as paraesthesia, pain or hypersensitivity in the upper limb and/or hand that could indicate neural tissue source. Consider whether symptoms are likely to be peripheral (e.g. in the distribution of the median, radial and ulnar nerves of the forearm and hand or spinal nerve) in origin. Are these symptoms unilateral or bilateral? Has the patient noticed any weakness in the hand? Progressive or deteriorating neurological symptoms of nerve root compression or symptoms of cord compression would require immediate onward referral.

Constant or Intermittent Symptoms

Ascertain the frequency of symptoms, whether they are constant or intermittent. If symptoms are constant, check whether there is variation in the intensity of the symptoms, because constant unremitting pain may be indicative of a serious pathology.

Relationship of Symptoms

The relationship between symptomatic areas can be explored by careful questioning (e.g. Do the symptoms come together or separately? Can the patient experience elbow pain without shoulder or neck pain, or are pains always present together?). Understanding the relationship between symptomatic areas is invaluable in identifying order and selection of assessment and management techniques.

Behaviour of Symptoms

Aggravating Factors

For each area, identify what movements or positions aggravate the patient's symptoms (i.e. what brings them on (or makes them worse)?). Is the patient able to maintain this position or movement (severity)? What happens to other symptoms when this symptom is produced (or is made worse)? How long does it take for

symptoms to ease once the position or movement is stopped (irritability)? The concepts of severity and irritability are discussed in Chapter 3.

The clinician also asks the patient about functional activities that could indicate the source of the symptoms. Common aggravating factors such as pain and stiffness when reaching or flexing the elbow may implicate the humeroulnar and humeroradial joints, whereas pain with gripping, turning a key in a lock and opening a bottle may implicate the common extensor tendon or the superior radioulnar joint. It is important to be as specific as possible when investigating aggravating factors. Where possible, break the movement or activity down into individual components because this may provide clues for what to expect during the physical examination (e.g. throwing action in athletes).

Aggravating factors for other regions may need to be considered if they are suspected to be a proximal or contributing source of the symptoms.

Easing Factors

For each symptomatic area, the clinician needs to explore the easing factors to confirm the relationship between symptoms, determine irritability and clinically reason the source of symptoms.

Painful, swollen elbows may be eased when held in a resting position of approximately 70 degrees flexion, with the hand supported, as in this position the elbow has least intracapsular pressure. It is also important to explore and confirm the relationship of symptoms when altering the position or moving proximal or distal joints. For example, symptoms from neural tissues may be relieved by shoulder girdle elevation, reducing tension on the brachial plexus and nerve roots.

The most notable functional restrictions are highlighted with asterisks (*), then explored in the physical examination and reassessed at subsequent treatment sessions to evaluate treatment intervention.

Twenty-Four-Hour Behaviour of Symptoms

The clinician determines this by asking the following:

Night symptoms. Suggested questions to establish the behaviour of symptoms at night are detailed in Chapter 3. Night pain may arise from sleep positions such as sustained elbow flexion (e.g. ulnar neuropathy).

Morning and evening symptoms. The clinician determines the pattern of the symptoms first thing in the

morning, throughout and at the end of the day. The status of symptoms on first waking establishes whether the patient is better with rest. Pain/stiffness that lasts for more than 30 minutes on waking would suggest an inflammatory component to the disorder.

Special/Screening Questions

Special questions as highlighted in Chapter 3 are routinely asked because these identify certain precautions or contraindications to the physical examination and/or treatment. The clinician must differentiate between musculoskeletal conditions that are suitable for treatment and management and systemic, neoplastic and other nonmusculoskeletal conditions which require referral to a medical practitioner.

In the elbow, the following conditions and findings are particularly relevant and should be noted during the subjective assessment to determine their contribution to elbow dysfunction.

Thyroid dysfunction is associated with a higher incidence of tendinopathy (Cakir et al., 2003), and similarly, diabetes mellitus is linked with tendinopathy, delayed tissue healing and peripheral neuropathy (Boissonnault, 2011). The presence of systemic conditions, which may affect the patient's prognosis, should be taken into account during treatment planning.

Primary bone tumours around the elbow are generally rare. The suspicion of a tumour, primary or secondary, should be raised in the patient with unremitting, unexplained, nonmechanical bony elbow pain (Goodman, 2010a, 2010b) or in someone with a past medical history of carcinoma.

Special Questions—Elbow Joint Specific

The presence of bruising following injury should always be ascertained. Bruising medially or laterally may indicate a ligament tear or possible elbow dislocation, whereas anterior bruising around the elbow crease and into the forearm may indicate a distal biceps rupture, both of which requires urgent onward referral.

Locking of the joint may result from intraarticular bodies catching between joint surfaces. The age of the patient may assist the examiner, in cases of locking, because more elderly patients may have arthrosis, whereas younger patients may have osteochondritis dissecans. Any athlete in his or her second decade presenting with elbow pain should always be considered

to have an osteochondral defect, unless proved otherwise, and warrants an immediate onward referral for further investigation.

In lateral elbow tendinopathy, symptoms usually occur after a period of overuse; however, if of sudden onset during one specific activity, such as a backhand during tennis, a full-thickness tear of the common extensor origin should be suspected, again requiring an onward referral.

Drug History

Previous use of medications such as steroids or the fluoroquinolone group of antibiotics has been linked with tendinopathy or complete tendon ruptures around the elbow. Smoking has also been linked to a sevenfold increased incidence of distal biceps rupture (Safran & Graham, 2002).

Past Medical and Family History

This should include details of any major or long-standing illnesses, accidents or surgery that are relevant to the patient's condition. Family history that is relevant to the onset and progression of the patient's problem is also recorded, including a family history of inflammatory arthritis, inflammatory bowel disease or psoriasis, which predisposes an individual to inflammatory arthritis. Check for a history of trauma or recurrent minor trauma. Patients with a history of elbow dislocation or fractures may be at risk of developing elbow instability secondary to the original injury (Bell, 2008) or secondary arthritis. Ascertain the results of any past treatment for the same or a similar problem. Past treatment records may be obtained for further information.

Elbow Stiffness or Arthritic Conditions

Elbow stiffness can be classified into

- degenerative (osteoarthritis),
- inflammatory, including rheumatoid arthritis and ankylosing spondylitis,
- posttraumatic arthritis—following fracture or instability
- heterotopic ossification following injury (e.g. formation of bone in extra-osseous tissues mostly in muscle or peri-articularly around capsule and ligaments).
- Postinfection (e.g. tuberculosis (TB)).

Rheumatoid arthritis commonly affects the elbow, either unilaterally or bilaterally, whereas primary

degenerative arthritis is less common. Comorbid conditions with known predisposition to elbow stiffness such as haemophilia should be investigated (Nandi et al., 2009). In those with haemophilia, the elbow is prone to haemarthrosis and is cited as the second most commonly affected joint after the knee (Utukuri & Goddard, 2005).

Sudden Swelling

Sudden swelling or sudden loss of range of motion in the absence of trauma suggests infection or inflammation of the joint. Septic arthritis is uncommon in the elbow, but it may be seen in patients with a suppressed immune system or diabetes, those taking cortisone medications or intravenous drug abusers. Sudden swelling over the olecranon may indicate an olecranon bursitis.

Radiography and Medical Imaging

X-rays are the first choice following a traumatic elbow injury, because this helps to establish initial injury and any associated fractures or dislocations. Other medical tests may include blood tests, computed tomography (CT) scans, magnetic resonance imaging or nerve conduction studies.

History of the Present Condition

For each area, the clinician needs to know how long symptoms have been present and if they develop suddenly or gradually. Was there a known cause that provoked the onset of the symptoms? If the onset was traumatic (e.g. a fall), the clinician establishes how the patient fell because identifying the mechanism of injury is essential when establishing a diagnosis (Aviles et al., 2008).

Did the patient fall on the outstretched hand or on the tip of the elbow? Did the bicep contour change, indicating a possible distal biceps rupture? If associated with a throwing action and medial elbow pain, did the patient feel a 'pop', which may indicate an acute ligamentous injury (Cain et al., 2003)?

Ligamentous injuries can result from acute injuries such as a dislocation or fracture, or chronic from repetitive overloading, possibly leading to chronic recurrent instability.

Patterns of instability include:

- Posterolateral rotatory instability—is the most common and usually occurs as a consequence of previous dislocation or fracture.

- Valgus instability—due to injury of the medial ligaments, often seen in throwing athletes.
- Varus instability—due to injury of the lateral ligaments.

Patients with ligament instability may report a diffuse ache and other symptoms, such as clicking, clunking and apprehension, or giving way when moving into elbow extension during weight-bearing activities. However, with chronic medial ligamentous injuries, seen in throwers, symptoms may be present only during throwing and may be accompanied by a loss of throwing velocity or accuracy. In chronic presentations, then part of the examination should include judicious use of joint integrity and ligament tests (Aviles et al., 2008).

Gradual Symptom Onset

With gradual onset, is this associated with a change in the patient's lifestyle (e.g. a new job, leisure activity) or a change in sporting activity? What happened when symptoms first began, and how have symptoms developed or changed? Is this the first episode, or is there a history of elbow problems? If so, how many episodes? When and what duration were they? Did full recovery occur between episodes? Has the patient had any episodes of pain stiffness in the spine or other upper limb joints?

Stage of the Condition

To determine the stage of the condition, ascertain whether the symptoms are getting better or worse or remain unchanged.

When all this information has been collected, the subjective examination is complete. For ease of reference, highlight with asterisks (*) important subjective findings and one or more functional restrictions. These can be reexamined at subsequent treatment sessions to evaluate treatment intervention.

KNOWLEDGE CHECK

1. What common resting position eases painful swollen elbows and why?
2. What might locking of the elbow indicate?
3. Why is exploring patient's beliefs important in management of elbow fractures?
4. Name common systemic conditions that are linked with a higher incidence of tendinopathy.
5. What could sudden elbow swelling indicate?

Plan of the Physical Examination

During the subjective examination the clinician will begin to form hypotheses based on verbal and nonverbal communication. This information enables the clinician to plan the physical examination and provides the clinician with a clear outline of what is safe and purposeful, whilst addressing the following key questions.

Precautions and Contraindications

The clinician must first establish whether the patient has a musculoskeletal dysfunction and then identify whether this is suitable for manual and exercise therapy. Within the elbow, specific contraindications and precautions may include recent fracture, trauma, suspicion of heterotopic ossification or long-term steroid therapy. Beyond the elbow, contraindications such as neurological nerve root compression with deteriorating symptoms will also need consideration. Identifying and reviewing any precautions or contraindications will indicate if caution is needed and help the clinician decide on the sequencing, extent and suitability of clinical examination tests. The elbow extension test can be used as a screening test for suspected fractures, confirming the need for immediate onward referral/radiological evaluation (Appleboam et al., 2008). Lack of extension following trauma indicates a 95% chance of fracture, whilst full extension results in less than 5% of risk.

Developing Working and Alternative Hypotheses

Based on the subjective information the clinician's clinical reasoning will help to identify a working hypotheses and possible sources/structures that could be the cause of the patient's symptoms, including local and remote structures (e.g. joints, muscles, nerves and fascia). Remote regions which may need to be examined are the cervical and thoracic spine, shoulder, wrist and hand. In complex cases it is not always possible to examine fully all sources at the first attendance, and so, using clinical reasoning skills, the clinician will need to prioritize what 'must' be examined in the first assessment session and what 'should' or 'could' be followed up at subsequent sessions. Table 11.2 shows a suggested planning sheet for this.

What Is the Predominant Pain Mechanism?

Pain has been classified into nociceptive, peripheral neuropathic, central sensitization and autonomic

TABLE 11.2 Must, Should and Could List of Planning^a

Must	Should	Could
• Observation (informal and formal) • Body chart and relationship of symptoms • Brief appraisal of cervical and thoracic spine active range • Brief appraisal of shoulder/shoulder girdle position and relationship to elbow • Functional demonstration • Active range of movements, noting range, quality and symptom response • Flexion • Extension • Supination • Pronation • Passive range of movements, noting range, quality and symptom response • Flexion, • Extension • Supination • Pronation • Palpate elbow structures: • Olecranon and fossa, humeroulnar, humeroradial and superior radioulnar joint • Anterior capsule, collateral ligaments, annular ligament • Relevant nerve palpation points for ulnar, radial and median nerves • Common flexor and extensor tendons • Accessory movements • Muscle testing, including grip assessment, length and strength tests • Ligamentous testing—only in cases of suspected instability • Hook test—for suspected distal biceps tear only	• Brief appraisal of shoulder, wrist and hand active movements • Neural and neurodynamic tests	• Differentiation testing—neural, arthrogenic and myogenic • Brief appraisal of the thoracic spine active movements • Passive physiological and accessory intervertebral movements of cervical/thoracic spine

^aTests would be selected depending on the type of dysfunction/condition and therefore would be prioritized according to the presenting patient's symptoms.

(van Griensven, 2014). The subjective examination should enable the clinician to reason clinically the symptoms' predominant pain mechanism. Clearly establishing which pain mechanisms may be causing and/or maintaining the condition will help the clinician to manage both the condition and the patient appropriately.

Sequence and Extent of Physical Tests

The severity, irritability and nature of the condition are the key factors that will influence the choice and priority

of physical testing procedures. With severe or irritable symptoms, physical tests may be carried out to just before or to the initial onset of symptom production, with fewer physical tests being examined. If the patient has constant and severe and/or irritable symptoms, then the clinician aims to find physical tests that ease the symptoms. If the patient's symptoms are nonsevere and nonirritable, then physical tests that reproduce each of the patient's symptoms should be used and may include combined, sustained or repetitive movements.

PHYSICAL EXAMINATION

The clinician should have a preferred primary clinical hypothesis after the subjective examination, and the purpose of the physical examination is to confirm or refute this hypothesis. The physical planning sheet should outline what needs to be examined. The order and detail of the tests described later will need to be modified for the patient being examined; some tests will be irrelevant, some tests will be carried out briefly, others more fully. It is important to recognize that the techniques shown in this chapter are not exhaustive and that there are many modifications and variations which can be used. It is also important to understand that the reliability, sensitivity and specificity will vary between all physical tests (see Chapter 4). The diagnostic accuracy of the elbow tests which have the best available evidence to support their use has been presented and may be helpful for the clinician in appraising their clinical utility. Each significant physical test that either provokes or eases the patient's symptoms is highlighted in the patient's notes by an asterisk (*) for easy reference.

Observation

Informal Observation

Informal observation occurs throughout the consultation. The clinician should observe the patient in dynamic and static situations, assessing the patient's ability and willingness to move the upper limb, the quality of movement and any associated facial expressions.

Formal Observation

This is particularly useful in helping to determine the presence of predisposing factors such as abnormal bony alignments, preferred patterns of muscle use and observation of resting muscle lengths.

Observation of posture. The clinician assesses the bony landmarks and soft-tissue contours of the elbow region, as well as the patient's cervical spine, shoulder, wrist and hand. Careful examination of the neck and shoulder should be performed in elbow pain of insidious onset to exclude possible referral of symptoms.

Observation of bony alignment. The clinician may initially observe the relative position of the olecranon

and the medial and lateral epicondyles. They should form a straight line with the elbow in extension and an isosceles triangle with the elbow in 90 degrees flexion (Fig. 11.1) (Magee & Manske, 2021). Anatomical and gender variations may alter this alignment; however, gross alterations in this positioning may indicate a fracture, dislocation, a malunion or a congenital deformity.

The clinician can assess the carrying angle of the elbow by placing the patient's arm in the anatomical position. The normal carrying angle is 5 to 10 degrees in males and 10 to 15 degrees in females; greater than 15 degrees is cubital valgus, and less than 5 to 10 degrees is cubital varus (Magee & Manske, 2021). The carrying angle should be symmetrical on each side. A fracture of the distal humerus may result in a cubital varus or a gun stock deformity. Cubital varus and valgus may also result from collateral ligament instability.

Hyperextension of up to $-5/-10$ degrees in the elbow, especially in females, can be normal. Increased resting elbow extension may be a result of hyperextension/lax anterior capsule and may indicate screening for generalized hypermobility should be considered (Simmonds & Keer, 2007). Decreased resting elbow flexion may suggest elbow joint stiffness or tight elbow flexor muscles.

Observation of bruising. The presence of bruising around the elbow should always be noted, with its

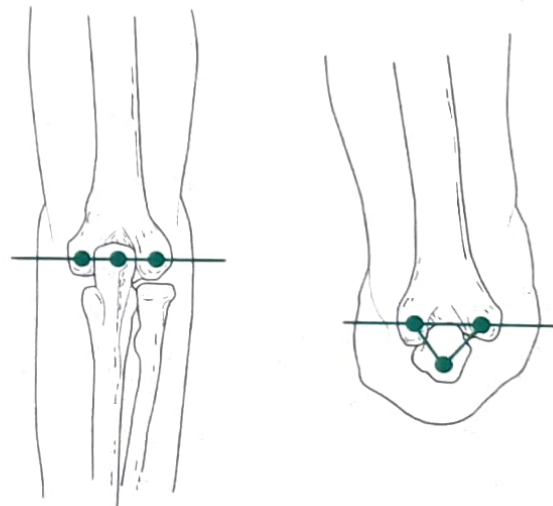


Fig. 11.1 The position of the olecranon and medial and lateral epicondyles should form a straight line with the elbow in extension and an isosceles triangle with the elbow flexed to 90 degrees. (From Magee & Manske, 2021, with permission.)

significance previously discussed in the special questions—elbow-specific section.

Observation of swelling. Swelling at the elbow can occur within the joint or be discrete. Because the elbow joints share a capsule, joint swelling will affect all three joints and the elbow may be held in a semiflexed position (approximately 70 degrees). On the lateral aspect of the elbow, intraarticular swelling may be noted as fullness in the triangular space between the lateral epicondyle, head of the radius and tip of the olecranon. Posteriorly swelling of the olecranon bursa may be observed (Magee & Manske, 2021). An infected olecranon bursa may be associated with fever and erythema.

Observation of muscle form. The clinician examines the patient's upper limb muscle bulk and tone, comparing both sides. It must be remembered that handedness and level and frequency of physical activity may well produce differences in muscle bulk between sides. Care should be taken to note any changes in biceps contour, because a distal biceps rupture will result in a proximal biceps bulge.

Wasting in the muscles of the hand could indicate a possible peripheral nerve entrapment. Loss of muscle bulk of the intrinsic, particularly in the first dorsal interosseous space, is seen with ulna nerve lesions, along with Wartenberg sign of an abducted little finger secondary to the unopposed action of extensor digiti minimi.

Functional Testing

Informal and formal observation would already include some assessment of functional ability. Asking the patient to demonstrate a functional task such as eating will help to provide invaluable clues as to the potential structures involved. For example, eating involves elbow flexion (up to 120 degrees), supination (for positioning a spoon or fork) and shoulder flexion. Any motion deficits will quickly become apparent. Other examples of functional activities may include using the arm to rise out of a chair, throwing an object, gripping and carrying a bag.

Active Physiological Movements

Flexion and extension are the primary movements that occur at the humeroulnar and humeroradial joints. Pronation and supination are predominantly centred around the superior/inferior radioulnar joints, although there will be some contribution from the humeroradial joint (Magee & Manske, 2021). Active physiological movements of the elbow complex should be performed first, comparing sides, and be sequenced so that the

most painful movements are performed last. The clinician establishes symptoms at rest prior to each movement and corrects any compensatory movement to determine its relevance to the patient's symptoms. Active physiological movements of the elbow and forearm and possible modifications are shown in Table 11.3. The clinician notes the following:

- range of movement
- quality of movement—for example, compensatory shoulder adduction and abduction can occur during supination and pronation respectively, giving the appearance of a normal range
- behaviour of pain through the range of movement
- resistance through range and at the end of movement
- provocation of any muscle spasm, guarding or apprehension which may be indicative of pain or ligament instability.

Where appropriate, active movements can be tested with overpressure with the patient lying supine or sitting (Fig. 11.2).

TABLE 11.3 Active Physiological Movements and Possible Modifications

Active Physiological Movements

Elbow flexion
Elbow extension
Forearm pronation
Forearm supination

Possible Modifications to Physiological Movements

Repeated
Speed altered
Combined movements and sequencing, e.g.
• Elbow flexion with pronation or supination
• Elbow pronation with elbow flexion or extension
Sustained
Injuring movement
Differentiation tests
Functional movements

Identify any effect of the modifications of physiological movements on patient's signs and symptoms

Reassess all *asterisks

If necessary, screen any proximal and distal regions that may refer to the area

Cervical spine
Thoracic spine
Shoulder
Wrist and hand



Fig. 11.2 Overpressures to the elbow complex. (A) Flexion. The left hand supports underneath the elbow while the right hand flexes the elbow. (B) Extension. The right hand supports underneath the elbow while the left hand extends the elbow. (C) Supination. (D) Pronation. The arrows represent the direction of the clinician's force.

Symptom Modification or Differentiation Testing

Various differentiation tests (Hengeveld & Banks, 2014) can be performed, and selection will depend on the patient's signs and symptoms. For example, when elbow flexion reproduces the patient's elbow pain, differentiation between the humeroradial and humeroulnar joint may be required.

The 'grip and grind' test, performed by asking the patient to rotate the loaded forearm with the elbow flexed at 90 degrees, whilst gripping the examiners hand, (like turning a door handle), will load the radiohumeral joint and confirm pathology if pain is encountered; it is positive in intraarticular conditions such as osteoarthritis, or osteochondral defects in adolescent patients.

Passive Physiological Movements

All active movements can be examined passively with the patient usually in supine, comparing sides. The clinician feels through range for restriction and/or reproduction of symptoms and assesses end-feel of the joint in the following movements (Fig. 11.3):

- elbow flexion
- elbow extension
- forearm pronation
- forearm supination
- combined movements (e.g. extension/abduction)

Joint Integrity Tests

These are included in the assessment when the history suggests a chronic instability (clicking, loss of control or throwing performance). A provocative test is used to investigate the presence of instability and therefore care should always be taken. For all of the following tests, a positive test is traditionally indicated by excessive movement relative to the unaffected side. However, 'patient apprehension' can also be considered positive

with the patient requiring onward referral for further investigation.

Medial Collateral Ligament Testing

The valgus test. The integrity of the medial collateral ligament (MCL) is tested by applying an abduction force to the forearm with the elbow in 30 degrees flexion, to unlock the olecranon from the fossa, and the forearm in supination. The clinician uses one hand to stabilize the humerus in external rotation, thereby ensuring that the tension is directed at the MCL (Fig. 11.3E). Where medial elbow pain is used as the criteria for a positive test, sensitivity is 65% and specificity is 50%, but where laxity is used as the criteria for a positive test, sensitivity is 19% and specificity is 100% (O'Driscoll et al., 2005).

The moving valgus stress test examines the MCL through range (Fig. 11.4). In the seated position, the clinician externally rotates and abducts the shoulder to 90 degrees and then passively extends the elbow whilst simultaneously applying a constant valgus force. Medial



Fig. 11.3 Passive physiological movements to the elbow complex. (A) Abduction. The right hand stabilizes the humerus while the left hand abducts the forearm. (B) Adduction. The right hand stabilizes the humerus while the left hand adducts the forearm.

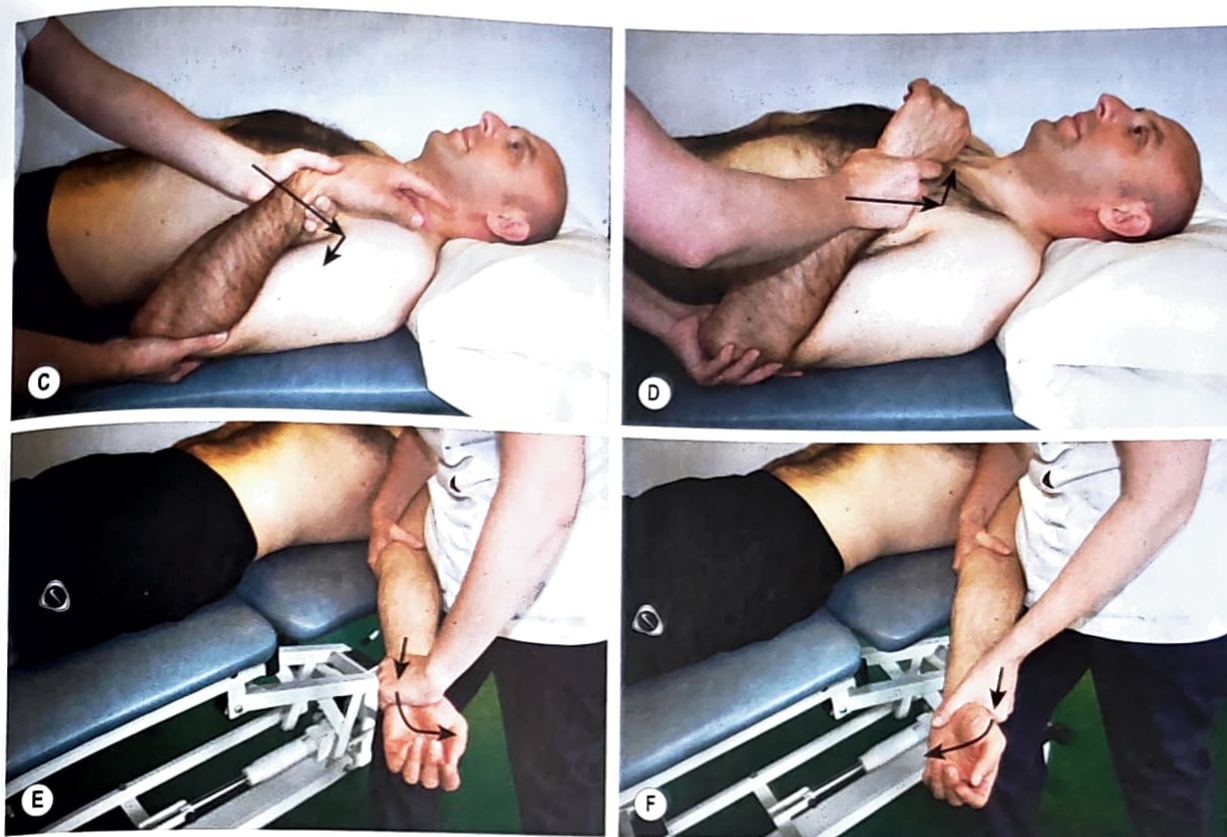


Fig. 11.3, cont'd (C) Flexion/abduction. The right hand supports underneath the upper arm while the left hand takes the arm into flexion and abduction. (D) Flexion/adduction. The left hand supports underneath the upper arm while the right hand takes the arm into flexion and adduction. (E) Extension/abduction. The right hand supports underneath the upper arm while the left hand takes the arm into extension and abduction. (F) Extension/adduction. The right hand supports underneath the upper arm while the left hand takes the forearm into extension and adduction. The arrows represent the direction of the clinician's force.

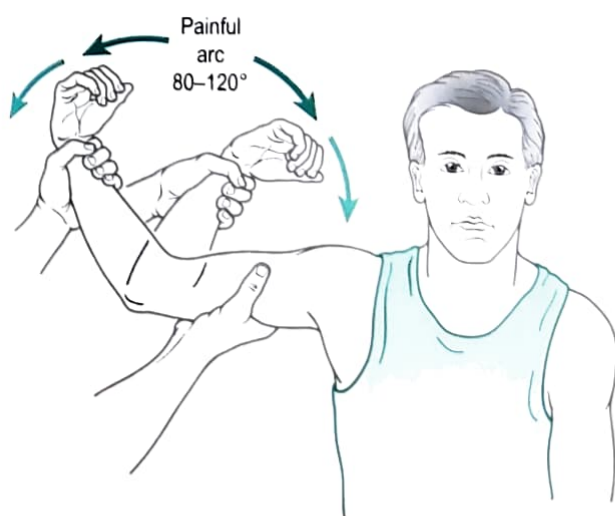


Fig. 11.4 Moving valgus stress test. (From Magee et al., 2009, with permission.)

elbow pain between an arc of 120 and 70 degrees of elbow flexion is considered a positive test (O'Driscoll et al., 2005). The moving valgus stress test for MCL tears of the elbow has been found to be sensitive (100%) and specific (75%), with likelihood ratios (LRs) of LR+ 4 and LR- 0 in a small population study by O'Driscoll et al. (2005).

Lateral Collateral Ligament Testing

The lateral collateral ligament complex is tested by applying a varus force to the forearm with the elbow in 30 degrees flexion, to unlock the olecranon from the fossa. The clinician should use one hand to stabilize the humerus in internal rotation. Quality of end-feel, excessive movement or reproduction of the patient's symptoms is a positive test and suggests instability of the elbow joint (Volz & Morrey, 1993). No diagnostic

accuracy studies of this test have been performed to determine the sensitivity and specificity values.

Tests for posterolateral rotatory instability. Recurrent posterolateral instability of the elbow can be difficult to diagnose and requires a careful history and

examination. It results from a rotatory subluxation of the radius and ulna relative to the humerus. The lateral ulnar collateral ligament is cited as the primary culprit in this form of elbow instability. The three tests described next should be examined sequentially, and if

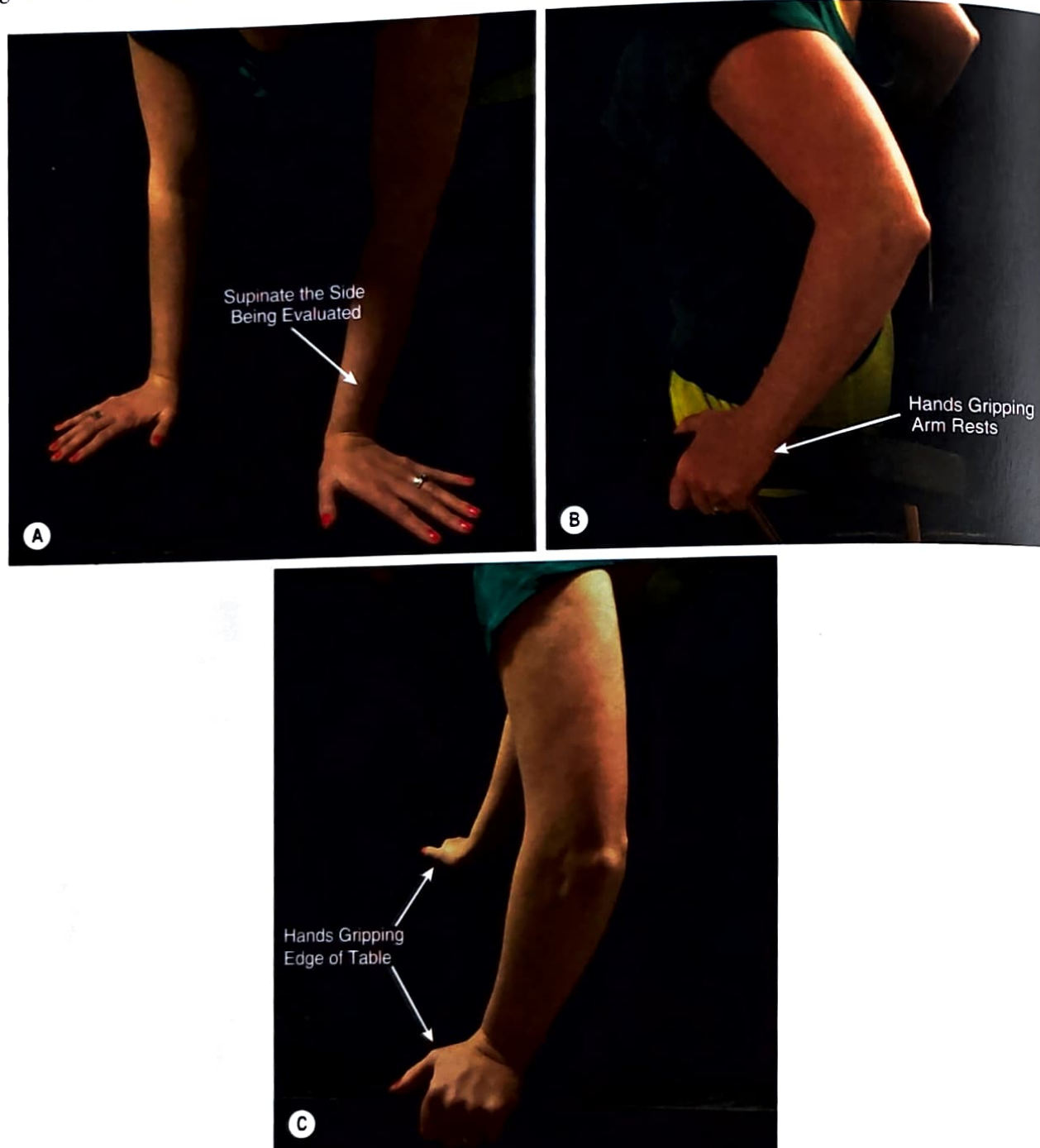


Fig. 11.5 The prone push-up test (A), the chair push-up test (B), and the tabletop relocation test (C) are additional methods for assessing posterolateral rotatory instability. In these figures, the patient's left elbow is evaluated as they push up from a flexed and supinated position into an extended position. The patient's body weight applies the necessary axial load. Each of these examinations relies on the patient pushing themselves up, which reduces apprehension because they are in control of the force and pace. A positive test is noted when the patient experiences lateral elbow pain, instability, or apprehension. (From Camp et al., 2017)

any test is positive, the remaining tests are abandoned (Fig. 11.5A–C).

Table-top relocation test. The patient stands in front of a table, hand placed over the lateral edge of a table, elbow flexed and pointing laterally, with forearm supinated. Ask patient to perform a press up with the symptomatic arm. Positive test is pain or apprehension around 40 degrees of flexion. Sensitivity for this test was reported at 100% (Arvind & Hargreaves, 2006).

Stand-up test/chair push-up test. Patient position is seated, both elbows 90 degrees flexion, holding armrests with shoulder abduction and forearm supinated. Ask the patient to arise from the chair by pushing down on both arms. A positive test is where pain increases as the elbow moves into an extended position. The sensitivity of this test is reported as 88% (Regan & Lapner, 2006; Anakwenze et al., 2014).

Push-up test. Patient lies prone with their chest on floor, elbows flexed to 90 degrees, shoulders abducted and forearms supinated. The patient is then asked to perform a push up. A positive test is apprehension, pain or radial head dislocation during the test. The sensitivity of the test is reported at 88% (Arvind & Hargreaves, 2006; Regan & Lapner, 2006).

Muscle Tests

Muscle tests include examining muscle strength, length and isometric muscle testing. The muscles that need testing will depend on the area of symptoms and functional aggravating movements.

Muscle Strength

A complete assessment of a muscle's strength would include testing the muscle isotonicity through the available range. During the physical examination of the elbow, it may be appropriate to test the elbow flexors/extensors, pronators and supinators, wrist flexors, extensors, radial and ulnar deviators and any other muscle groups of relevant regions. Grip strength testing using a hand-held dynamometer is especially useful in the assessment and treatment of lateral elbow tendinopathy.

Muscle Length

To determine if the muscles of the elbow, wrist and hand are tight, passive muscle length tests are performed. The outcome of the length test may be affected by factors such as starting position of shoulder, elbow and forearm and whether the muscles are two-joint muscles. For example, passive tension in the triceps muscle may limit elbow flexion if the test starting position is in shoulder

flexion or if the shoulder simultaneously moves into flexion during the test. To test triceps, the patient should be tested in sitting with the arm passively taken into full shoulder elevation while the elbow is extended. The elbow is then passively flexed, and range and end-feel of elbow flexion are noted.

Isometric Muscle Testing

The clinician tests the elbow flexors, extensors, forearm pronators, supinators, wrist flexors, extensors, radial deviators and ulnar deviators (and any other relevant muscle group), in different parts of the physiological range and, if indicated, in sustained positions with or without load. In the elbow, the greatest amount of isometric elbow flexion is found in the position of 90 to 100 degrees, with the forearm supinated. Elbow flexion ranges above or below this position significantly reduce the available isometric power (Magee & Manske, 2021). The clinician notes the strength and quality of the contraction, as well as any reproduction of the patient's symptoms. Fig. 11.6 demonstrates basic isometric elbow and wrist muscle strength tests.

Test for Muscle Integrity

A visible defect of proximal retraction of the biceps muscle belly can indicate a tendon rupture. This may be accompanied by weakness and pain in supination and, to lesser degree, weakness in elbow flexion. The hook test can be used to evaluate for the presence of an intact distal biceps tendon (O'Driscoll et al., 2007). The patient abducts the shoulder, flexes the elbow to 90 degrees and actively supinates the forearm while the examiner attempts to hook an index finger laterally under the tendon (Fig 11.7). The test is negative if the finger can be inserted 1 cm under the tendon and positive if no cord-like structure can be hooked. Sensitivity has been reported at 80% and specificity at 100% (O'Driscoll et al., 2007).

Triceps injuries are rare but may present with swelling, bruising and a palpable gap in the triceps tendon. Weakness is demonstrated by the individual being unable to extend the elbow against gravity.

Special Tests

Repeated microtrauma to the common flexor and extensor tendon origins can produce degenerative changes. Provocative tests are commonly used; however, few diagnostic accuracy studies are available to determine the clinical utility of these tests (Cook & Hegedus, 2013).



Fig. 11.6 Positioning for isometric resisted movements. Black arrows indicate clinician's direction of resistance, and white arrows represent the patient's action. (A) Elbow extension. (B) Elbow flexion. (C) Elbow/forearm supination. (D) Elbow/forearm pronation. (E) Wrist extension. (F) Wrist flexion.

Lateral elbow tendinopathy (tennis elbow tests). Pain over the lateral epicondyle accompanying gripping of the hand is generally associated with a diagnosis of tennis elbow or lateral elbow tendinopathy. Provocative clinical examination tests are used to reproduce pain and are as follows:

Cozens test—The clinician supports the patient's arm in elbow extension and then asks the patient to make a fist and resist to the wrist extensors

isometrically—reproduction of pain at the lateral aspect of the elbow indicates a positive test.

Maudsley test—resisted extension of the third proximal interphalangeal joint activating extensor carpi radialis brevis—reproduction of pain or weakness over the lateral epicondyle indicates a positive test.

No data are available for the sensitivity or specificity of the Maudsley or Cozen test.



Fig 11.7 Hook test for distal biceps rupture at the elbow. It is important to do the “hook” from lateral to medial. (From Magee & Manske, 2021)

Grip strength test—The patient is seated, holding a handheld dynamometer, with the shoulder adducted and the forearm in the mid pro and supination position, wrist neutral. The patient squeezes the dynamometer as strongly as possible, firstly in 90 degrees elbow flexion and secondly in full elbow extension. A 5% or more decrease in grip strength between flexion and extension indicates lateral elbow tendinopathy, with sensitivity reported as 78% and specificity at 80% (Dorf et al., 2007).

Both sides are compared for grip strength, but variance due to hand dominance needs to be accounted for. The pain-free grip test is a reliable, valid and sensitive measure of the physical impairment of lateral elbow tendinopathy (Coombes et al., 2009). Most protocols recommend performing the pain free grip test with the elbow in relaxed extension and forearm pronation, repeating the test 3 times, at 1-minute intervals. The average of these three tests is then compared against the contralateral arm (Coombes et al., 2009; Lim, 2013). Ensure that the test position is documented, because alternative test positions can be used.

Symptom modification for lateral elbow tendinopathy. Although largely seen as treatment techniques, mobilization with movements can serve as a useful differentiation tool. In the elbow, accessory glides to the humeroulnar joint and the radial head may reduce pain during gripping activities. To test, the patient is

positioned supine with the upper limb fully supported and holding a grip dynamometer. The clinician applies a lateral glide to the humeroulnar joint as the patient actively grips (Fig. 11.8). For patients with suspected tennis elbow, pain relief is a positive finding. Similarly, applying a posteroanterior glide to the radial head while the patient performs gripping may also be helpful in relieving pain. These techniques can be used to confirm and refute hypotheses of lateral elbow tendinopathy and may be helpful in guiding future management.

Medial elbow tendinopathy (golfer's elbow test). Isometric contraction of the flexor muscles of the wrist and hand can be examined for common flexor origin pain. Reproduction of pain or weakness on wrist flexion or forearm pronation over the medial epicondyle indicates a positive test. Tenderness on palpation of the area will also help to confirm a diagnosis.

Neurological Tests

Neurological examination includes neurological integrity testing, neural sensitization tests and testing for compression neuropathy. The extent of symptoms will determine the appropriate neurological examination to be carried out.

Dermatomes/Peripheral Nerves

Following trauma or compression to peripheral nerves, it is vital to assess cutaneous sensation. Knowledge of



Fig. 11.8 (A) Lateral elbow mobilization with movement. The clinician applies a sustained lateral humeroulnar accessory glide while the patient grips and relaxes the dynamometer or performs the painful action. If there is significant improvement in the pain-free grip, then the clinician repeats the technique for 6 to 10 repetitions. A belt as in the example may be used to assist the accessory glide. (B) Radial head posteroanterior mobilization with movement. The clinician applies a sustained posterior–anterior accessory glide over the radial head whilst the patient grips and relaxes the dynamometer or performs the painful action. If there is significant improvement in the pain-free grip then the clinician repeats the technique for 6 to 10 repetitions. The arrows represent the direction of the clinician's force.

the cutaneous distribution of nerve roots (dermatomes) and peripheral nerves—radial (C5–T1), median (C5–T1) and ulnar (C7–T1)—enables the clinician to distinguish the sensory loss due to a nerve root lesion from that of a peripheral nerve lesion. Testing for sensory loss must therefore involve the whole upper limb and not just the elbow. The cutaneous nerve distribution and dermatome areas are shown in Chapter 4.

Myotomes/Peripheral Nerves

A working knowledge of the muscular distribution of nerve roots (myotomes) and peripheral nerves enables the clinician to distinguish motor loss due to a root lesion from that due to a peripheral nerve lesion. The peripheral nerve distributions are shown in Chapter 4.

Neurodynamic Tests

The upper-limb neurodynamic tests (1, 2a, 2b and 3) may be carried out to ascertain the degree to which neural tissue is responsible for the production of the patient's elbow symptom(s). These tests are described in detail in Chapter 4.

Testing for Ulnar Nerve Instability

Ulnar nerve instability, which has been identified in 37% of elbows, can be determined by having the patient actively extend the elbow with the forearm in supination, placing a finger at the posteromedial aspect of the medial humeral epicondyle and having the patient actively

extend the elbow. The nerve dislocates if trapped anterior to the examiner's finger (Calfee et al., 2010).

Ulnar nerve compression neuropathy tests. Compression neuropathies are common in the elbow. Ulnar neuropathy of the elbow is the second most common entrapment neuropathy in the upper extremity. Ulnar neuropathy can be caused by habitual and repetitive activities (e.g. leaning on the elbows), trauma, including fractures and dislocations, rheumatic and degenerative joint disease and immobilization during surgery.

Tinel test. The clinician taps the cord-like ulnar nerve, where it lies in the groove between the olecranon and the medial epicondyle and repeats four to six times. A positive sign is indicated by paraesthesia in the distribution of the ulnar nerve (Hattam & Smeatham, 2010; Magee & Manske, 2021). Novak et al. (1994) investigated the diagnostic accuracy of this test and found values of 70% for sensitivity and 98% for specificity in a small population group; however, up to 30% of asymptomatic individuals also present with a positive test, indicating this test alone should not be used in the diagnosis of cubital tunnel syndrome.

Elbow flexion test for cubital tunnel syndrome. The cubital tunnel is formed by a tendinous arch connecting humeral and ulnar heads of flexor carpi ulnaris approximately 1 to 2 cm distal to the medial epicondyle. During elbow flexion, the cubital tunnel narrows, causing an increase in pressure on the nerve. To test for cubital tunnel syndrome the patient sits with elbow

fully flexed with the forearm in supination and wrist in neutral for at least 1 minute. Variations in both the test position and the length of hold recommended do exist; however, sustained elbow flexion is common to all. A positive sign is indicated by paraesthesia or numbness in the distribution of the ulnar nerve (Buehler & Thayer, 1988). The sensitivity of elbow flexion with a hold of 30 seconds has been demonstrated by Novak et al. (1994) at just 32%, and this increases to 75% with a hold of 60 seconds. This low to moderate sensitivity suggests that the clinical examination needs to be combined with the subjective examination to aid the diagnosis of cubital tunnel syndrome. The most sensitive provocative test in the diagnosis of cubital tunnel syndrome was elbow flexion with a hold of 60 seconds when combined with pressure on the ulnar nerve (sensitivity 98% and specificity 95%; Novak et al., 1994).

Froment test. This test can be performed to assess the adductor pollicis, innervated by the ulna nerve. The examiner places the hands together with flat palms and holds a piece of paper between the thumbs and index fingers. The patient mirrors the examiner and tries to pull the paper away from the patient. If there is weakness, due to ulna nerve entrapment, the patient will instinctively flex the interphalangeal joint of the thumb using the strength of flexor pollicis longus, innervated by the anterior interosseous portion of the median nerve.

Median nerve compression neuropathy tests. Median nerve entrapment is less common in the elbow; however, proximal injury is well described, particularly around the origin of the anterior interosseous nerve (anterior interosseous syndrome), around pronator teres (pronator syndrome) or at the ligament of Struthers (supracondylar process syndrome), giving rise to symptoms similar to those seen in carpal tunnel syndrome. Common provocative tests are commonly used; however, no diagnostic accuracy studies are available to determine the sensitivity and specificity for these particular tests (Cook & Hegedus, 2013).

Pinch-grip test. This tests for anterior interosseous nerve entrapment (anterior interosseous syndrome) between the two heads of pronator teres muscle (Magee & Manske, 2021). The test is considered positive if the patient is unable actively to pinch the tips of the distal interphalangeal joints of the index finger and thumb together. The test is also known as the OK sign.

Test for pronator syndrome. With the elbow flexed to 90 degrees, the clinician resists pronation as the elbow

is extended. Tingling in the distribution of the median nerve is a positive test. This involves compression of the median nerve just proximal to the formation of the anterior interosseous nerve (Magee & Manske, 2021). In addition to the anterior interosseous syndrome, with a weakened pinch grip, described previously, the flexor carpi radialis, palmaris longus and flexor digitorum muscles are affected, thus weakening grip strength; there is also sensory loss in the distribution of the median nerve.

Radial nerve compression. Radial tunnel syndrome is uncommon and often goes undiagnosed due to the relative absence of hard signs or symptoms, with pain the only finding. Compression of the proximal portion of the radial nerve in the forearm can be identified with pain approximately 2 to 3 cm distal to the common extensor origin with sustained pressure, in comparison with the contralateral elbow. There are generally no motor findings, and neurophysiology can be normal.

The posterior interosseous nerve, a branch of the radial nerve, may be injured at the elbow, as it passes through the supinator muscle (arcade of Frohse), causing posterior interosseous nerve syndrome. This presents with lateral elbow pain and weakness in the wrist extensors and ulnar deviators of the wrist. Radial deviation is intact. Symptoms can be reproduced with resisted supination.

Vascular Considerations in Examination and Assessment

Palpation of Pulses

The incidence of elbow neurovascular injury is rare but may occur following elbow dislocation and reduction. Cyanosis, pallor, lack of pulses and marked pain may suggest vascular injury or possible compartment syndrome. If compromised circulation is suspected, then palpate the brachial artery on the medial aspect of the humerus in the axilla and in the cubital fossa and check the radial artery at the wrist (Carter et al., 2010).

Palpation

The structures in the elbow region are relatively superficial and accessible to palpation. Sound knowledge of anatomy and structural relations will help the clinician to conduct a systematic and informative examination whilst noting the following:

- temperature of the area
- presence of oedema or effusion; using a tape measure and comparing sides

- mobility and feel of superficial tissues (e.g. ganglions, nodules and scar tissue)
- pain provoked or reduced on palpation; positive Tinel sign on nerve palpation
- crepitus or clicking—clicking over the radial head as the elbow moves into combined flexion and pronation, may indicate the presence of a plica.

Suggested Approach to Systematic Palpation

- Anteriorly: cubital fossa, distal biceps tendon, median nerve medial to the biceps tendon and brachial artery and head of the radius (confirmed by pronation and supination of the forearm).
- Medially: flexor pronator muscles, fan-shaped MCL and the ulnar nerve posterior to medial epicondyle.
- Laterally: wrist extensors, brachioradialis and supinator, cord-like lateral collateral ligament and annular ligament.
- Posteriorly: olecranon process, triceps and anconeus tendon insertions.

Common palpation findings:

- Laterally, fullness in the area behind the lateral epicondyle may indicate an increase in synovial fluid. Tenderness of the lateral epicondyle/common extensor tendon is typical of lateral elbow tendinopathy
- Posteriorly, the olecranon bursa, if inflamed, may be palpable and visible. Rheumatoid nodules may be present on the posteromedial aspect of the elbow.

It is useful to record palpation findings on a body chart (see Fig. 3.2)

Accessory Movements

The clinician notes the:

- quality of movement
- range of movement
- resistance through the range and at the end of the range of movement
- behaviour of pain through the range
- provocation of any muscle spasm.

Humeroulnar joint (Fig. 11.9), humeroradial joint (Fig. 11.10), superior and inferior radioulnar joint (Figs 11.11 and 11.12) accessory movements are listed in Table 11.4. Note that each of these accessory

movements will move more than one of the joints in the elbow complex—for example, a medial glide on the olecranon will cause movement at the superior radioulnar joint as well as the humeroulnar joint.

Following accessory movements, the clinician reassesses all the physical asterisks (movements or tests that have been found to reproduce the patient's symptoms) to establish the effect of the movements on the patient's signs and symptoms. Accessory movements can then be tested for other regions suspected to be a source of or contributing to the patient's symptoms. Regions likely to be examined are the cervical spine, thoracic spine, shoulder, wrist and hand (see Table 11.4).

KNOWLEDGE CHECK

1. What structures may be injured, seen by the presence of bruising at the elbow?
2. Which test has been shown to be sensitive and specific in the diagnosis of lateral elbow tendinopathy?
3. What device can be used to tests grip strength?
4. Identify a symptom modification identified as useful in differentiating lateral elbow tendinopathy.
5. Name and describe the tests used to examine for ulnar nerve entrapment.

COMPLETION OF THE EXAMINATION

On completion of the physical examination, the clinician will need to collate the information to evaluate and revisit how findings compare with expected findings, based on the initial working hypothesis. Throughout the physical examination the hypothesis is revisited and refined (adapted from Jones & Rivett, 2004):

- What can and can't the patient do? How are symptoms impacting on the patient's life?
- What are the mechanisms of symptoms (include anatomy, biomechanics, mechanism of injury, pain mechanism, stages of tissue healing,). Are they arthrogenic/myogenic/neurogenic?
- What are the physical impairments and associated structures/tissue sources driving the patient's symptoms?
- Does this patient's problem have any other contributing factors that may be influencing the onset or



Fig. 11.9 Humeroulnar accessory movements. (A) Medial glide on the olecranon. The left hand supports underneath the upper arm, and the right heel of the hand applies a medial glide to the olecranon. (B) Lateral glide on the olecranon. The right hand supports the forearm while the left hand applies a lateral glide to the olecranon. (C) Longitudinal caudad. Longitudinal caudad can be applied directly on the olecranon; (Ci) the left hand supports underneath the upper arm and the right heel of the hand applies a longitudinal caudad glide to the olecranon or (Cii) the left hand stabilizes the upper arm and the right hand grips the shaft of the ulna and pulls the ulna upwards to produce a longitudinal caudad movement at the humeroulnar joint. (D) Compression. The left hand supports underneath the elbow while the right hand pushes down through the shaft of the ulna. The arrows represent the direction of the clinician's force.



Fig. 11.10 (A and B) Humeroradial movements.

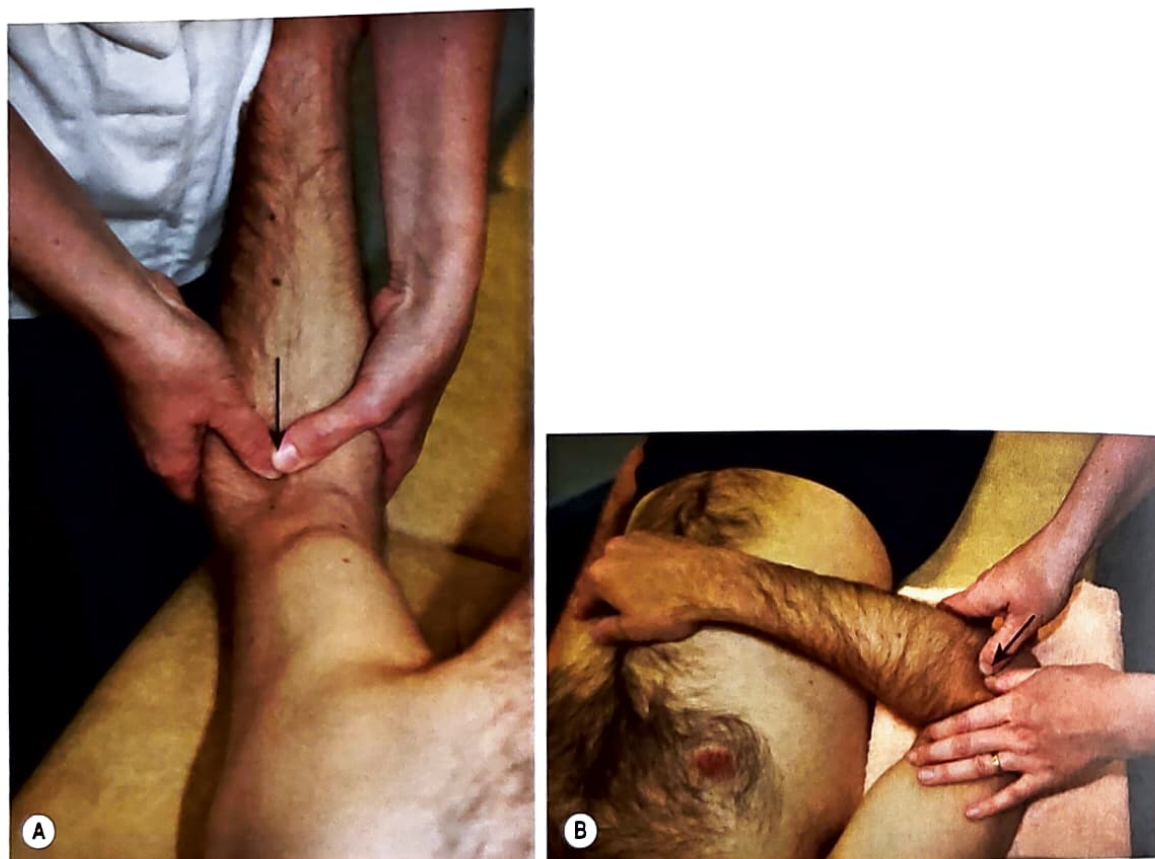


Fig. 11.11 Superior radioulnar joint accessory movements. (A) Anteroposterior. Thumb pressure is applied slowly through the soft tissue to the anterior aspect of the head of the radius. (B) Posteroanterior. Thumb pressure is applied to the posterior aspect of the head of the radius. The arrows represent the direction of the clinician's force.

- maintenance of symptoms (e.g. environmental, psychosocial, behavioural, physical or heredity factors)?
- Are there any precautions/contraindications to treatment and management? This includes the severity and irritability of the patient's symptoms and the underlying cause(s) of the patient's symptoms.
- Where will initial management/treatment be focused?
- Assessing prognosis—this can be affected by factors such as the stage and cause of symptoms, patient's expectations, personality and lifestyle. Included in the prognosis should be an initial estimate of the percentage improvement for the patient, number of



Fig. 11.12 Inferior radioulnar joint accessory movements: anteroposterior/posteroanterior glide. The left and right hands each grasp the anterior and posterior aspects of the radius and ulna. The hands then apply a force in opposite directions to produce an anteroposterior/posteroanterior glide. The arrows represent the direction of the clinician's force.

treatments required to achieve this and the time period over which it will occur.

Before the patient leaves, the clinician:

- explains the findings of the physical examination and how these relate to the subjective assessment, offering initial advice if appropriate
- allows the patient sufficient opportunity to discuss thoughts and beliefs

TABLE 11.4 Accessory Movement, Choice of Application and Reassessment of the Patient's Asterisks

Humeroulnar Joint	Superior Radioulnar Joint	Inferior Radioulnar Joint
Med Medial glide on olecranon	Anteroposterior Posteroanterior	Anteroposterior Posteroanterior
Lat Lateral glide on olecranon		
Caud		
Longitudinal		

- revisits the patient's initial expectations, and through collaboration, identifies an agreed treatment strategy in order to achieve agreed goals
- warns the patient of possible exacerbation up to 24 to 48 hours following the examination
- requests the patient to report details on the behaviour of the symptoms following examination at the next attendance.

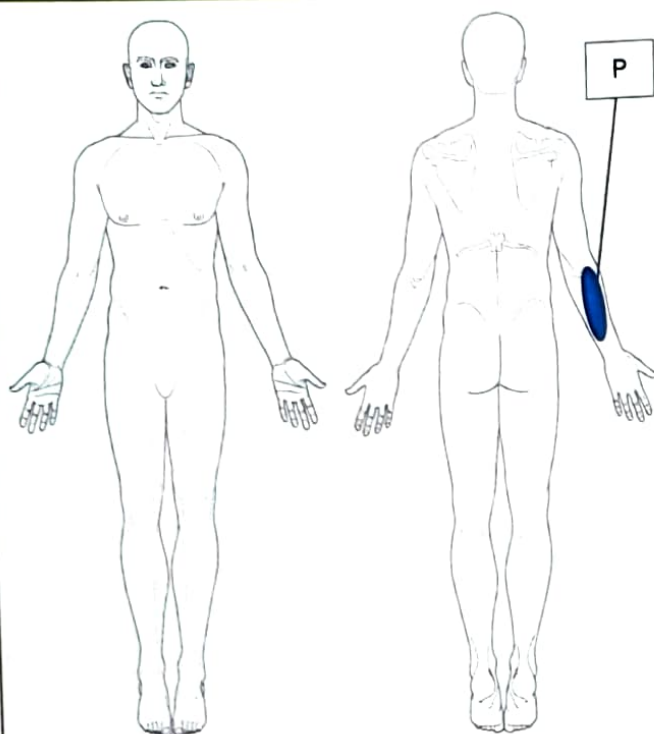
For guidance on treatment and management principles, the reader is directed to the companion textbook (Petty & Barnard, 2024).

REVIEW AND REVISE QUESTIONS

Complete the following:

1. The elbow is a complex region made up of the _____, _____ and _____ joints.
2. Medial elbow pain on throwing may indicate an injury to?
3. Distal biceps ruptures are seven times more likely in smokers than nonsmokers. TRUE or FALSE
4. Name four conditions that might cause elbow joint stiffness.
5. What symptoms in the subjective history might raise a suspicion of elbow instability?
6. Name three tests for posterolateral instability, their order of application and what would be considered a positive finding
7. What medications are considered to negatively affect tendon health?
8. What common functional restrictions are reported by patients with elbow pain?
9. What might swelling over the olecranon bursa indicate?
10. How would you check that the elbow was clinically in joint and what might malalignment of the elbow indicate?

Case Study Mr. E



P—intermittent pain, with lingering ache once pain subsides 7/10, reducing to 0/10

Aggravating factors—immediate onset of pain with lifting, e.g. picking up a kettle, gardening and driving for long periods (over 1 h)

Easing factors—relieved after rest—30 min

24-h pattern—Morning stiffness and increased pain on rising for 15 min. Reduces after warm shower. Worse at end of day, especially after a day at work, compared with day off.

Sleep—Can take some time to get to sleep, and wakes 2–3 nights per week, if he rolls onto that side at night. Takes up to 30 min to get back to sleep again

No symptoms anywhere else

HPC

Mr. E was a 56-year-old male, right hand dominant, who presented with a 6-month history of right lateral elbow pain. He reported that his symptoms were of gradual onset after a slight jarring injury to the lateral aspect of his right elbow at work. He was working longer hours during pandemic, due to staff shortages. He feels as if pain is worsening and takes longer to settle.

Symptoms were aggravated by any repetitive use of the lower right arm, such as using a kettle, or lifting and

relieved by rest. There was some residual discomfort, for 2 to 4 h following repeated use of the right wrist and hand but otherwise pain was of intermittent nature. He noticed pain got worse in cold weather.

Lifestyle/Occupation/Home Life

Lives with wife and two teenage children. Generally happy home life and no real caring responsibilities other than usual gardening, shopping, etc. Works as a bus driver, with increased workload during the pandemic. Does not take regular exercise but likes gardening in his free time.

Has recently reduced his hours at work and had been unable to participate in home activities like gardening due to the severity of his symptoms.

Impact on Function/Beliefs and Expectations

Fed up that this is affecting his ability to work but also worrying about returning to work full time because of the risks of face-to-face encounters during the pandemic. Feels that rest is his only option because activity, including previous physiotherapy exercises, flares his symptoms up. A colleague had mentioned a steroid injection, and he feels he would like to explore this option.

PMH

Type 2 diabetes and hypertension, controlled with medication. He has recently stopped smoking.

Overweight with a body mass index (BMI) of 32.

No previous history of problems.

DH/Investigations

Mr. E reported that he had been referred to a physiotherapy service early in the onset of his symptoms. He had received a course of ultrasound and stretches for the wrist extensors and been placed on an isotonic resisted wrist extensor strengthening program. He reported that during this treatment it had resulted in a significant increase in his pain and disability and his discontinuance of the treatment.

Losartan for hypertension. Metformin for diabetes.

Occasional paracetamol for pain relief, no history of steroid use. No warfarin.

X-rays following his jarring injury - nothing abnormal detected (NAD)

FH nil of note

GH Feels tired, and struggling with diabetic control

Clinical Reasoning

Mr. E had an onset of elbow pain, following a jarring injury at work, and which also coincided with a change in work

Case Study Mr. E—cont'd

life. The complaint has been worsening in the past few weeks, and he is now unable to continue with his normal occupational or recreational activities.

Psychologically (**yellow flags**)—no clear diagnosis, concerned that this is starting to affect work, frustrated that exercises made him worse, looking for a quick fix with an injection

Blue/black flag—loss of socialization with work colleagues

Red flag symptoms—symptoms followed jarring injury, although nil seen on X-ray

Evaluation of Severity, Irritability and Nature

Severity (Pa)—moderate to high (intermittent night disturbances, no regular medication, NPRS of 7/10)

Irritability (Pa)—moderate to high (symptoms with lifting a kettle immediately, and eases after 20 to 30 min of rest)

Nature—chronic lateral elbow tendinopathy with degenerative and inflammatory changes, in the same tendon

What are you treating? It is likely at this point we are treating a tendinopathy, which has moved from a sub-clinical to clinical complaint due to change in circumstances with working linked to the Covid-19 pandemic, with coexisting comorbidities, such as diabetes, obesity and smoking increasing his risk for developing the problem.

Mr. E's main **functional limitation** is being unable to grip and lift objects, because of pain

Subjective markers (link to genics)

1. Gripping causes immediate pain, takes 20 min to settle
2. Stiffness in elbow when he first wakes
3. Intermittent sleep disturbance 2–3 nights per week

Does any aspect of the history indicate caution?

Moderate to high levels of severity and irritability indicate caution, during physical examination process.

Can you predict the comparable signs? (Subjective marker linking with an objective sign)

Pain on gripping, worse in elbow extension, compared with elbow flexion

What is the relationship between pain and resistance?

Pa - Pain > resistance

What pain mechanisms can you identify? There is evidence of some central affective (psychology) mechanisms at play as well as peripheral nociceptive (elbow), and possibly some central sensitization due to worsening in cold weather.

Analysis of percentage weighting (Pain source)
Myogenic 70%, central affective 20%, central neurogenic 10%.

Analysis of percentage weighting (driver/contributing factors) Given the persistent nature of Mr. E's complaint, it is important to consider the following questions:

1. Why has he developed this complaint?
2. Why has it not settled (comorbidities, beliefs regarding activity)
3. What does his occupation require him to do?

Based on duration of complaint and age (degenerative changes) proposed weighting could be reduced strength in wrist extensors 60%, reduced strength globally in upper limb 20%, beliefs/psychological 20%.

Hypotheses to test/working diagnosis? (Differentiate between genics)

1. Reduced strength/endurance of wrist extensors
2. Reduced strength in shoulder girdle and elbow
3. Faulty/dysfunctional movement pattern of wrist extensors—will tend to grip in wrist flexed position.

Planning the Physical Examination

Observation to include resting position of elbow and wrist, bony alignment of the elbow (Fig. 11.1), and oedema

Observe movements to assess elbow and wrist range of motion, as well as clearing shoulder and cervical spine. Observe where movement is originating from (quality, range and reproduction of any symptoms). Compare gripping in elbow extension to elbow flexion to aid differentiation.

Passive range of motion (ROM) of elbow, forearm and wrist also aids differentiation between muscle and joint.

Muscles

Assess

- Pain free grip strength using a hand-held dynamometer
- Strength in scapula, shoulder and elbow muscles

Main clinical findings for Mr. E included

Marked reduction in pain free grip strength, compared with nondominant hand, and also compared with normative grip strength data, stratified for age and gender. Adopted a wrist flexion position to grip. Reduction in grip strength worse in elbow extension, compared with elbow flexion, by 10%

Reduced strength in external rotators and flexors of ipsilateral shoulder joint

Management included

Education and advice

Advice and education to aid understanding of tendinopathy and contributing factors. Discussion regarding time-scales for recovery, adoption of a graded loading programme and acceptable symptoms during exercise.

Case Study Mr. E—cont'd

Given progression and regression of exercise programme dependent on symptomatic reproduction. Advice on how systemic health including diabetic control and BMI can affect tendons, and advice on WHO advice on weekly activity guidelines. Evidence regarding detrimental effects of steroid injection examined.

Muscle strengthening to wrist extensors and supinators
Home exercise programme

1. Isometric wrist extensor loading programme
2. To start every other day, to avoid exacerbation and increase as symptoms allow

3. General cardiovascular exercise—150 min per week target of moderate intensity exercise (e.g. walking briskly).

Outcome

After 4 weeks Mr. E had an increase in pain free grip strength, but pain levels remained ISQ. Reassurance was given that functional ability was improving and tendinopathy can take weeks/months to resolve. Sleep disturbance was improved. Felt much more positive and whilst he had not yet returned to full work duties, did feel like that this was achievable.

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