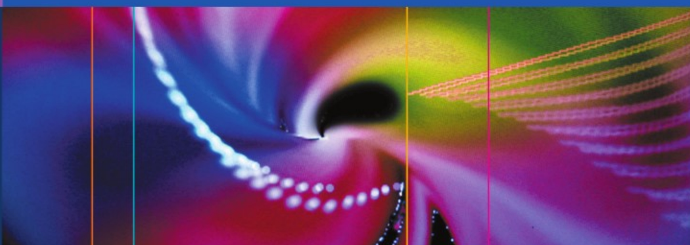
Seyed Behrooz Mostofi



Rapid Orthopedic Diagnosis

Springer

Rapid Orthopedic Diagnosis

Rapid Orthopedic Diagnosis

Seyed Behrooz Mostofi

With 267 Figures

Springer

Seyed Behrooz Mostofi, FRCS (TR&Orth)
Senior Registrar in Orthopaedics
University of London
UK

ISBN 978-1-84800-208-1 e-ISBN 978-1-84800-209-8
DOI 10.1007/978-1-84800-209-8

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Control Number: 2008925046

Printed on acid-free paper

9 8 7 6 5 4 3 2 1

springer.com

To Kian and Tania Mostofi

Foreword

It is indeed a pleasure to write the foreword to this useful book which describes the most commonly used orthopedic clinical diagnostic tests to assist a wide audience within the medical world.

The organization of this book is easy to follow and logical. Each chapter begins with the patient's initial presentation, which is followed by an outline of the need to take account of specific variables in arriving at a differential diagnosis. The author underlines the importance of using the patient's own account as a valuable tool in reaching a diagnosis. Essential anatomy is included throughout the book. For ease of reference, all the chapters are similarly structured. Its style is simple and uncluttered, offering a step-by-step approach and avoiding overlong explanations.

All in all, this book fulfills the criteria of a reference book, a practical guide, and a succinct aide memoire for those preparing for exams. It is truly a text for everyone who must conduct orthopedic examinations, including medical students, general practitioners, and orthopedic residents. It is an outstanding contribution to the orthopedic literature.

Francis J. Hornicek, MD, PhD
Chief, Orthopaedic Oncology Service
Co-director, Center for Sarcoma and
Connective Tissue Oncology
Massachusetts General Hospital
Harvard Medical School
Boston, MA, USA

Foreword

Judgment – the ability to make the correct decision for the individual patient is the hallmark of the good clinician. For the surgeon, this is "the knowing what to do" and when to do it or equally important "the knowing what not to do." For the general practitioner, it is the art of distinguishing the ill from the worried well and knowing which patient needs specialist advice.

Good judgment derives from the ability to synthesize clinical experience, basic knowledge, and clinical diagnosis (i.e. the history and signs) with the interpretation of investigations to reach the best treatment option. This basic process of how to practice medicine dates back to the ancient Egyptians, probably to the era of the Pyramids. If you have never read the case histories from Mr. Edwin Smith Papyrus, your medical education is incomplete! The Egyptians only had history and signs plus clinical experience by which to reach a conclusion. Today, we have the power of modern science and a vast array of treatments. However while the advances in results are remarkable, errors remain.

All too often, failure is the result of history and signs, the areas in which the ancient Egyptians excelled. Only rarely is error due to the lack of high-powered knowledge. If you do not believe me, read the annual report of any medical defence society. Doctors who take a proper history, know how to examine, and keep good records do not often feature in these publications. If by mischance they are sued, they have a good defence, for it is clear they have provided conscientious care.

This book aims to remind, refresh, and improve the essential basic skills of history taking and clinical signs. With practice, they can indeed be "rapid." Without these, "judgment" will be prone to error. I am reminded of a story about the late Professor Kessel of the Royal National Orthopaedic Hospital, who in being asked by his trainee "sir what shall I do with this x-ray?" replied "file it my boy, file it!" Imaging, however clever, does not tell you whether the pathology is relevant or, if relevant, how much it hurts. The knowledge and skills so clearly summarized and displayed in this book remains essential to good practice.

Frederick W. Heatley
Emeritus Professor of Orthopaedics
King's College
London

Preface

The first decade of the twenty-first century has witnessed the continuation of an explosion in our knowledge and understanding of all aspects of disease. Accompanying this has been the increasing reliance of clinicians on more and more complex imaging modalities and laboratory tests. It is the assertion of this author, however, that the fundamental skills of history taking and clinical examination remain the most important tools in reaching diagnosis.

This book aims to nurture these age-old skills of listening, observation, and examination by demonstrating their invaluable application in modern medical practice. In writing this book, I have drawn on not only my own experience, but on a wealth of advice from both those I have taught and those who have taught me. The omission of an exhaustive inventory of differential diagnoses for every clinical finding has been an intentional one; I strictly adhere to listing the most common conditions that a clinician will encounter to maintain practical value and clarity. For the same reason, I have also endeavored to describe the most useful and frequently performed clinical tests only, rather than the multitude of possible tests that exist for all conditions.

It is my hope that the resulting book will be useful for all those involved in the care of orthopaedic patients; for medical students in emphasising the most salient features of common presentations, for general practitioners in providing clear and concise information on which to base daily practice and for residents as a ready reference for day-to-day use and also for professional examinations.

Seyed Behrooz Mostofi
London
January 2008

Acknowledgments

I acknowledge the help and advice I received from the following surgeons who have helped me enormously with constructive criticism and helpful suggestions:

Richard J. de Asla M.D.
Co-director, Foot and Ankle Service, Department of Orthopaedic Surgery, Massachusetts General Hospital *and* Instructor of Orthopaedics, Harvard Medical School, Boston, MA, USA

S. Ali Mostoufi MD, FAAPMR, FAAPM
Assistant Professor of Physical Medicine and Rehabilitation, Tufts University School of Medicine *and* Medical Director, Boston Spine Center, Boston, MA, USA

Roderick G Wetherell MD FRCS
Consultant Hand & Orthopaedic Surgeon, East Kent Hospitals NHS Trust. UK

Philip L. Housden FRCS (Orth)
Consultant Orthopaedic Surgeon, William Harvey Hospital, Ashford, Kent, UK

Adrian J Carlos MBChB, MRCS, MSc
Specialist Registrar in Orthopaedics, South East Thames, London Deanery,UK

Barry Hinves FRCS
Consultant Orthopaedic Surgeon, Conquest Hospital, St. Leonards-On-Sea, East Sussex, UK

Francis Lam FRCS (Tr & Orth)
Consultant Orthopaedic Surgeon, Hillingdon Hospital, UK

Benedict A Rogers MA, MSc, MRCGP, MRCS
Specialist Registrar in Orthopaedics, South West Thames, London Deanery, UK

Seyed Behzad Mostofi DDS, MDS, FRACDS
Consultant Oral & Maxillofacial Surgeon, Toronto, Canada

In addition:

I am grateful to Dr. Andrée Bates, whose unfailing support is a source of inspiration.

I am appreciative of the assistance from Dr. Joanna Maggs, who has critically read many versions of this manuscript.

I would like to express my appreciation to the many patients who agreed to have their photographs appear in this book.

I am grateful to Mrs. Emma Singh for being affable and extremely tolerant while modeling, and to Mr. Ravi Singh, consultant orthopaedic surgeon, for his photography skills.

I thank Mr. James Farley for his time and cooperation while modeling for some of the photographs.

I recognize the efforts of Mr. Abbas Rashid for his help in the preparation of the elbow chapter.

I offer special thanks for the help, support, and encouragement which I received from Mr. Grant Weston at Springer, who made the production of this book possible.

Seyed Behrooz Mostofi

Contents

Chapter 1
Shoulder

LISTEN

Mechanism of Injury (If Applicable)

Certain mechanisms of injury result in characteristic patterns of structural damage.

Common Examples

Fall on outstretched hand → anterior dislocation of shoulder
→ fracture of proximal humerus

Electrocution, seizures → posterior dislocation of shoulder

Holding on to an object while falling from a height (severe traction to the arm) → brachial plexus injury

Fall on to the elbow/blow to the tip of the shoulder → acromio-clavicular joint (ACJ) dislocation/subluxation

Age

Young → instability
→ ACJ dislocation

Middle age → calcifying tendonitis
→ rotator cuff tear
→ adhesive capsulitis
→ ACJ arthritis

Old → rotator cuff tear
→ glenohumeral joint arthritis
→ cuff arthropathy (combination of cuff tear and arthritis)

Pain

Site of Pain

Localized pain (to which the patient can point with a finger (Figure 1.1) → ACJ pathology

Generalized pain (especially over deltoid) (Figure 1.2) → rotator cuff lesion
→ subacromial pathology

Figure 1.1.

Figure 1.2.

What Activity Brings on the Pain?

Pain during midrange of arm elevation → subacromial impingement
→ rotator cuff lesion

Pain during terminal degrees of arm elevation → ACJ pathology

Pain during throwing → SLAP (Superior Labrum Anterior to Posterior) lesion

Type of Pain

Aching pain → degenerative changes

Sharp pain/catching pain → ACJ pathology
→ subacromial impingement

Pain after activity → inflammatory arthropathy
→ tendinosis

Night pain → rotator cuff lesion
→ glenohumeral arthritis
→ adhesive capsulitis
→ infection
→ tumor

Stiffness

Rest stiffness/ early morning stiffness → rheumatoid arthritis
→ inflammatory arthropathy
→ osteoarthritis

LOOK

From the Front

Alignment:

Ask the patient to stand facing you. In this position the patient should be able to keep both arms by the side.

Arm held in internal rotation → posterior dislocation of shoulder

Arm held in internal rotation with flexion of the wrist → Erb's palsy

Arm held in abduction → inferior dislocation of shoulder (luxatio erecta)

Shoulder Height

Normally shoulders should be at the same level.

If one shoulder is higher than the other → painful shoulder
→ Sprengel's deformity

If one shoulder is lower than the other (drooping shoulder) → trapezius paralysis

Scars

Comment on:

Position: posterior triangle incision may have caused spinal accessory nerve palsy Surgical or traumatic
Healed with primary or secondary intention

Deformity and muscle wasting

1. Trapezius muscles: These should be symmetrical. Wasting can be easily identified (Figure 1.3). Injury to spinal accessory nerve which supplies the muscle can occur in:
   Dissection of the neck
   Lymph node biopsy
   Brachial plexus injuries

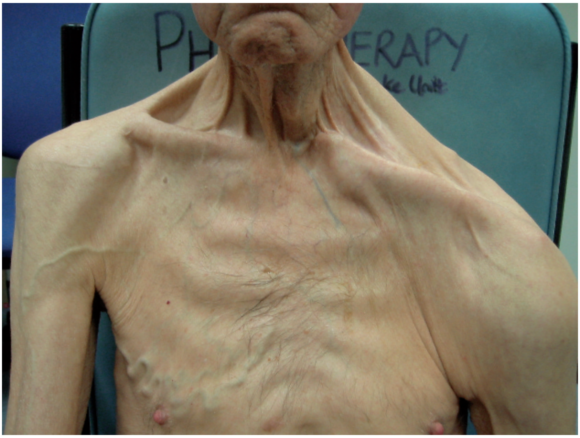


FIGURE 1.3. Injury to the spinal accessory nerve following a lymph node biopsy. Note drooping shoulder and wasting of trapezius. Prominent left SCJ is due to osteoarthritis.

2. Deltoid: Makes the contour of the shoulder. Anterior and middle fibers are best visualized from the front.
   - Flattening of the shoulder → anterior dislocation of the shoulder (causes prominent lateral edge of the acromion)
   - Swelling of deltoid → fractured neck of humerus
   - Atrophy of deltoid → axillary nerve injury
3. Acromioclavicular joint: Prominence of the ACJ is usually easy to spot (Figure 1.4). It varies between individuals and may be normal. Pathological causes of prominent ACJ:
   - Subluxation/dislocation
   - Degenerative arthritis
   - Chronic/acute inflammation
4. Clavicle: A subcutaneous bone, but may be difficult to see its length in obese individuals.
   - Asymmetry of clavicle → fracture/non-union

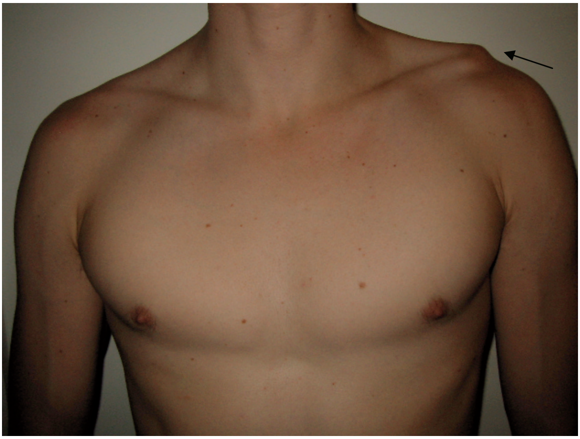


FIGURE 1.4. Subluxation of left ACJ (*black arrow*).

5. Sternoclavicular joint: this is easily seen in most patients though more difficult in the obese.
   If SCJ is more prominent →
      Anterior dislocation/subluxation of SCJ as a result of trauma or subsequent to incorrect internal fixation of the clavicle (Figures 1.5)

a

b

FIGURE 1.5. Subluxation of right SCJ. (*a*) Note the surgical scar, subcutaneous plate and prominence of SCJ. (*b*) On shoulder abduction, the subluxation is more visible.

→ Infection
→ Arthritis and osteophyte formation
→ Tumors
If SCJ less prominent → posterior dislocation of SCJ

From the Side

If ACJ prominent → dislocation/subluxation

Deltoid: Makes the contour of the shoulder. Middle fibers are best visible from the side.

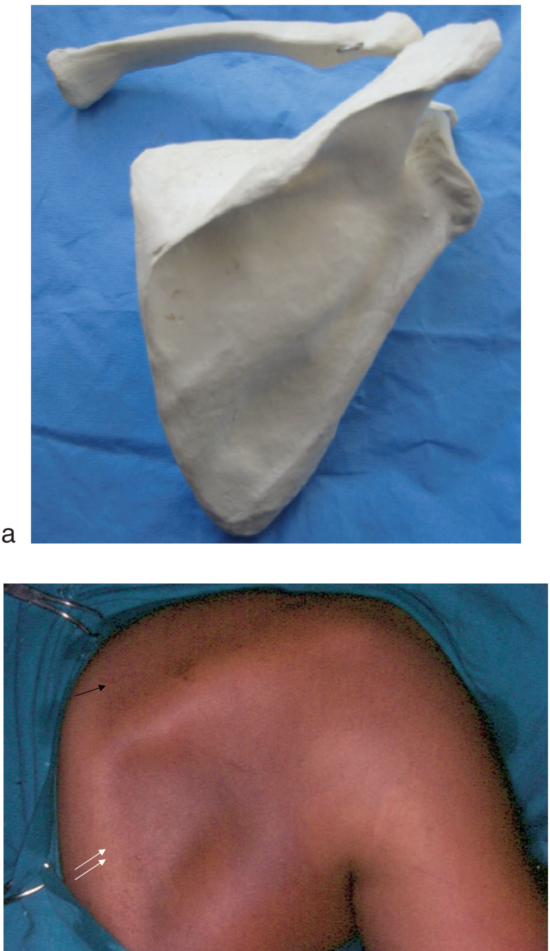
If acromion prominent
→ Anterior dislocation of the shoulder
→ Atrophy of deltoid

From Behind

1. Trapezius muscles: These should be symmetrical. Wasting can be easily identified.
   Injury to spinal accessory nerve which supplies the muscle can occur in:
      Dissection of the neck
      Lymph node biopsy
      Brachial plexus injuries
2. Deltoid: Makes the contour of the shoulder. Middle and posterior fibers are best visualized from behind.
   Flattening (squaring off) of the shoulder → anterior dislocation of the shoulder (causes prominent lateral edge of the acromion)
   Swelling of deltoid → fracture neck of humerus
   Atrophy of deltoid → axillary nerve injury
3. Scapula: This is the key structure while inspecting the shoulder joint from behind.
   Size and position:
      Prominent, small and high scapula → Sprengel's deformity (congenital elevation of the scapula)

Borders of scapula:

The scapula has three borders: superior, medial and lateral (Figure 1.6a). All are well covered by various muscles in normal individuals. Prominent borders means there is an atrophy of the muscles and this gives the vital clue to the possible diagnosis, especially in longstanding cases.



a

b

FIGURE 1.6. (*a*) Borders of scapula. (*b*) Sever atrophy of supraspinatus (*black arrow*) and infraspinatus (*white arrows*) of the right shoulder. Spine of scapula is easily visible.

Superior border: This is further divided by the spine of the scapula. The supraspinatus muscle lies in the superior fossa. The infraspinatus and teres minor muscles fill the infraspinatus fossa. Atrophy of these muscles make the spine of the scapula more prominent (Figure 1.6b), despite the fact that the trapezius covers the supraspinatus completely.

Prominent spine of scapula:

Atrophy of supraspinatus/trapezius (above the spine of the scapula) → rotator cuff tear
→ suprascapular nerve palsy (entrapment at the suprascapular notch)

Infraspinatus and teres minor muscles (below the spine of the scapula) → rotator cuff tear
→ suprascapular nerve palsy (entrapment at the spinoglenoid notch)

Medial border: This is covered by the serratus anterior, trapezius and rhomboid muscles. The serratus anterior is the main muscle which stabilizes the scapula against the chest wall.

Prominent medial border:

Internal rotation of the arm (normal)
Tight posterior and/or inferior capsule of the shoulder joint
Atrophy of serratus anterior/ trapezius/ rhomboid muscle

Lateral border: This is covered by the latissimus dorsi.

Prominence of lateral border of scapula:

Atrophy of latissimus dorsi → brachial plexus injury (Thorcodorsal nerve C6, 7, 8 nerve roots)

FEEL

Patient in sitting position in front of a mirror, with examiner standing behind the patient looking at his face in the mirror.

Sternoclavicular Joint

Start your palpation in the middle of the clavicle and move medially toward the joint. The SCJ is 1.5cm to 2cm lateral to the middle of the sternal notch. Tenderness may be present due to:

Injury
Infection
Tumor

Clavicle

Run your fingers along the clavicle. Tenderness or swelling may be due to:

Fracture
Non-union

ACJ

Follow the clavicle laterally to its end. Usually one can feel the articulation between the acromion and the clavicle. If you are not sure, grasp the patient's elbow with one hand and push ever so gently upward while your index finger is placed over the acromion and clavicle to detect the subtle movement in the joint.

Coracoid

This can be felt 2 cm inferior to the junction between the middle and lateral thirds of the clavicle. Its tenderness may signify adhesive capsulitis due to involvement of the coracohumeral ligament or pectoralis minor enthesopathy.

Coracoclavicular Ligament

As the name suggests, it runs between the coracoid and the lateral end of the clavicle. It is important to check it for tenderness once you have palpated the acromion. It is helpful to distinguish between types I and II of ACJ injuries if tenderness is present (type II) (Figure 1.7).

FIGURE 1.7. Coracoclavicular ligament.

Acromion

The anterior edge of the acromion is lateral to the ACJ. The posterolateral edge is easily felt if you run your thumb backward as you follow the curve of the deltoid muscle. Hold the acromion between your index finger and thumb. It is much larger than you may have thought.

If painful:

Fracture

Os acromiale

> **Os acromiale**
>
> An ossification center that fails to unite to the acromion.

Eliciting the tenderness over the anterior and lateral to the acromion is more useful. To facilitate the palpation, passively extend the arm.

If painful:

Subacromial bursitis

Rotator cuff tear (variable)

Biceps Tendon

Hold the arm in 10° of internal rotation and run your thumb just distal to the anterior edge of the acromion. It is often very difficult to palpate the biceps tendon as it lies deep to the deltoid muscle. Tenderness in the area 1–4 cm distal to the anterior edge of the acromion is considered as biceps tendinitis.

Trapezius

Tenderness and trigger points may be elicited, which are usually associated with cervical spine pathology.

Range of Movement

Active movements are inspected first from the front and then from behind for scapulothoracic and scapulohumeral rhythm. If you observe a difference in the range of movement between the two shoulders, assist the patient and passively take the arm through the remaining range of movement. This is a passive range of movement.

Forward Flexion

This occurs in the sagittal plane. Whilst the patient is sitting or standing, ask him to lift the arm as far as possible (Figure 1.8).

Normal range: 160–180°

If limited → arthritis
→ adhesive capsulitis
→ rotator cuff tear

Note: Shoulder surgeons use the term forward elevation. This movement is forward flexion performed in the most comfortable plane for the patient; usually about 30° from the sagittal plane.

FIGURE 1.8. Forward flexion.

FIGURE 1.9. Abduction.

Abduction

This occurs in the coronal plane. While the patient is sitting or standing, ask him to lift the arm sideways as far as he can (Figure 1.9). Observe the rhythm and overall movement. The glenohumeral movements account for 0–90° of abduction. The initial abduction occurs entirely at the glenohumeral joint and then the scapula starts to rotate as the arm is abducted further.

The ratio of glenohumeral to scapulothoracic movements is usually 2:1 between 30–90° of abduction. The last 60° of abduction occurs entirely at the scapulothoracic joint.

Pressing firmly on the glenohumeral joint eliminates scapulothoracic movement, while making it possible to assess the passive range of movements.

Normal range of movement: 160–180°

Decreased in:
- Arthritis of the glenohumeral joint
- Adhesive capsulitis

If abduction is painful, note the degree of abduction when the pain is elicited.

Pain only between 60–120° (Painful arc) → impingement
→ rotator cuff tear

Pain in terminal degrees of abduction → ACJ pathology

If the patient cannot initiate abduction → weakness of deltoid
→ massive rotator cuff tear

Note: If the patient cannot abduct the arm, he will try to do so by shrugging the shoulder, thus substituting / supplementing the glenohumeral movement with scapulothoracic abduction.

Adduction

Ask the patient to put the hand over the opposite shoulder. Pain in this movement is usually due to ACJ pathology (Figure 1.10). The patient is unable to adduct the arm in anterior dislocation of the shoulder. Passive adduction is an important clinical test to determine if the humeral head is located immediately after reduction of the shoulder joint.

FIGURE 1.10. Adduction.

External Rotation

Ask the patient (sitting or standing) to bend the elbow to 90° of flexion, while keeping it by the side and externally rotating the forearm (Figure 1.11). It is often necessary to maintain the position of the patient's arm by gently putting your hand on the lateral aspect of the elbow to prevent abduction. External rotation can also be measured with the shoulder abducted to 90° (Figure 1.12).

FIGURE 1.11. External rotation.

FIGURE 1.12. External rotation in abduction.

Normal range of movement: 45–90°

Increased passive external rotation → Massive rotator cuff tear involving subscapularis

Decreased external rotation → Adhesive capsulitis
→ Glenohumeral arthritis
→ Posterior dislocation of the shoulder (Rowe's sign)

Internal Rotation

The patient is asked to reach up his back with the back of his hand. The vertebral level reached is noted and compared with the other side. This is a complex movement of internal rotation and extension of the shoulder (Figure 1.13).

Spinous Process Levels

Spine of scapula: T3
Inferior angle of scapula: T7
Iliac crest: L4–5

FIGURE 1.13. Internal rotation.

Normal level: T7–T9

Internal rotation can also be measured with the shoulder abducted to 90° (Figure 1.14).

FIGURE 1.14. Internal rotation in abduction.

Muscle Testing

Trapezius (Spinal Accessory Nerve C3,4)
Stand behind the patient and ask him to shrug his shoulders. Contraction of the trapezius is seen and compared with the opposite side. (Figure 1.15)

Muscle power is tested throughout this book according to the MRC grading scale.

Medical Research Council Scale

Grade	Description
0	no contraction
1	flicker or trace of contraction
2	active movement with gravity eliminated
3	active movement against gravity
4	active movement against gravity and resistance
5	normal power

The inferior fibers are assessed by asking the patient to push against the wall. If weak or paralyzed, *rotary* winging of the scapula is observed, in which the inferior angle of the scapula moves laterally and away from the midline.

Cause of weakness:

Injury during dissection of the neck /lymph node biopsy

a

b

FIGURE 1.15. (*a*) Assessing the trapezius muscle. Ask the patient to "shrug the shoulders." (*b*) The power can be assessed by applying resistant.

Serratus Anterior (Long Thorascic Nerve C5,6,7)
Stand behind the patient and ask him to push against the wall with arms at the level of the shoulder. If weak or paralyzed, the medial border of the scapula moves away from the chest wall (scapular winging) (Figure 1.16).

If the patient is unable to lift the arm to push the wall due to weakness of other muscles, the examiner passively lifts the arm and holds it in the desired position and then asks the patient to push against the wall.

FIGURE 1.16. Winging of right scapula due to wasting of serratus anterior. This fireman sustained a traction injury to right arm while falling form a height.

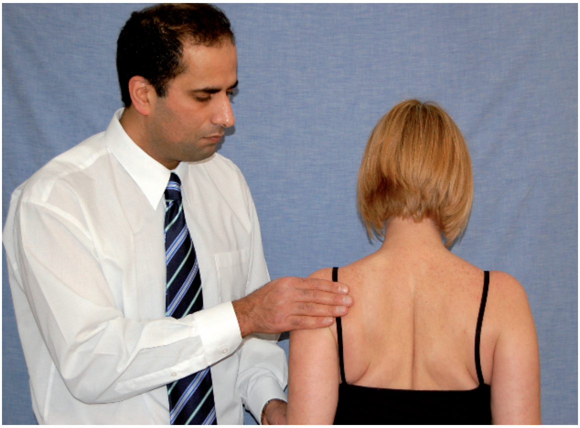


FIGURE 1.17. Assessing the rhomboid.

Rhomboid (Dorsal Scapular Nerve C5)
The patient is asked to pull the shoulders back, while the examiner applies resistance to the spine of the scapula (Figure 1.17).

Latissimis Dorsi (Thoracodorsal Nerve C6,7,8)
Ask the patient to abduct the arm to 90°. The examiner applies resistance to the point of the elbow and asks the patient to pull the elbow down to the side. The other hand feels for the contracting muscle (Figure 1.18).

FIGURE 1.18. Assessing the Latissimus dorsi.

Deltoid (Axillary Nerve C5, 6)

Ask the patient to abduct the shoulder to 90° and hold the position. The anterior, middle, and posterior fibers are now palpable.

If the patient is unable to abduct the shoulder, either due to pain (after dislocation of the shoulder or surgery) or injury to the axillary nerve, the following method is very useful.

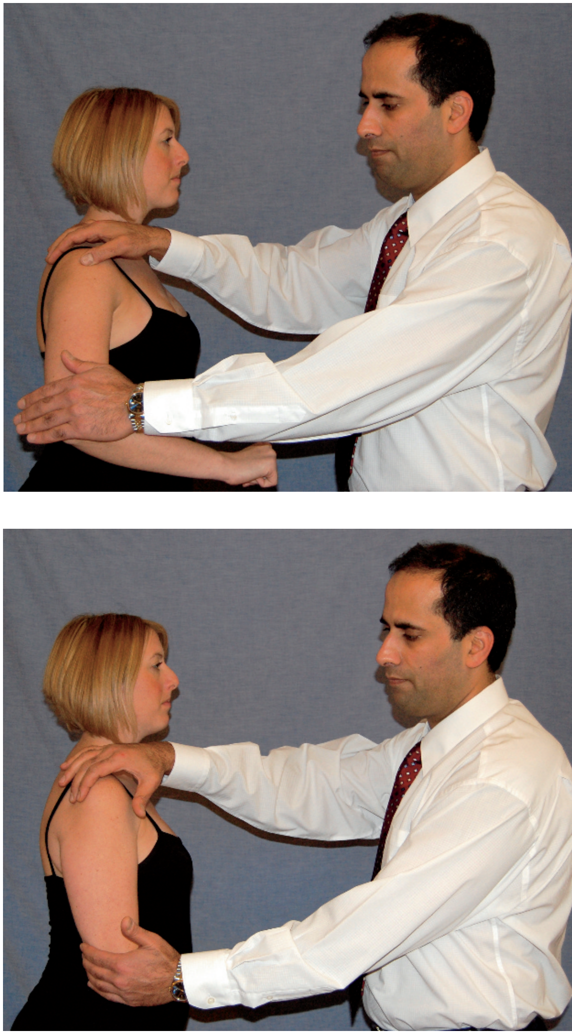
The anterior fibers of the deltoid assist flexion. To assess the anterior fibers, stand facing the patient. Put the arm in slight flexion and ask the patient to try to flex it further while you apply resistance just above the elbow. Your other hand is placed over the deltoid to palpate the contracture of the muscle (Figure 1.19a).

The middle fibers of the deltoid are pure abductors. To assess the middle fibers, stand facing the patient. Put the arm in slight abduction and ask the patient to try to abduct it further while you apply resistance just above the elbow. Your other hand is placed over the deltoid to palpate the contracture of the muscle (Figure 1.19b).

Likewise, to assess the posterior fibers which assist extension, stand facing the patient. Put the arm in slight extension and ask the patient to try to extend it further while you apply resistance just above the elbow. Your other hand is placed over the deltoid to palpate the contracture of the muscle (Figure 1.19c).

a

FIGURE 1.19. (*a*) Assessing the anterior fibers of deltoid. (*b*) Assessing the middle fibers of deltoid. (*c*) Assessing the posterior fibers of deltoid.



b

c

FIGURE 1.19. Cont'd.

Pectoralis major (Lateral Pectoral Nerve C5, 6)
Stand facing the patient, who is instructed to place the hands on the hips and press firmly. The tendon is often visible or can be palpated in the anterior axillary fold (Figure 1.20).

FIGURE 1.20. Pectoralis major tendon.

Rotator Cuff

The rotator cuff, consists of the tendons of four muscles: subscapularis, supraspinatus, infraspinatus and teres minor.

Subscapularis (Suprascapular Nerve C5, 6)

Stand behind the patient. The patient is asked to place the back of his hand into the small of the back (to eliminate the action of pectoralis major). Then the patient is asked to hold the hand away from the back (Figure 1.21). If he is able to do so, it means the subscapularis is functioning (negative lag test). The examiner then pushes against the patient's distal forearm toward the spine to assess the power. This is called Gerber's lift off test.

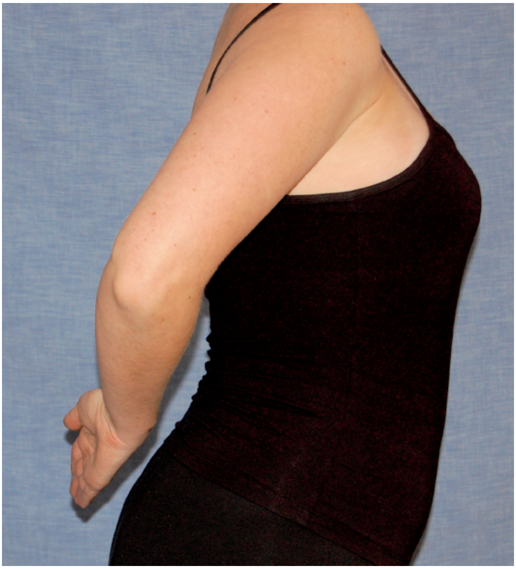


FIGURE 1.21. Assessing the subscapularis.

In patients who cannot internally rotate due, for example, to osteoarthritis, ask the patient to push his hands on the abdomen firmly and bring the elbows forward. In weakness of the subscapularis (positive test), the patient is unable to bring the elbows forward and the arm falls posterior to the coronal plane of the body. To assess the power, the examiner applies resistance to the elbow anteriorly. This is the Napoleon belly press test (Figure 1.22).

FIGURE 1.22. Napoleon belly press test.

Supraspinatus (Suprascapular Nerve C5, 6)

Stand facing the patient. Place the patient's arm in 30° of abduction and 30° of forward elevation (in the plane of the scapula) with thumb facing down (position of emptying a can). The examiner then applies resistance, while asking the patient to maintain the position. The examiner can feel the muscle contraction with the other hand (Figure 1.23). This is Jobe's or the empty can test.

For the lag test (Drop arm sign), the shoulder is forward elevated to 90° in the scapular plane and the patient is asked to hold the arm in that position. In the presence of weakness or a tear, the patient is unable to do so and the arm drops down with minimal control.

FIGURE 1.23. Jobe's test.

Infraspinatus (Suprascapular Nerve C5, 6) and Teres Minor (Axillary Nerve C5, 6)

These two muscles are tested together.

Ask the patient (sitting or standing) to bend the elbow to 90° of flexion and keep it by his side. It is often necessary to maintain the position of the patient's arm by gently putting your hand on the lateral aspect of the elbow. Then ask the patient to externally rotate the forearm while you apply resistance to the distal forearm (Figure 1.24). The examiner can feel the muscle contraction with the other hand.

FIGURE 1.24. Assessing the infraspinatus and teres minor.

The external rotation lag test is carried out by holding the arm passively in maximum external rotation and then releasing it. If the arm falls into internal rotation, there is severe weakness of the external rotators, which is seen in massive rotator cuff tears.

Special Tests

Subacromial Impingement Tests

1. Neer's sign: While the patient is sitting or standing, the examiner passively elevates the patient's internally rotated arm in the plane of the scapula (about 30° from the coronal plane), thereby bringing the supraspinatus to a level where it impinges against the coracoacromial ligament and the anteroinferior aspect of the acromion (Figure 1.25) . A painful arc of movement between 70° and 120° is taken as a positive sign for impingement.

Figure 1.25. Neer's sign.

2. Neer's test: If the Neer's impingement sign is positive, inject local anesthetic into the subacromial space and repeat the test. If the pain is eliminated by the injection (positive Neer's test) a rotator cuff impingement or tear is suspected.
3. Hawkins' test: Ask the patient, sitting or standing, to forward flex the shoulder to 90° and keep the forearm parallel to the floor. The examiner holds the patient's arm and internally rotates it further (Figure 1.26).

If this produces pain, it suggests pathology of the rotator cuff or subacromial bursitis.

FIGURE 1.26. Hawkins' test.

Instability Tests

Before testing, ask the patient if the shoulder feels unstable and in which direction. Voluntary dislocators can dislocate and relocate their shoulders with ease. Assess for evidence of generalized ligamentous laxity according to Beighton's score (out of 9).

Beighton's Score for Assessing Hypermobility

1. Hyperextension of the little finger beyond 90°
2. Passive apposition of the thumb to the flexor aspect of the forearm.
3. Hyperextension of the elbow beyond 10°
4. Hyperextension of the knee beyond 10°
5. Forward flexion of the trunk so that the palms of the hands rest easily upon the floor.

1. Drawer tests: These are performed to quantify the amount of anterior and posterior laxity.

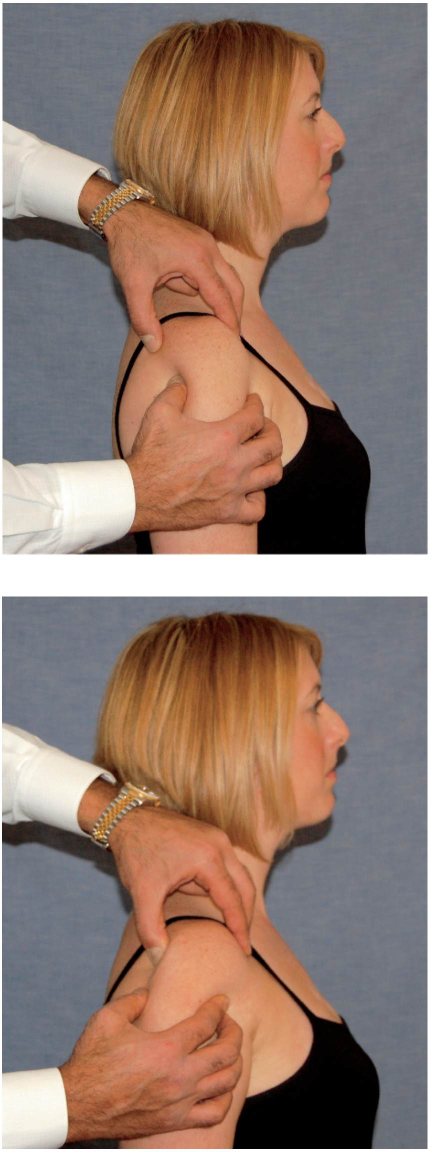
   While standing behind the patient, use one hand to stabilize the shoulder girdle by holding on to the scapula with your thumb and coracoid with your index finger and, with the other hand, hold on to the humeral head.

   For the anterior drawer test, apply an anterior translational force (Figure 1.27a) and for the posterior drawer test apply a posterior translational force (Figure 1.27b). Quantify the amount of translation in relation to the diameter of the humeral head:

   Hawkins grading of anterior draw

0	<25%
1	25–50%
2	50–100%
3	Dislocatable

   Note: The amount of posterior laxity is greater than the anterior in most normal individuals.



a

b

FIGURE 1.27. (*a*) Anterior drawer test. (*b*) Posterior drawer test.

2. The sulcus sign: Inferior laxity is demonstrated by the sulcus sign. With a relaxed patient standing or sitting, apply inferior traction to the arm by holding just above the elbow and look for a sulcus between the lateral edge of the acromion and the head of the humerus (Figure 1.28). The patient may show signs of apprehension during the test. In an individual with hypermobile joints, the sulcus sign may be positive bilaterally. In these situations, usually the size of the sulcus is larger in the symptomatic side.

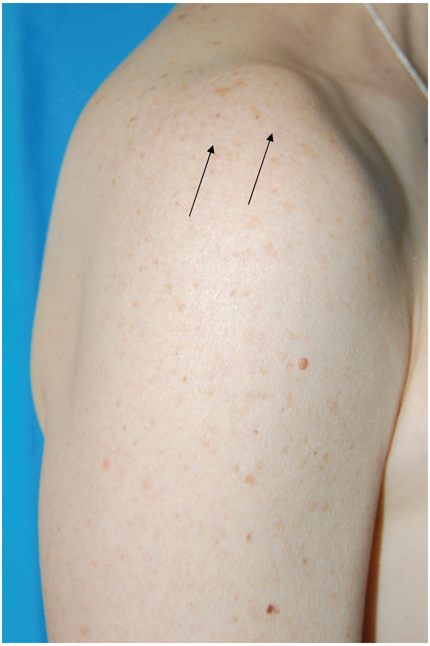


FIGURE 1.28. Sulcus sign.

3. Anterior apprehension test: With the patient sitting, standing or preferably in the supine position, the examiner abducts the arm to 90° and slowly externally rotates it. A positive test is indicated by an apprehensive look on the patient's face or an uncomfortable feeling of instability (Figure 1.29). Sometimes the pectoralis major can be seen to contract. If there is evidence of anterior instability, proceed to the Jobe's relocation test, with the patient in the supine position.

FIGURE 1.29. Anterior apprehension test.

4. Jobe's relocation test: The shoulder is again abducted and externally rotated to the maximum. When the point of apprehension has been reached, apply a posteriorly directed force to the front of the humerus using the palm of your hand. A positive test is indicated by a decrease in pain or apprehension (Figure 1.30). On releasing the pressure, the pain and apprehension returns. If the relocation test produces increased pain, consider other causes, such as posterior instability or impingement.
5. Posterior apprehension test: The arm is forward flexed to 90° and internally rotated to the maximum. Whilst applying a posteriorly directed force along the humeral shaft, adduct the arm across the body. A positive test is indicated by pain or apprehension.

FIGURE 1.30. Jobe's relocation test.

a


FIGURE 1.31. O'Brien's test. (*a*) Thumb down position. (*b*) Palm up position.

Labral Tests

There are numerous tests described for diagnosing a tear of the glenoid labrum or SLAP (Superior Labrum Anterior to Posterior) lesions. Unfortunately none of them is specific. However, for completeness, we are mentioning a few tests commonly performed.

1. O'Brien's test: Patient is standing or sitting and facing the examiner. The arm is forward flexed to 90° and adducted 10° medial to the sagittal plane of the body. With the arm in internal rotation so that the thumb is facing downward, apply downward force and ask the patient to resist. Repeat the test with the palm facing upward (Figure 1.31).

   Pain produced deep in the shoulder joint with palm up → Labral tear

   Pain produced on top of the shoulder with thumb down → ACJ pathology.

b

FIGURE 1.31. Cont'd.

ACJ Pathology

Scarf Test: The examiner stands facing the patient. Ask the patient to put the hand over the opposite shoulder while holding the elbow at the level of the shoulder. Then the examiner applies force to the patient's elbow, moving it into further cross chest adduction (Figure 1.32). Reproduction of pain over the ACJ indicates a positive test.

FIGURE 1.32. Scarf test.

Chapter 2
Elbow

LISTEN

Mechanism of Injury (If Applicable)

Patient usually remembers their position at the time of injury
Certain mechanisms of injury result in characteristic patterns

Fall on outstretched hand → supracondylar fracture
→ posterior dislocation
→ radial head fracture

Direct blow to elbow → olecranon fracture

Fall on to flexed elbow → supracondylar fracture
→ anterior dislocation
→ capitellar fracture

A child being lifted by arms → subluxation of radial head

Pain

Site of Pain

Localized pain (to which the patient can point with a finger)

Medial epicondyle → medial epicondylitis (golfer's elbow)
→ cubital tunnel syndrome
→ ulnar collateral ligament injuries

Lateral epicondyle → lateral epicondylitis (tennis elbow)
→ radial tunnel syndrome
→ osteochondritis of capitellum

Generalized pain → osteoarthritis and other inflammatory arthropathy
→ gout
→ infection
→ tumors

Type of Pain

Aching pain → degenerative changes

Sharp pain/ catching pain → loose body

Pain after activity → inflammatory arthropathy
→ tendinosis

Radiation of Pain

Conditions involving the lateral compartment (radiocapitellar joint) provoke pain that extends over the lateral aspect of the elbow, with radiation proximally to the midhumerus and distally over the forearm.

Stiffness

Rest stiffness/early morning stiffness → rheumatoid arthritis
→ inflammatory arthropathy
→ osteoarthritis

Swelling

Spontaneous → rheumatoid arthritis
→ bursitis
→ septic arthritis

Localized posterior → rheumatoid nodules
→ olecranon bursa
→ gouty tophi

Neurological Symptoms

Altered sensation
Weakness/Atrophy

LOOK

With the Arms by the Side (Elbow in Extension)

Scars, skin grafts, sinuses, erythema
Carrying angle: Normal valgus angulation of the elbow. Ask the patient to stand with the arms by their side with the elbows extended and forearms supinated. The angle formed between the longitudinal axis of the arm and the forearm is the carrying angle. (Figure 2.1)

FIGURE 2.1. Carrying angle.

Normal average:

Men → 10°

Women → 13°

Increased carrying angle (cubitus valgus) → nonunion lateral condyle fracture
→ premature closure of lateral epiphysis

Decreased carrying angle (cubitus varus) → malunited supracondylar fractures
→ premature closure of medial epiphysis

With the Elbow in Flexion

Scars, sinuses, erythema
Swellings in the posterior aspect of the elbow are easily seen.

Causes → effusions
→ rheumatoid nodules
→ olecranon bursa

FEEL

Increased skin temperature → septic arthritis
→ bursitis
→ acute attack of gout

Lateral Side

Lateral Epicondyle
Visible landmark in most patients.
Flexion of the elbow to 90° helps identification in obese patients.

Radial head:

With the patient's elbow flexed to 90°, the examiner first palpates the lateral epicondyle with his thumb. The radial head is 2 cm distal to the lateral epicondyle. Pronation and supination of the patient's forearm facilitate the palpation of the radial head (Figure 2.2).

a

b

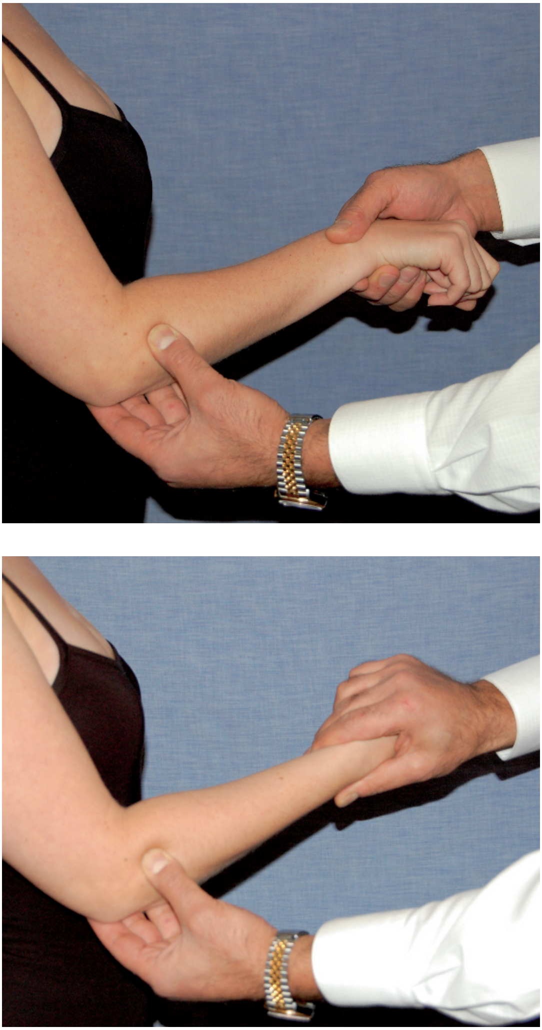
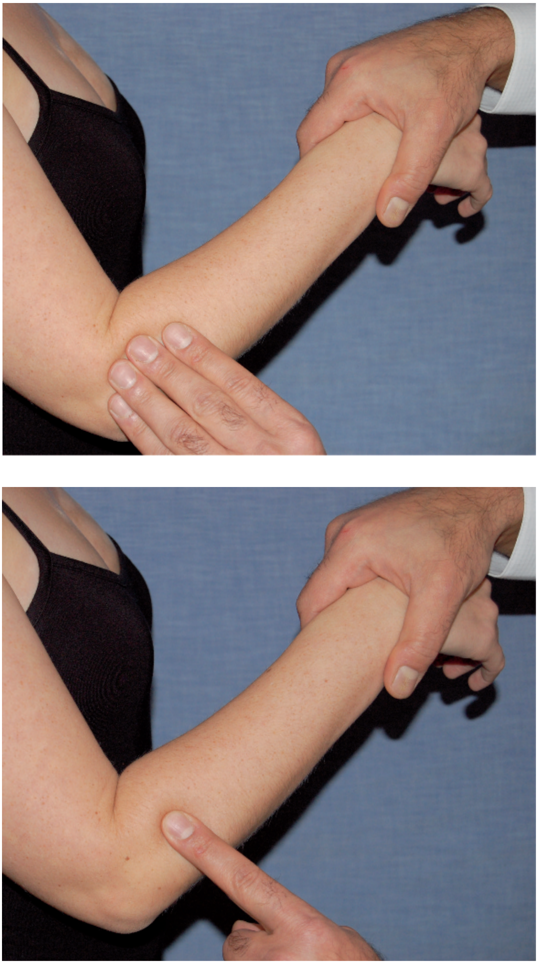


FIGURE 2.2. *(a)* Palpation of the radial head. Forearm pronated. *(b)* Palpation of the radial head. Forearm supinated.

If painful → Radial head fracture
→ Radiohumeral arthritis

Posterior Interosseous Nerve

Four finger breadths distal to lateral epicondyle (Figure 2.3), the posterior interosseous nerve passes between two heads of supinator under a thick ligament called *arcade of Frohse*. Entrapment of the nerve at this site is known as radial tunnel syndrome.



a

b

FIGURE 2.3. *(a)* Posterior interosseous nerve. *(b)* The index finger is over the *arcade of Frohse*.

From Behind

Tip of the Olecranon

The tip of the olecranon and the olecranon fossa are palpated for tenderness.

The bony prominences of the lateral epicondyle, the radial head and the olecranon form a triangle (Figure 2.4). The center of this triangle is the radiohumeral joint capsule . Careful palpation may reveal minor effusions or low grade synovitis.

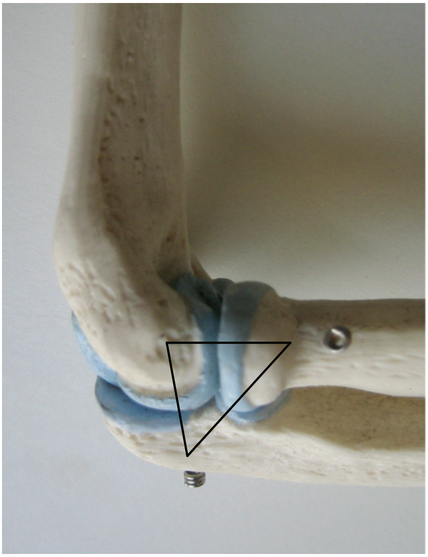


FIGURE 2.4. Relationship of the three bony points.

Medial Side

Medial Epicondyle

The most prominent structure of the medial side of the elbow is the medial epicondyle. The ulnar nerve can be felt behind the medial epicondyle (Figure 2.5). To facilitate palpation, the patient's arm should be in slight abduction, external rotation, and the elbow flexed between 20 and 70°.

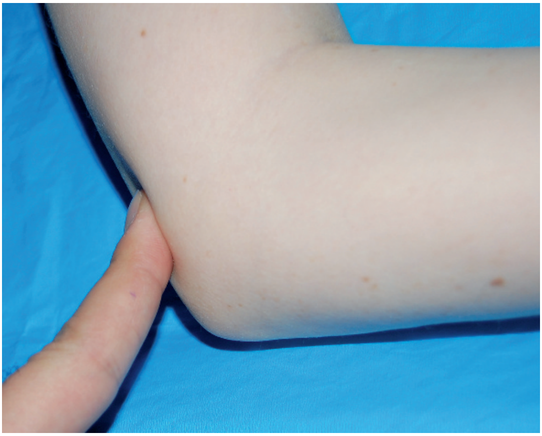


FIGURE 2.5. Palpation of ulnar nerve behind medial epicondyle.

Bony Prominences of the Epicondyles and the Apex of the Olecranon

The examiner puts his thumb on the lateral epicondyle, the index finger on the olecranon and the middle finger on the medial epicondyle and feels for the relationship of these bony prominences. They form a triangle when the elbow is flexed to 90° and a straight line when the elbow is in extension (Figures 2.6 and 2.7).

FIGURE 2.6. Three bony points.

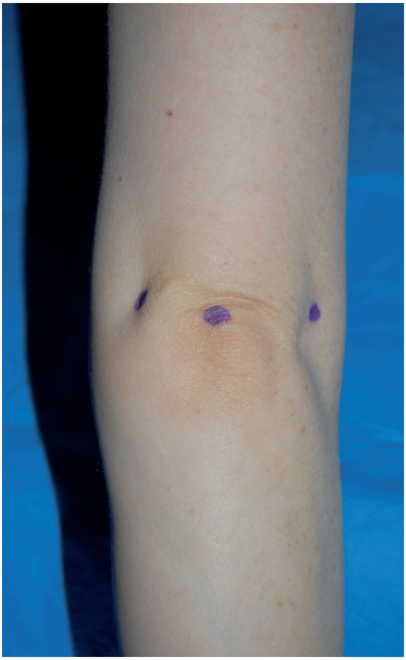


FIGURE 2.7. Three bony points in full extension.

From the Front

Lacertus fibrosus is the most prominent band anteriorly when the patient is made to flex the forearm against resistance (Figure 2.8)

The biceps tendon is lateral to lacertus fibrosus
The brachial artery is felt medial to the biceps tendon
The median nerve is medial to the brachial artery.
The musculocutaneous nerve is lateral to the biceps tendon.

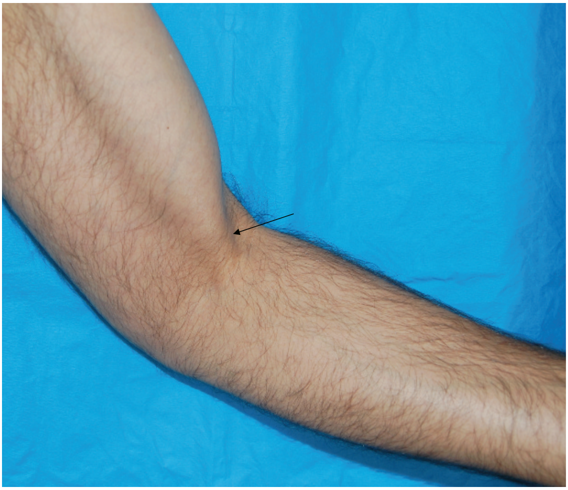


FIGURE 2.8. Lacertus fibrosus.

Range of Movement

Flexion – Extension

The patient is asked to abduct the shoulder to 90°, and then bend the elbow as far as possible. The degree of flexion and extension is measured (Figures 2.9 and 2.10).

Normal Flexion →0 to 140°

Hyperextension →0 to –10°

FIGURE 2.9. Flexion.

FIGURE 2.10. Extension.

Pronation – Supination

The patient is instructed to show the palm and back of the hands while he flexes the elbows to 90°and keeps the arms by his side (Figures 2.11 to 2.14).

Normal Range:

Pronation → 0 to 70°

Supination → 0 to 85°

The passive range of movement is evaluated after the active range is measured by the examiner.

Passive movements should be pain-free.

If pain elicited

with hyperextension → posterior impingement

with hyperflexion → anterior impingement (between coronoid tip and fossa)

FIGURE 2.11. Neutral rotation.

FIGURE 2.12. Supination.

FIGURE 2.13. Pronation.

During examination for the passive range, the examiner feels for the end point of each movement. The common end points are:

Bony → Two hard surfaces meeting, bone to bone (e.g., elbow extension as the olecranon locks into the olecranon fossa).

Capsular → Leathery feel, further motion available (e.g. forearm pronation and supination).

Soft tissue approximation → Soft tissue contact (e.g., elbow flexion as the movement is blocked by the bulk of the arm and forearm muscles).

Spasm → Muscle contraction limits motion

Springy block → Intra-articular block; rebound is felt

Empty → Movement causes pain, pain limits movement

FIGURE 2.14. Incorrect method of recording pronation. The elbows must be kept by the sides.

Muscle Testing

Biceps (Musculocutaneous nerve)
To assess the biceps, the patient is asked to flex the elbow to 90° and maintain the position. The examiner supports the elbow with one hand, holds the wrist with the other hand and attempts to extend the elbow (Figure 2.15).

FIGURE 2.15. Assessing the biceps.

Triceps (Radial Nerve)

To assess the triceps, the patient is asked to flex the elbow to 90° and maintain the position. The examiner supports the elbow with one hand and holds the wrist with the other hand and attempts to flex the elbow (Figure 2.16).

FIGURE 2.16. Assessing the triceps.

Brachioradialis (Radial Nerve)
The patient is asked to flex the elbow to 90° with the wrist in neutral and to maintain that position. The examiner holds the elbow with one hand and exerts downward pressure to the radial border of the distal forearm with the other hand. The brachioradialis muscle stands out in the proximal forearm (Figure 2.17).

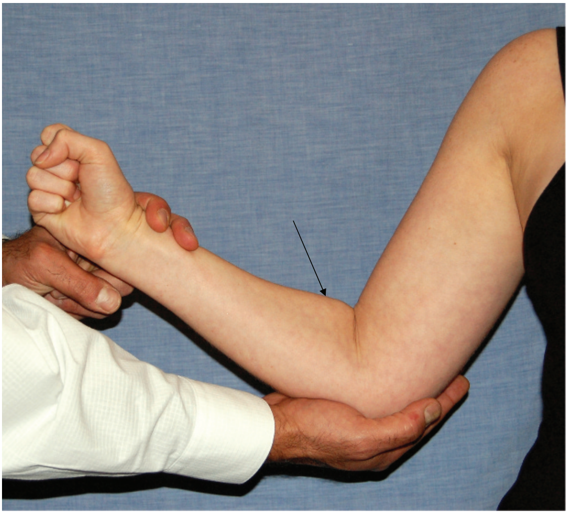


FIGURE 2.17. Assessing the brachioradialis. The black arrow points toward the muscle.

Pronator teres and Pronator quadratus (Median nerve)
(Tested together)
The patient is asked to flex the elbow to 90° with the forearm fully pronated and maintain the position. The examiner stabilizes the elbow with one hand and with the other hand holds the wrist and attempts to supinate the forearm (Figure 2.18).

FIGURE 2.18. Assessing the pronators.

Supination of the elbow joint is provided by the supinator (radial nerve) and the biceps muscle (musculocutaneous nerve). The power of the supinator muscle cannot be elicited in isolation. To assess the overall supination power of the forearm, the patient is asked to flex the elbow to 90° with the forearm fully supinated and maintain the position. The examiner stabilizes the elbow with one hand and with the other hand holds the wrist and attempts to pronate the forearm (Figure 2.19).

FIGURE 2.19. Assessing the supinators.

Complete neurological examination is mandatory and this is covered in the Hand and Wrist chapter.

Special Tests

Varus Stress Test

The examiner puts one hand above and one hand below the elbow. With the forearm in full supination and the elbow in extension, the examiner exerts varus force (Figure 2.20).

Opening of the lateral compartment → lateral ligament laxity

FIGURE 2.20. Varus stress test. Note the direction of force.

Valgus Stress Test

The examiner puts one hand above and one hand below the elbow. With the forearm in full supination and the elbow in slight flexion, the examiner exerts valgus force (Figure 2.21).

Opening of medial compartment → medial ligament laxity

FIGURE 2.21. Valgus stress test. Note the direction of force.

Lateral Pivot Shift Test

This is a test for posterolateral rotatory instability of the elbow: Ask the patient to place the arm over his head. The examiner then holds the patient's wrist and the elbow. The forearm is fully supinated, and valgus stress is applied as the elbow is moved from the fully extended position to a flexed position. This reproduces posterolateral rotatory instability, which manifests as pain and apprehension in the patient.

Tinel's Test

For ulnar nerve neuropathy.
With the elbow flexed to 20°, the examiner taps gently over the ulnar groove between the olecranon and the medial epicondyle. In a positive test, there is a tingling sensation down the forearm to the ulnar distribution in the hand.

Provocative Test for Lateral Epicondylitis

The patient is instructed to extend the wrist and fingers and maintain the position. The examiner applies downward force to the middle finger (ECRB inserts into the base of the third metacarpal) while the elbow is in full extension. In a positive test, it produces pain at the lateral epicondyle.

Chapter 3
Wrist and Hand

LISTEN

Mechanism of Injury (If Applicable)

Certain mechanisms of injury result in characteristic patterns of structural damage.

Common Examples

Punching a hard object → Fracture head/neck of little finger metacarpal

Being hit by a ball over the finger/sudden flexion while making bed → Mallet finger

"Catching" the thumb by snowboarder/skier[1] → ulnar collateral injury

Using the hand like a hammer → fracture/nonunion of hook of hamate[2]

Fall on to extended wrist → Colles' fracture

Fall on to flexed wrist → Smith's fracture

Cut on flexor aspect of finger → Tendon and/or nerve injury

---

[1] Traditionally it is called gamekeeper's thumb and it was one of the occupational injuries. It is however more often seen in winter sport enthusiasts.

[2] Cobblers's fracture.

Account of Symptoms

Waking up at night with hand pain, pins and needles → carpal tunnel syndrome

Pain and pins and needles in hand after trauma or using a crutch → ulnar tunnel syndrome

Pain and stiffness in finger on waking → flexor tenovaginitis

Location of Pain

Radial Side of the Wrist

de Quervain's disease
Radiocarpal osteoarthritis
Scaphoid nonunion
Scaphotrapeziotrapezoid (STT) osteoarthritis

Ulnar Side of the Wrist

Ulnar styloid fracture
Injuries to triangular fibrocartilage complex (TFCC)
Ulnar abutment
Caput ulnae (rheumatoid patients)
Radiolunar osteoarthritis
Pisotriquetral osteoarthritis

In the Center of the Wrist

Avascular necrosis (AVN) of lunate
Scapholunate dissociation
Midcarpal osteoarthritis

LOOK

The patient is facing the examiner with hands over a pillow or on the table. The examiner begins by asking the patient to keep their hands relaxed.

The Palm

1. In a relaxed position the arcade of flexion of fingers should be observed. With the wrist in the neutral position, each finger is slightly more flexed than its radial neighbor (Figure 3.1).

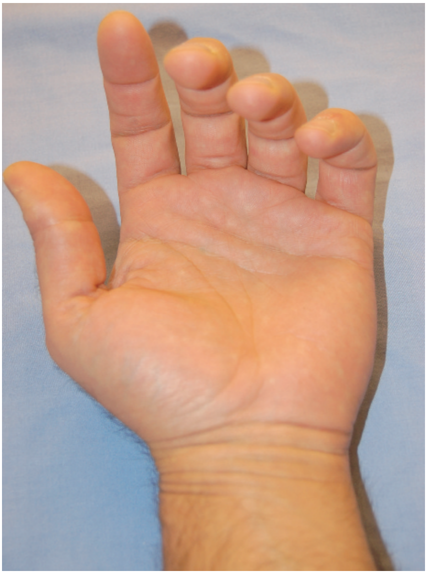


FIGURE 3.1. Normal arcade of flexion.

Abnormal Arc

One or more fingers remain in the fully extended position (Pointing finger sign) → flexor digitorum profundus (FDP) tendon avulsion or laceration (Figure 3.2).

Limited flexion in a finger → flexor digitorum superficialis tendon laceration
→ stiff finger

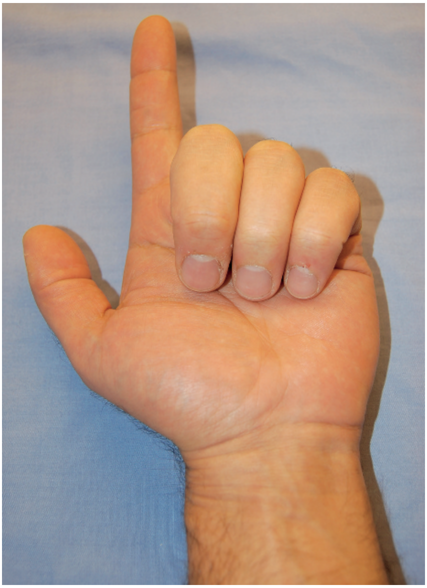


FIGURE 3.2. Pointing finger sign.

FIGURE 3.3. Normal rotational alignment of the fingers.

At the same time one must look for the rotational alignment of the finger by observing the fingernails. Usually fingernails are parallel with each other. Abnormal rotation due to fractures or malunion can be observed in this way (Figure 3.3).

Then ask the patient to fully extend all the fingers.

2. Swelling of the finger/s

Fusiform swelling → rheumatoid arthritis (synovitis)
→ fracture and ligamentous injuries
→ flexor tendon sheath infection

Pyogenic Flexor Tenosynovitis

Kanavel's classical signs

1. Tenderness over flexor tendon
2. Fusiform swelling of the finger
3. Finger held in slightly flexed position
4. Increased pain on passive extension

Common Hand Swellings

Ganglion
Mucous cyst
Giant cell tumour of tendon sheath
Villonodular synovitis
Bone tumour (Enchondroma)

FIGURE 3.4. Dupuytren's contracture. (Courtesy of Mr. Wetherell)

3. Nodular thickening of palm, especially ring and little finger → Dupuytren's contracture (Figure 3.4).

Compare the Thenar Eminences

Atrophy of thenar muscles → median nerve pathology
→ osteoarthritis base of thumb

Compare the Hypothenar Eminences

Atrophy of hypothenar muscles → ulnar nerve pathology

4. Swelling Around the Wrist

Radial Side

Ask the patient to bring the palms close together (Figure 3.5)

i. Compare the thenar muscles. Subtle differences can be observed easily.
ii. Alignment of the thumb and its deformity can be observed (look at the deformity section later in this chapter).

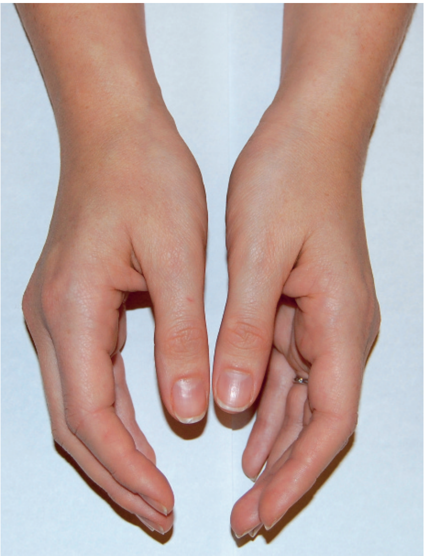


FIGURE 3.5. Compare the thenar eminences.

FIGURE 3.6. Compare the hypothenar eminences.

While palms are together, ask the patient to flex the elbows and observe the ulnar border of the hands (Figure 3.6).

Ulnar Side

i. Compare the hypothenar muscles. Subtle differences can be observed easily.
ii. Flexion deformity of the little finger metacarpal, if present, can be seen.
iii. Look at the elbow joint. Any scars which may be associated with ulnar nerve pathology or other abnormalities can be seen.

Dorsum of the Hands

Nails

Pitting of the nails → psoritic arthropathy (Figure 3.7)

Swelling around the nail bed → paronychia

Thickening and distortion → fungal infection

Figure 3.7. *(a)* Psoriasis lesion on the hand. *(b)* Nail changes in psoriasis.

Swelling of Fingers and Hand

Abbreviations

DIPJ: Distal interphalangeal joint
PIPJ: Proximal interphalangeal joint
MCPJ: Metacarpophalangeal joint
CMCJ: Carpometacarpal joint
IPJ: Interphalangeal joint

Around the base of the nail → mucous cyst
→ giant cell tumour

DIPJ level (Heberden's nodes) → osteoarthritis (Figure 3.8)

PIPJ level (Bouchard's nodes) → rheumatoid arthritis
→ Gouty tophus

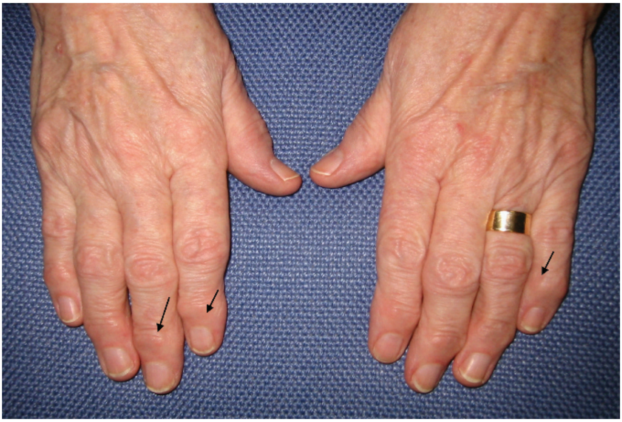


FIGURE 3.8. Heberden nodes.

MCPJ level → rheumatoid arthritis (synovitis) (Fig 3.9)

CMCJ of the thumb → osteoarthritis (Figure 3.10)

Thickening of the dorsal skin over PIP joints (Garrod's pad) → Dupuytren's disease

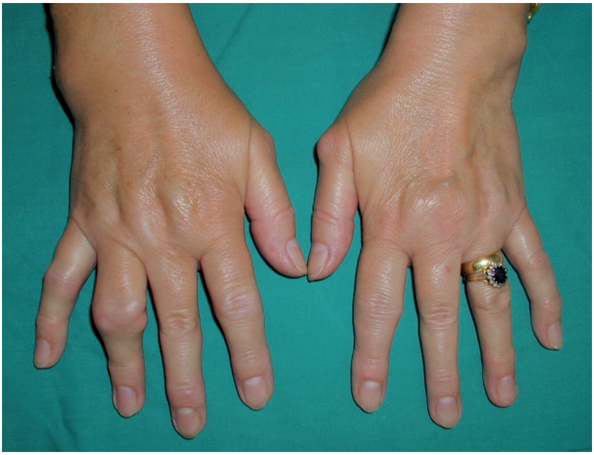


FIGURE 3.9. Synovitis MCPJs level and PIPs especially right ring finger. (Courtesy of Mr. Wetherell)

FIGURE 3.10. Arthritis at base of the thumbs.

FIGURE 3.11. Atrophy of first dorsal interosseous *(black arrow),* guttering of the dorsum of the hand *(white arrows)* and abduction of the little finger.

Atrophy of first dorsal interosseous → ulnar nerve pathology. Intrinsic wasting of other fingers follows later which causes guttering of the dorsum of the hand (Figure 3.11).

Swellings of the Wrist

Radial side
- Fracture of radius
- Synovitis (Dumbbell shape swelling, either side of extensor retinaculum in rheumatoid arthritis)
- Ganglion
- de Quervain's (nodular swelling proximal to radial styloid)

Ulnar side
- Rheumatoid arthritis
- Synovitis
- Caput ulnae

Deformities

Mallet Finger

Flexed DIPJ that is unable to actively extend
Due to extensor tendon rupture / avulsion fracture (Figure 3.12)

Figure 3.12. Mallet finger deformity.

Mallet Thumb

Flexed IPJ that is unable to actively extend

Swan Neck Deformity

DIPJ flexed, PIPJ hyperextended (Figure 3.13)

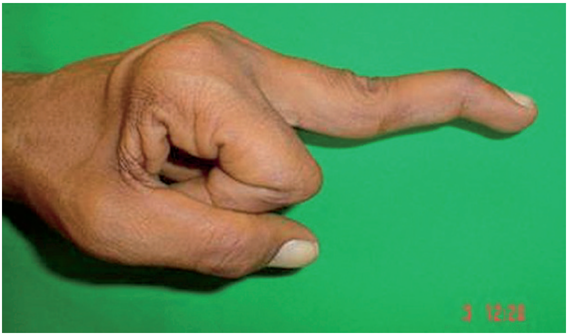


Figure 3.13. Swan neck deformity. (Courtesy of Dr. Anil K. Bhat[3])

[3] Dr. Anil K. Bhat, Associate Professor, Hand and Microvascular Surgery, Department of Orthopaedics, Kasturba Medical College, Manipal, India.

Due to:
imbalance of forces at the PIPJ and lax volar plate, seen in rheumatoid arthritis
Mallet finger (secondary to retraction of extensor mechanism)
Laceration /transfer of FDS
Intrinsic contracture

Boutonniere Deformity

PIPJ flexed, DIPJ extended (Figure 3.14)
Due to rupture or attenuation central slip of extensor tendon.
Seen in:
- Laceration
- Traumatic rupture
- Rheumatoid arthritis (attenuation secondary to capsular distension)

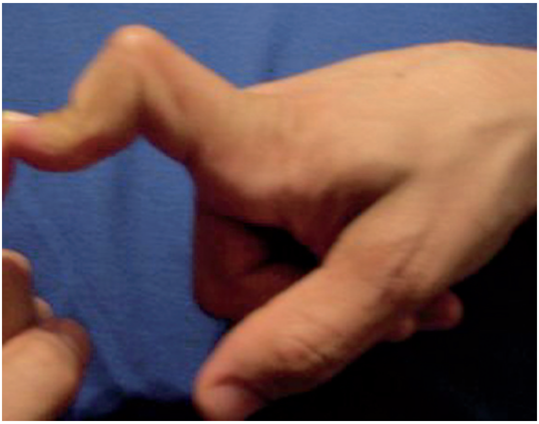


FIGURE 3.14. Boutonniere deformity.

Z Thumb

MCPJ flexed, IPJ hyperextended (Figure 3.15).
Due to imbalance of forces at the MCP and IPJ.
Seen in

Rheumatoid arthritis → EPB rupture
→ FPL rupture

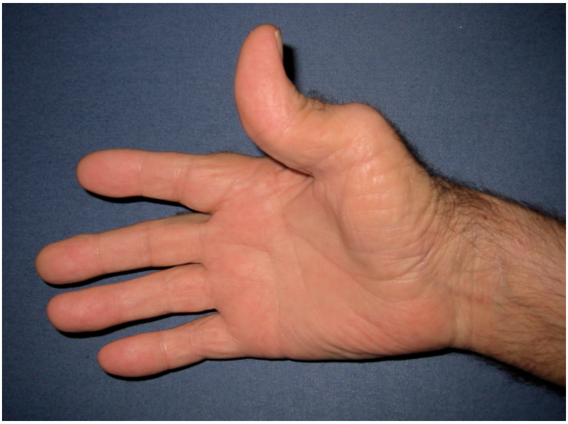


FIGURE 3.15. Z thumb deformity.

Vaughn-Jackson Syndrome

Inability to extend the little, ring, and middle finger (Figure 3.16) due to rupture (often sequential) of extensor tendons in rheumatoid arthritis.

FIGURE 3.16. Vaughn-Jackson syndrome.

Ulnar Drift

Ulnar deviation of the fingers at MCPJ (Figure 3.17). At the late stage, the MCPJ may sublux or dislocate. Seen in rheumatoid arthritis.

FIGURE 3.17. Ulnar drift. (Courtesy of Mr. Wetherell)

Claw Hand (Intrinsic Minus)

Hyperextension of MCPJ, flexion of PIPJ and DIPJ of all fingers Loss of intrinsic muscles and over activity of long extensors (Figure 3.18).

Seen in:

- Combined median and ulnar nerve palsy
- Volkmann's ischemic contracture
- Lower lesions of brachial plexus (Klumpke palsy)

a

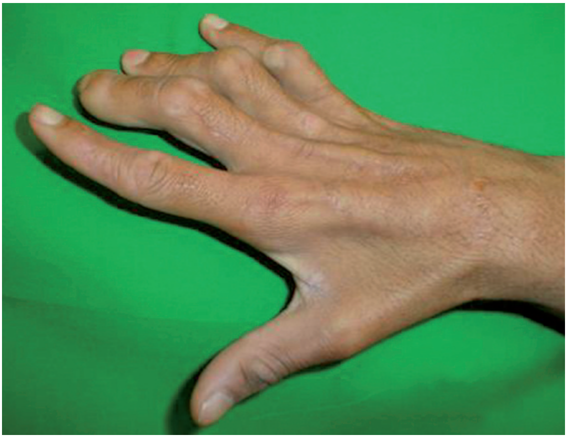
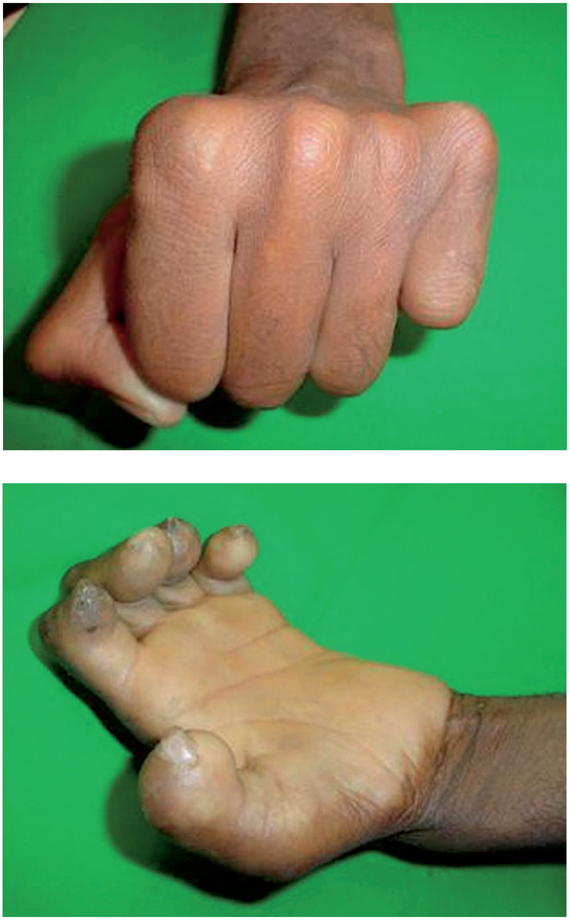


FIGURE 3.18. *(a)* Claw hand with interosseous muscle atrophy. *(b)* Flattening of distal metacarpal arch in claw hand. *(c)* Joint contracture in claw hand with resorption of distal phalanges in leprosy. (Courtesy of Dr. Anil K. Bhat)



b

c

Figure 3.18. Cont'd.

Intrinsic Plus Hand

Flexion of MCPJs and extension of PIPs and DIPs (Figure 3.19)

Seen in:

- Subluxation/dislocation of distal joints
- Intrinsic tightness in rheumatoid arthritis

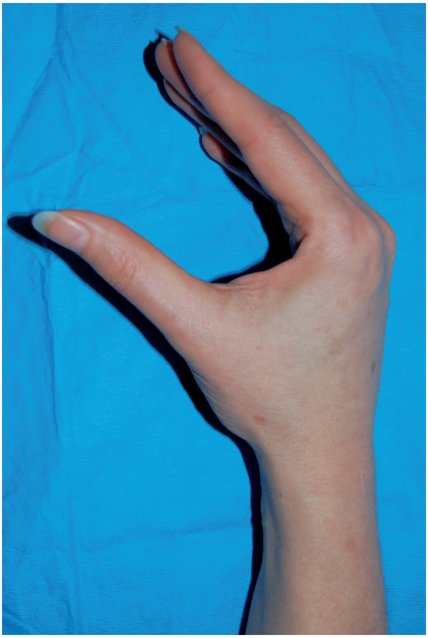


FIGURE 3.19. Simulation of intrinsic plus hand.

Ulnar Clawing

Hyperextension of MCPJ, flexion of PIPJ and DIPJ of ring and little finger (Figure 3.20).

Seen in:

Low ulnar nerve palsy

Note: In high ulnar nerve palsy the action of the FDP is lost; hence the DIPs are not flexed. This results in a lesser deformity in the hand called

Ulnar Paradox

The higher the lesion, the lesser the deformity

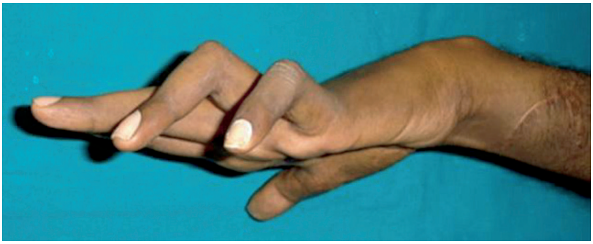


FIGURE 3.20. Ulnar claw hand. Note the laceration of distal forearm, hyperextension of MCPJ, and flexion of PIPJ. (Courtesy of Dr. Anil K. Bhat)

Benediction Hand Deformity (Bishop's Hand)

Hyperextension of MCPJs of index to little finger

Flexion of PIPJ and DIPJ; this manifests as slight flexion only in index and middle fingers and severe flexion in ring and little fingers (Figure 3.21).

Wasting of hypothenar, interosseous, and two medial lumbrical muscles.

Seen in: Longstanding ulnar nerve palsy

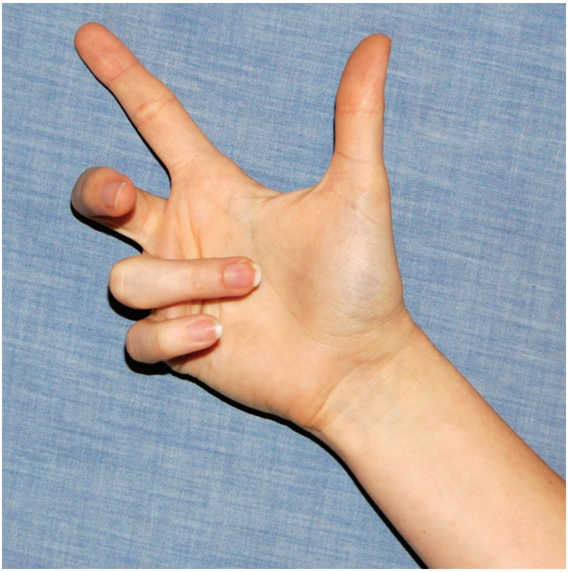


FIGURE 3.21. Simulation of Benediction hand deformity.

Ape Hand Deformity

The thumb rotates toward the other fingers due to pull of extensors as a result of wasting of thenar muscles. Seen in: Longstanding median nerve palsy.

Wrist Drop

Inability to extend the wrist, thumb and fingers (Figure 3.22) Seen in: High radial nerve palsy.

Note: Patients with low radial nerve palsy have at least one radial wrist extensor intact.

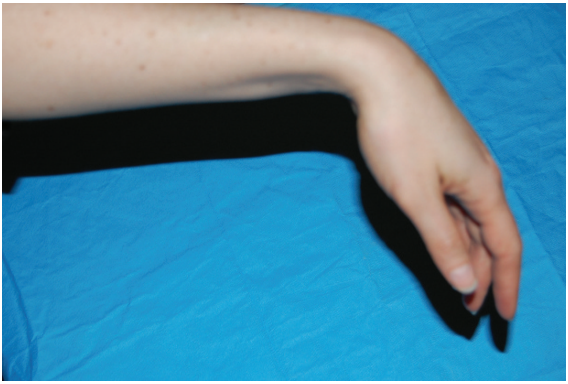


FIGURE 3.22. Wrist drop.

Mannerfelt-Norman Syndrome

Attritional rupture of FPL over osteophytes in carpal tunnel; Commonly seen in rheumatoid arthritis.

Common Congenital Deformities

Syndactyly: Webbed or conjoined fingers (Figure 3.23).

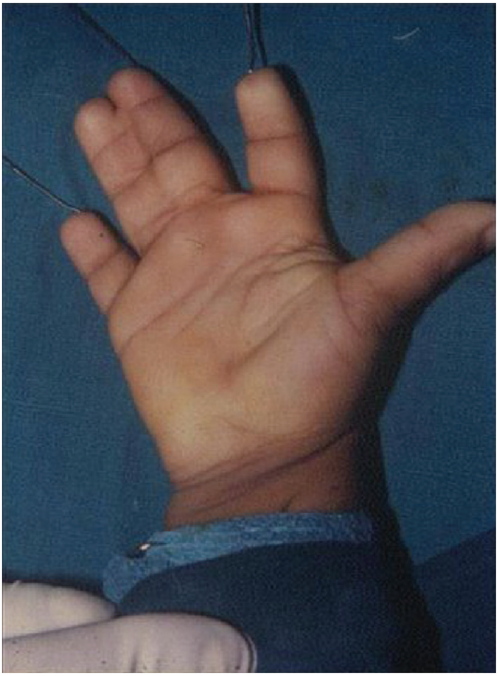


FIGURE 3.23. Syndactyly. (Courtesy of Dr. Bhaskaranand Kumar[4])

[4] Dr. Bhaskaranand Kumar, Professor and Unit Chief, Hand and Microvascular Surgery, Department of Orthopaedics, Kasturba Medical College, Manipal, India.

Polydactyly: Extra digit (Figure 3.24 and 3.25).

FIGURE 3.24. Polydactyly. (Courtesy of Dr. Bhaskaranand Kumar)

FIGURE 3.25. Polydactyly. (Courtesy of Dr. Bhaskaranand Kumar)

Macrodactyly: Overgrowth of one or more digits (Figure 3.26).

FIGURE 3.26. Macrodactyly of middle finger. (Courtesy of Dr. Bhaskaranand Kumar)

Camptodactyly: Fixed flexion deformity of PIPJ (usually the little finger) (Figure 3.27).

FIGURE 3.27. Bilateral Camptodactyly. (Courtesy of Dr. Bhaskaranand Kumar)

Clinodactyly: Radial deviation of the little finger (Figure 3.28).
Radial club hand: Marked radial deviation of the wrist (Figure 3.29).
Partial or complete absence of the radius and thumb.

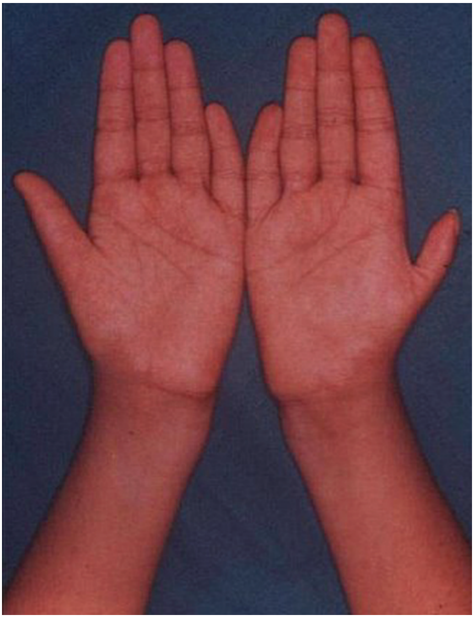


FIGURE 3.28. Bilateral clinodactyly. Not the hypoplastic right thumb. (Courtesy of Dr. Bhaskaranand Kumar)

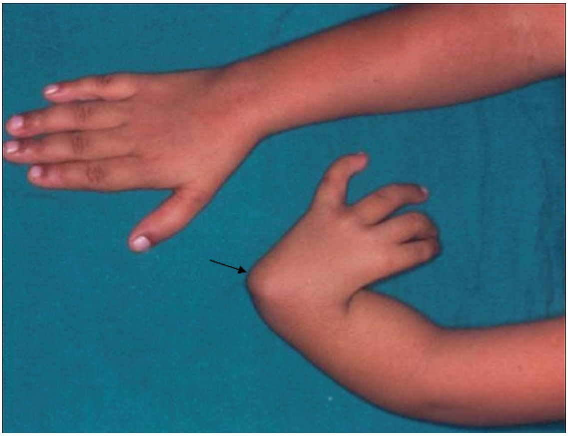


FIGURE 3.29. Radial club hand. Note the prominent head of the ulna (arrow) and absent thumb. (Courtesy of Dr. Bhaskaranand Kumar)

FEEL

Wrist

Radial Styloid Process

The distal-most projection from the lateral side of the radius is the radial styloid process. Its level compares with the ulnar styloid. Usually the radial styloid is more distal than that of the ulna in a pronated forearm. Shortening of the radial styloid (compared to the other side) may be due to:

radial fracture
radiocarpal arthritis
Kienböck's disease (advanced stage)

Tenderness at the radial styloid → fracture
→ radioscaphoid arthritis

Tenderness just proximal to the radial styloid → de Quervain's disease

Tenderness distal to the radial styloid → nonunion of scaphoid
→ trapeziometacarpal osteoarthritis
→ STT osteoarthritis

Anatomical Snuffbox (Figure 3.30)

The waist of scaphoid can be felt distal to the radial styloid process.
Tenderness → fracture or nonunion

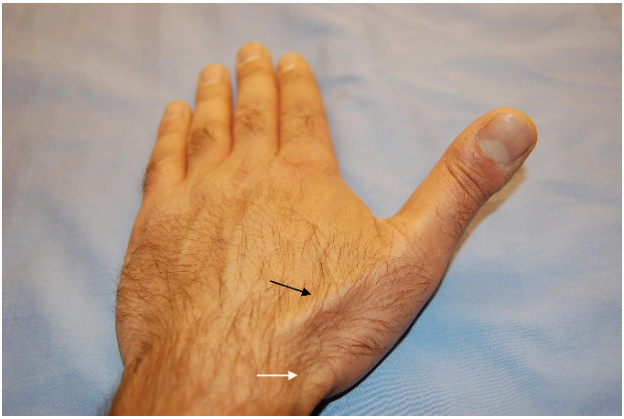


FIGURE 3.30. Anatomical snuffbox. Note the EPL tendon *(black arrow)* and APL, EPB tendons *(white arrow)*.

Anatomical Snuff Box

Dorsal border: EPL
Volar border: APL, EPB
Floor: waist of scaphoid
Content: Radial artery

Trapezium

Just distal to the waist of scaphoid, pulsation of the dorsal branch of the radial artery is felt with gentle palpation. The artery pulsates over the trapezium, which can be felt with firm palpation. The bony ridge immediately distal to this is the trapeziometacarpal joint.

Tenderness → trapeziometacarpal joint arthritis

Lister's Tubercle

About 2 cm ulnar to the radial styloid, a ridge can be felt on the dorsum of the radius. The tendon of the EPL sharply turns from the ulnar to the radial side of the tubercle to its insertion at the distal phalanx of the thumb.

Just distal to Lister's tubercle, with the wrist in slight flexion, the examiner's finger falls over the edge of the radius into a small depression, which is the scapholunate joint. With deeper palpation the proximal pole of the scaphoid can be felt.

Scaphoid

Keep your thumb over the proximal pole of the scaphoid (as described above). With your index finger, feel the radial pulse and follow the artery toward the wrist. Just distal to the wrist crease and about one finger-breadth toward the midline, a firm bony point is felt. This is the distal pole of the scaphoid. Put your index finger on it. With passive radial and ulnar deviation of the wrist, one can easily feel the movement of the scaphoid. Pressure over the poles of the scaphoid can confirm the fracture or nonunion.

Ulnar Head

This is a round structure on the ulnar side and it is visible in most individuals.

Tenderness → fracture/nonunion
→ dorsal subluxation
→ active synovitis (rheumatoid arthritis)
→ caput ulnae

Prominent → rheumatoid arthritis
→ malunited radial fractures
→ synovitis

Absent → previous surgical resection (Darrach's procedure)

Distal Radioulnar Joint

Feel the ulnar head. On palpation on the radial side of the ulnar head, the examiner can feel a depression, which is the distal radioulnar joint. Alternate pronation and supination to neutral, helps the examiner to locate the joint.

Tenderness → Fractures involving the joint
→ Instability
→ Active synovitis (rheumatoid arthritis)
→ Osteoarthritis

Ulnar Styloid Process

Palpate the ulnar head on the ulnar border. Slightly distal to it a small protuberance of ulna can be felt, which is the ulnar styloid process.

Tenderness → fracture
→ nonunion

TFCC

Feel the ulnar head dorsally. In the depression just distal to this is the TFCC. Sometimes slight flexion of the wrist helps to find the spot.

Tenderness → TFCC lesions

Note: Rotation of the hand on fixed forearm with wrist ulnar-deviated (Grind test) increases the TFCC symptoms.

Pisiform

This can be felt at the base of the hypothenar muscle and provides attachment for the flexor carpi ulnaris (FCU). The ulnar artery can be felt radial to the FCU tendon.

Tenderness → pisotriquetral osteoarthritis

Hamate

This is radial and distal to the pisiform in line with the ring finger. To locate it, the examiner puts the interphalangeal crease of his thumb on the pisiform of in direction of the base of the patient's index finger. The tip of the examiner's thumb should feel a firm bony point, which is the hook of hamate.

Tenderness → fracture, nonunion

The pisiform and hamate are connected by the pisohamate ligament which makes the roof of the ulnar tunnel (Guyon's canal).

Guyon's Canal

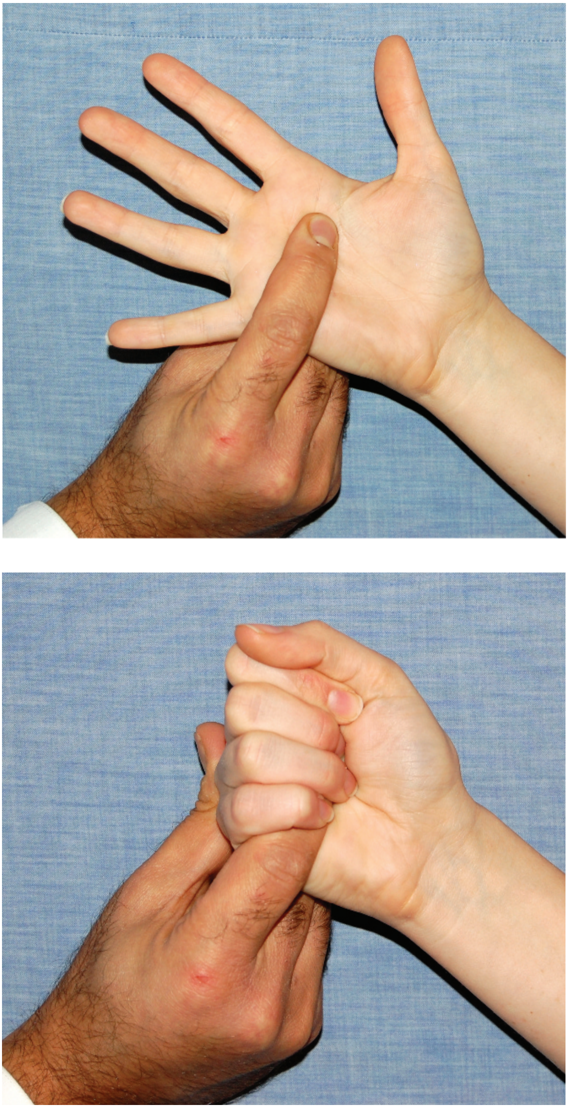
Floor: flexor retinaculum
Roof: pisohamate ligament
Ulnar border: pisiform
Radial border: hamate

The ulnar nerve has two sensory branches above the wrist which supply the dorsal and palmar aspects of the hand. Hence, if compression of the ulnar nerve occurs above the Guyon's canal, the patient will have altered sensation of the hand in addition to the fingers. The motor loss for a lesion above or in the canal is the same. In the other words, motor loss with preserved sensation in the little finger means lesion of the nerve beyond the bifurcation at the level of hook of hamate.

Trigger Finger

The examiner palpates the A1 pulley, which is at the level of the transverse flexor crease of the palm or proximal flexor crease of the thumb, by putting his index finger and his thumb in position

(Figure 3.31a) and asking the patient to gently flex and extend the finger (Figure 3.31b). As the finger extends, the examiner may feel a sudden jerky movement or a nodule on the tendon.



a

b

Figure 3.31. *(a)* Palpating the A1 pulley. *(b)* Active flexion and extension of hand by the patient.

Extensor Tendons

If subluxation or dislocation of the MCPJs has occurred, the examiner must ascertain whether a tendon rupture is present or not. To do this, the examiner tries to bring the finger in question into extension and then asks the patient to maintain that position.

If the patient can maintain the finger in extension the extensor tendon is intact.

Range of movement

Supination /Pronation

The patient is instructed to keep his elbows by his side and asked to show the palms of the hands and then the back of the hands. At times it is necessary for the examiner to keep a hand at the patient's elbow to ensure that movement of the shoulder does not compensate for deficient forearm rotation.

Normal range:
- supination: 0–90°
- pronation:0–80°

Wrist

To assess dorsiflexion, ask the patient to put the palms of the hands together and bring the elbows up (prayer position) (Figure 3.32).

FIGURE 3.32. Dorsiflexion.

To assess palmar flexion, ask the patient to put the backs of the hands together ('reverse' prayer position) (Figure 3.33).

FIGURE 3.33. Palmar flexion.

To assess radial and ulnar deviation, ask the paint to keep the elbow by the side, pronate the forearm and then bend the wrist toward the radius (Figure 3.34) and ulna (Figure 3.35) respectively. It is sometimes easier to do the movements yourself and ask the patients to copy. Always do both sides simultaneously to compare.

FIGURE 3.34. Radial deviation.

FIGURE 3.35. Ulnar deviation.

Normal range:
Dorsiflexion: 0–90°
Palmar flexion: 0–80°
Radial deviation: 0–20°
Ulnar deviation: 0–40°

Hand

Ask the patient to make a fist and assess the gross finger movements. Individual joints can be measured if abnormality is detected.

Normal Flexion of Finger

MCPJ	0–90°
PIPJ	0–100°
DIPJ	0–80°

Passive movements of the finger should be performed with the MCPJ in hyperextension and repeated with the MCPJ in flexion. This differentiates intrinsic from extrinsic tightness and is known as the Bunnell test. In the presence of intrinsic tightness, the amount of flexion of the IPJs is less when the MCPJs are hyperextended.

Normal Flexion of Thumb

MCPJ	–5° (hyperextension) to 55°
IPJ	–20° (hyperextension) to 80°

Nerve and Muscle Examination

The causes of neurological disorders vary widely.
The differential points of some of the neurological disorders are mentioned with each condition:

Lacerations → complete / incomplete loss of nerve function

Poliomyelitis → motor weakness only, no sensory loss

Leprosy → sensory changes first then motor weakness

Charcot-Marie-Tooth disease → extensive motor weakness, later dissociated sensory loss

Common Neurological Conditions in Orthopedic Patients
(in the developed world)

Individual nerve lesion:

1. Laceration
2. Compression neuropathy
3. Mononeuritis (diabetes mellitus)

Neurological disorders

1. MS, demyelination
2. Diabetic peripheral neuropathy
3. Polio (Rare)

Radial Nerve

The radial nerve is divided into the posterior interosseous nerve and a sensory branch at the level of the lateral epicondyle.
The following muscles are innervated by the radial nerve above the elbow joint:

1. Brachioradialis
2. Extensor carpi radialis longus (ECRL)

Injury to the nerve above the elbow joint results in high radial nerve palsy.

Posterior Interosseous Nerve

This is predominately a motor nerve and carries sensory fibres only from the dorsal wrist capsule. The following muscles are innervated by the posterior interosseous nerve:

1. Supinator (*Cannot be tested clinically*).[5]
2. Extensor carpi radialis brevis (ECRB): Variable
3. Extensor digitorum communis (EDC)
4. Extensor carpi ulnaris (ECU)
5. Extensor digiti minimi (EDM)
6. Abductor pollicis longus (APL)
7. Extensor pollicis longus (EPL)
8. Extensor pollicis brevis (EPB)
9. Extensor indicis proprius (EIP)

Injury to the nerve below the elbow joint results in low radial nerve palsy.

---

[5] Extension of the elbow limits action of the biceps and may reveal weakness in supinator.

Brachioradialis

The patient is asked to flex the elbow to 90° with the wrist in neutral and maintain the position. The examiner holds the elbow with one hand and exerts downward pressure to the radial border of the distal forearm with the other hand. The brachioradialis muscle stands out in the proximal forearm (Figure 3.36).

FIGURE 3.36. Assessing the Brachioradialis. The *black arrow* points toward the muscle.

Extensor Carpi Radialis Longus and Brevis (ECRL and ECRB)

The patient is asked to extend the wrist with radial deviation and flex the elbow to 90° while the arm is held tightly at the side. The examiner stabilizes the forearm with one hand and with the other hand exerts downward pressure on the radial side of the dorsum of the patient's hand (Figure 3.37). The tendons of the ECRL & ECRB can be felt about 1 cm ulnar to the radial styloid process.

Note: It is extremely difficult to ascertain the integrity of the ECRB in the presence of an intact ECRL. The presence of an intact ECRB is variable in posterior interosseous never palsy. A patient with posterior interosseous nerve palsy will have at least one radial wrist extensor intact thus wrist extension is present but deviates to radial side.

FIGURE 3.37. Extensor carpi radialis longus and brevis.

Extensor Carpi Ulnaris (ECU)

The patient is asked to extend the wrist with ulnar deviation and flex the elbow to 90° while the arm is held tightly at the side. The examiner stabilizes the forearm with one hand and with the other hand exerts downward pressure on the ulnar side of the dorsum of the patient's hand (Figure 3.38). The tendon of ECU can be felt just distal to the head of the ulna.

FIGURE 3.38. Extensor carpi ulnaris.

Extensor Digitorum Communis (EDC)

To test the EDC, the patient is asked to extend the fingers at the MCPJs and flex the PIPJs and IPJs (claw like position) and maintain the position, with the wrist in neutral and the forearm pronated. The examiner stabilizes the forearm with one hand and exerts pressure just distal to the MCPJs to flex the fingers (Figure 3.39).

FIGURE 3.39. Extensor digitorum communis.

Extensor Digiti Minimi (EDM) and Extensor Indicis Proprius (EIP)

These two muscles can be tested together. Ask the patient to make a fist and then extend the index and little fingers. The examiner stabilizes the forearm with one hand and exerts pressure just distal to the MCPJs to flex the fingers (Figure 3.40). The tendons of EIP and EDM are *ulnar* to the EDC in the index and little fingers.

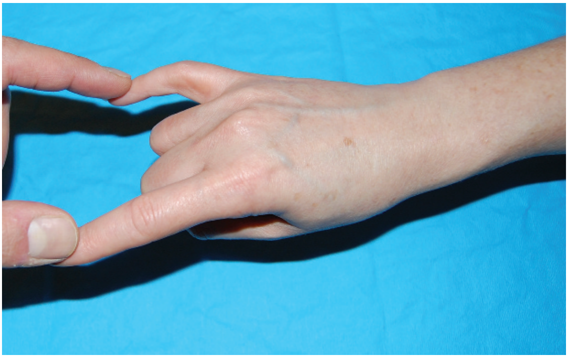


FIGURE 3.40. Extensor digiti minimi (EDM) and extensor indicis proprius (EIP).

Abductor Pollicis Longus (APL)

The examiner asks the patient to put his hand on the table and abduct the thumb against resistance. The APL tendon is visible just distal to the tip of the radial styloid process. (Figure 3.41).

FIGURE 3.41. Abductor pollicis longus tendon *(black arrow)*.

Extensor Pollicis Longus (EPL)

The patient keeps the hand flat on the table, and lifts the thumb off the table while keeping the palm in contact (table top test). The examiner may exert pressure to the tip of the thumb. The tendon of EPL is easily seen. This can be considered as an autonomous test for the radial nerve (Figure 3.42).

EPL Tendon Rupture

Seen in:
Rheumatoid arthritis
Complication of Colles' fracture

FIGURE 3.42. Extensor pollicis longus.

Extensor Pollicis Brevis (EPB)

The patient is asked to do a thumbs up sign and maintain the position. Then the examiner exerts pressure to the dorsum of the proximal phalanx to flex the MCPJ (Figure 3.43).

FIGURE 3.43. Extensor pollicis brevis.

Muscle Insertion

Brachioradialis	Radial styloid
ECRL	Base of 2nd metacarpal
Supinator	Neck and shaft of radius
ECRB	Base of 3rd metacarpal
EDC	Middle and distal phalanx
ECU	Base of 5th metacarpal
EDM	Extensor expansion little finger
APL	Base of first metacarpal
EPL	Base of distal phalanx of thumb
EPB	Base of proximal phalanx of thumb
EIP	Extensor expansion index finger

Median Nerve

The median nerve gives off a muscular branch and an anterior interosseous branch in the proximal forearm. It supplies the following muscles:

1. Pronator teres (PT)
2. Flexor carpi radialis (FCR)
3. Palmaris longus (PL)
4. Flexor digitorum superficialis (FDS)
5. Flexor digitorum profundus (FDP) middle finger
6. Anterior interosseous nerve:
   a. Flexor digitorum profundus (FDP) index finger
   b. Flexor pollicis longus (FPL)
   c. Pronator quadratus (PQ)

Injuries to the nerve *proximal to the origin of the anterior interosseous nerve* result in high median nerve palsy.
The median nerve supplies the following muscles after crossing the wrist joint:

1. Abductor pollicis brevis (APB)
2. Opponens pollicis
3. Flexor pollicis brevis (FPB)
4. Two radial lumbricals

Note: Thumb abduction and opposition are frequently retained in low median nerve palsy due to variability of thenar muscle innervations.

Pronator Teres (PT) and Pronator Quadratus (PQ)
These two muscles are tested together. The patient is asked to keep the elbow flexed to 90° and keep the forearm in full supination. The examiner holds the distal forearm and asks the patient to turn the hand over (Figure 3.44).

FIGURE 3.44. Assessing pronator teres and pronator quadratus.

Flexor Carpi Radialis (FCR)

The patient is asked to supinate the forearm, flex and radially deviate the wrist and flex the elbow to 90° while the arm is held tightly at the side. The examiner stabilizes the forearm with one hand and exerts downward pressure to the radial side with the other hand (Figure 3.45).

FIGURE 3.45. Flexor carpi radialis.

Palmaris Longus (PL)

The patient is asked to bring the pulps of the thumb and little finger together, with the wrist in slight flexion (Figure 3.46). Occasionally exerting resistance to the wrist helps the tendon to become more prominent. The presence of this muscle is important, especially when planning tendon transfer.

FIGURE 3.46. Palmaris longus tendon *(black arrow)*.

Flexor Digitorum Superficialis (FDS)

The patient's hand is palm up on the table. The patient is then instructed to flex one finger while the examiner holds the other three fingers in full extension (Figure 3.47). To ensure the FDP is not acting, the examiner moves the DIPJ passively. It should be flail.

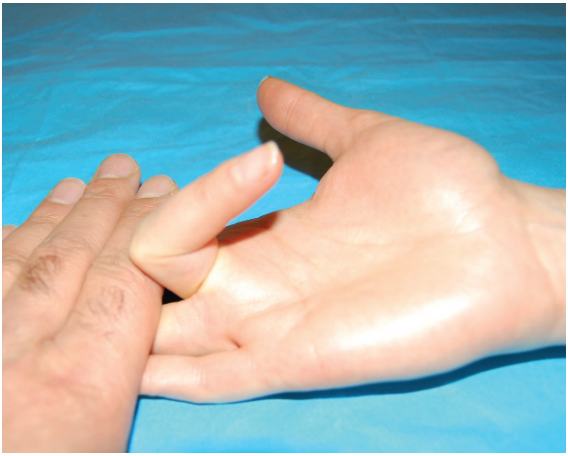


FIGURE 3.47. Assessing the flexor digitorum superficialis.

Flexor Digitorum Profundus (FDP) Middle Finger

The examiner stabilizes the PIPJ of the finger in extension and then asks the patient to bend the tips of the finger (Figure 3.48).

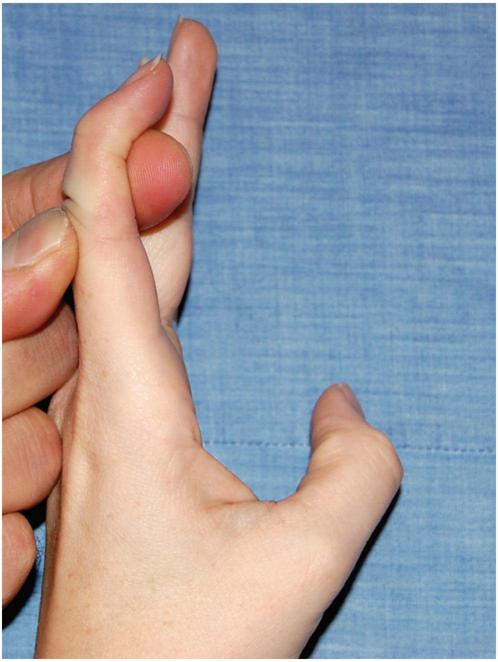


FIGURE 3.48. Assessing the flexor digitorum profundus.

Abductor Pollicis Brevis (APB)

The patient is asked to put the hand on the table with the palm facing up, then bring the thumb toward the ceiling and maintain the position (Figure 3.49). The examiner exerts pressure on the radial side of the thumb (Figure 3.50) and feels for contracture of the muscle at the thenar eminence. This is the autonomous motor test for the median nerve.

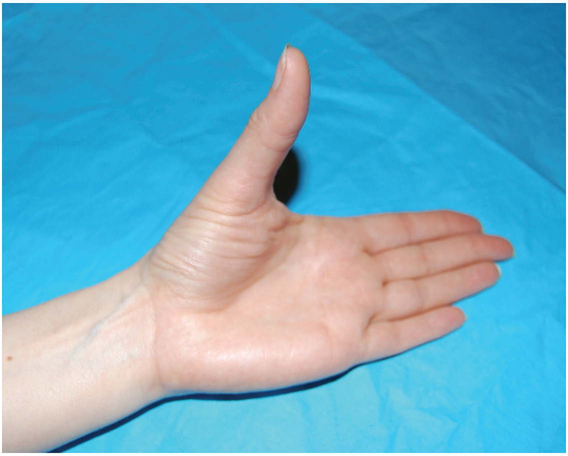


FIGURE 3.49. Thumb toward the sealing to assess abductor pollicis brevis.

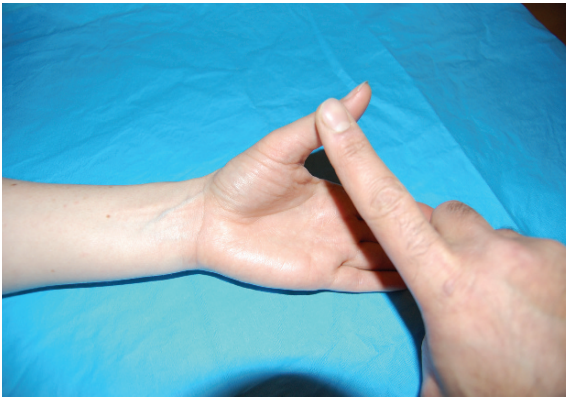


FIGURE 3.50. Assessing abductor pollicis brevis.

Opponens Pollicis

The patient is asked to bring the tips of the thumb and little finger together and maintain the position. The examiner then exerts pressure to the little finger and the thumb to pull them apart (Figure 3.51).

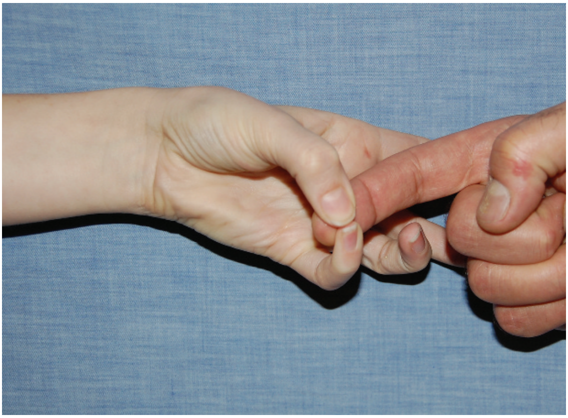


FIGURE 3.51. Assessing the opponens pollicis.

Flexor Pollicis Brevis (FPB)

The patient is asked to flex the thumb in the palm and maintain the position. The examiner then exerts pressure to the proximal phalanx, trying to being it into extension (Figure 3.52).

FIGURE 3.52. Assessing the flexor pollicis brevis.

Two Radial Lumbricals

All the lumbricals are tested together. The patient is asked to flex the MCPJs to 90° with the fingers straight. The examiner then exerts pressure to the DIPJs, trying to flex the fingers (Figure 3.53).

Muscle Insertion

PT	Lateral shaft of radius
FCR	Base of 2nd and 3rd metacarpals
PL	Flexor retinaculum and palmar aponeurosis
FDS	Middle phalanx
FDP	Distal phalanx
FPL	Distal phalanx of thumb
PQ	Anterior shaft of radius
APB	Base of proximal phalanx of thumb
Opponens pollicis	Shaft of metacarpal of thumb
FPB	Base of proximal phalanx of thumb
Lumbricals	Extensor expansion

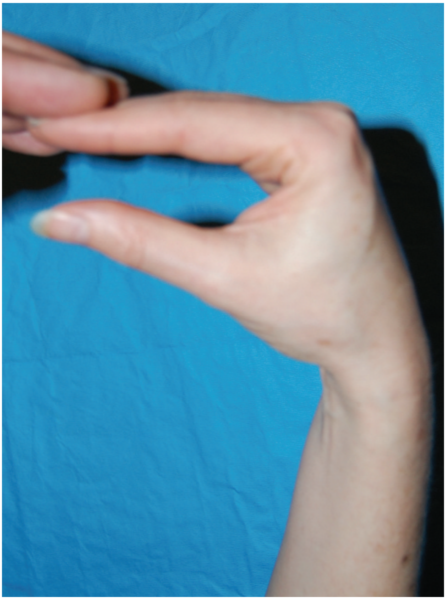


FIGURE 3.53. Assessing the lumbricals.

Ulnar Nerve

The ulnar nerve gives off two muscle branches in the proximal forearm:

1. Flexor carpi ulnaris (FCU)
2. Flexor digitorum profundus (FDP) ring and little finger

Injury to the nerve proximal to the elbow joint results in high ulnar nerve palsy.

The ulnar nerve innervates the following muscles after crossing the wrist joint:

1. Opponens digiti minimi
2. Abductor digiti minimi
3. Flexor digiti minimi brevis
4. Adductor pollicis
5. Two ulnar lumbricals
6. Dorsal Interossei
7. Palmar Interossei
8. Flexor pollicis brevis (deep head) - variable

Flexor Carpi Ulnaris (FCU)

The patient is asked to supinate the forearm, flex and ulnar-deviate the wrist and flex the elbow to 90°, while the arm is held tightly at the side. The examiner stabilizes the forearm with one hand and exerts downward pressure to the ulnar side with the other hand (Figure 3.54).

Flexor Digitorum Profundus (FDP) Ring and Little Finger

The examiner stabilizes the PIPJ of the fingers in extension and then asks the patient to bend the tips of the fingers.

FIGURE 3.54. Assessing the Flexor carpi ulnaris.

Opponens Digiti Minimi

The patient is asked to bring the tips of the thumb and little finger together and maintain the position. The examiner then exerts pressure to the little finger and the thumb to pull them apart (Figure 3.51).

Abductor Digiti Minimi

The patient is asked to abduct the little the finger and maintain the position while the forearm is pronated and the elbow flexed to 90°. The examiner then presses his index finger against the ulnar border of the patient's little finger, while with the other hand feeling for the muscle contracture in the hypothenar eminence (Figure 3.55). This can be considered an autonomous motor test for the ulnar nerve.

FIGURE 3.55. Assessing the abductor digiti minimi.

Adductor Pollicis

The examiner places one finger between the thumb and the index finger metacarpal and asks the patient to adduct the thumb against the examiner's finger (Figure 3.56).

FIGURE 3.56. Assessing the adductor pollicis.

Two Ulnar Lumbricals

All the lumbricals are tested together. The patient is asked to flex the MCPJs to 90° with the fingers straight. The examiner then exerts pressure to the DIPJs, trying to flex the fingers (Figure 3.53).

Dorsal Interossei

Dorsal interossei are finger abductors. The patient is asked to spread the fingers as far apart as possible and maintain the position, while the forearm is pronated and the elbow flexed to 90°. The examiner then exerts pressure to the index and little finger to push them back together (Figure 3.57).

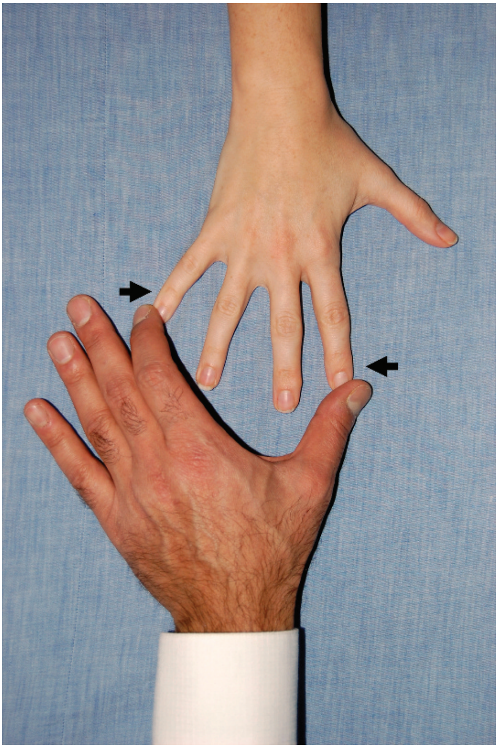


FIGURE 3.57. Note the direction of the force.

Alternatively, to test the first dorsal interosseous, the patient is asked to put the hand on the table palm down and abduct the index finger and maintain the position. The examiner then presses his index finger against the radial border of the patient's index while with the other hand feeling for the muscle contracture (Figure 3.58).

The action of different sets of lumbricals can be remembered as:

Dorsal → **AB**duct
Palmar → **AD**duct

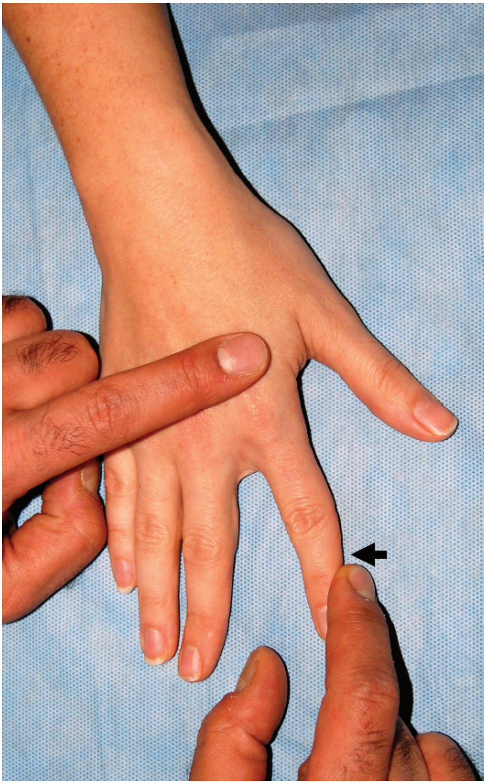


FIGURE 3.58. Note the direction of the force.

Palmar Interossei

Palmar interossei are finger adductors. The examiner places a piece of paper between the patient's index and middle fingers and asks him/her to squeeze the fingers together and hold the paper. The examiner then withdraws the paper and resistance is noted (Figure 3.59). The test is repeated for the other fingers.

If the patient can do a thumbs up sign, all the three nerves above the elbow joint are intact.[6]

Radial nerve → EPL
Median nerve → FDP index and middle finger
Ulnar nerve → FDP ring and little finger

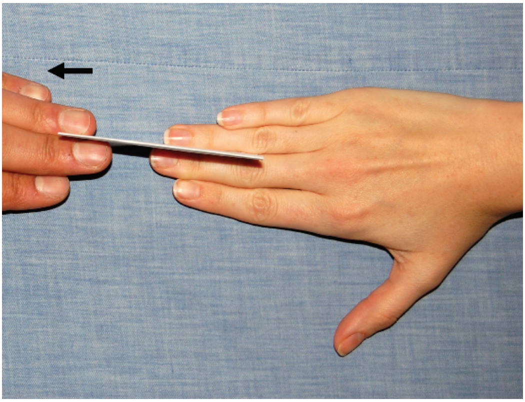


FIGURE 3.59. Assessing the palmar Interossei.

[6] I learned this from one of my great teachers, Dr. Sharath Kumar Rao (Professor and Unit chief, Department of Orthopaedics, Kasturba Medical College, Manipal, India), a gifted surgeon and a superb clinician. To my knowledge, it has not been reported in the literature.

Muscle Insertion

FCU	Pisiform, base of 5th metacarpal
FDP	Distal phalanx
Opponens digiti minimi	Medial border 5th metacarpal
Abductor digiti minimi	Base of proximal phalanx
Flexor digiti minimi brevis	Base of proximal phalanx
Adductor pollicis	Base of proximal phalanx
Lumbricals	Extensor expansion
Dorsal Interossei	Proximal phalanges, dorsal expansion
Palmar Interossei	Proximal phalanges, dorsal expansion

Sensory Branches

All three nerves supply sensory branches to the hand.

Radial nerve: lateral side of dorsum of the hand and the lateral 3½ fingers

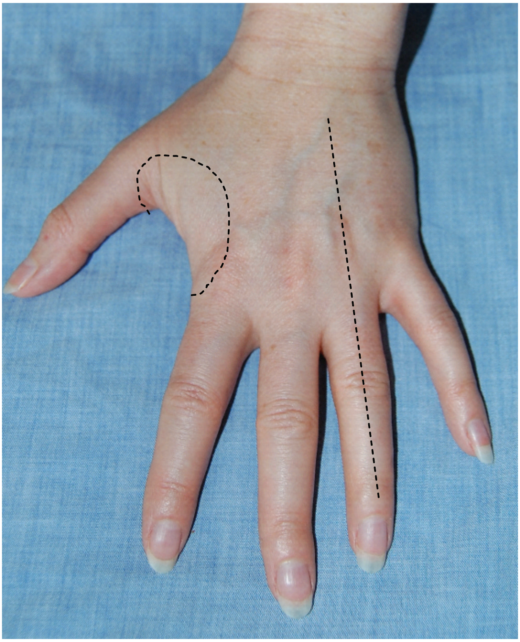
Autonomous zone: dorsal 1st web space

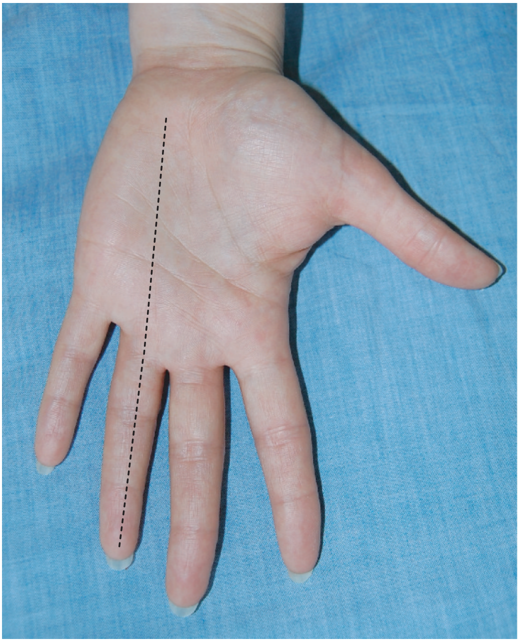
Median nerve: palmar and dorsal lateral 3½ fingers, thenar eminence

Autonomous zone: tip of the index finger

Ulnar nerve: palmar and dorsal medial 1½ fingers, hypothenar eminence medial side of dorsum of the hand

Autonomous zone: tip of the little finger





Special Tests

Modified Durkan's Test

This is a test for diagnosis of carpal tunnel syndrome. The examiner exerts direct compression over the median nerve between the tendons of PL and FCR at the wrist joint with his index finger for a minute (Figure 3.60). If compression of the median nerve produces numbness or tingling of the fingers, then irritation of the nerve is suspected. The time for development of symptoms and severity of the compression of the median nerve are in direct proportion.

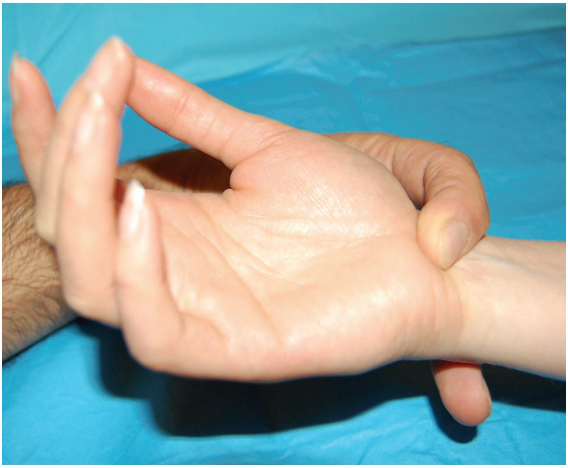


FIGURE 3.60. Modified Durkan's test.

Tinel's Sign

This is another test for diagnosis of carpal tunnel syndrome. The patient's wrist is supported on the table. With the tip of the middle finger, the examiner taps the median nerve between the tendons of PL and FCR. The test is considered positive if the patient complains of pain or a shooting electric current sensation down the hand (Figure 3.61). *Advancing* Tinel's sign is the most important clinical test in eliciting regeneration of a peripheral nerve after injury at any site.

FIGURE 3.61. Tinel's sign.

Finklestein's Test

This is a test for stenosing tenovaginitis (de Quervain's disease) of the EPB and APL tendons. The patient is instructed to flex the thumb in the palm. The examiner then either passively deviates the wrist toward the ulna or asks the patient to do it actively (Figures 3.62 and 3.63). If painful, the diagnosis is confirmed.

Note: This test can be uncomfortable; hence it is important to do it last in the sequence of the examination.

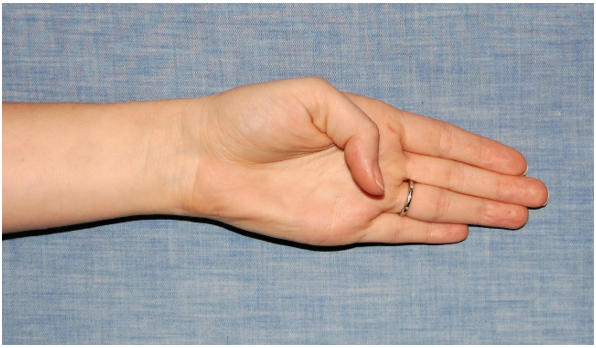


FIGURE 3.62. Finklestein's test.

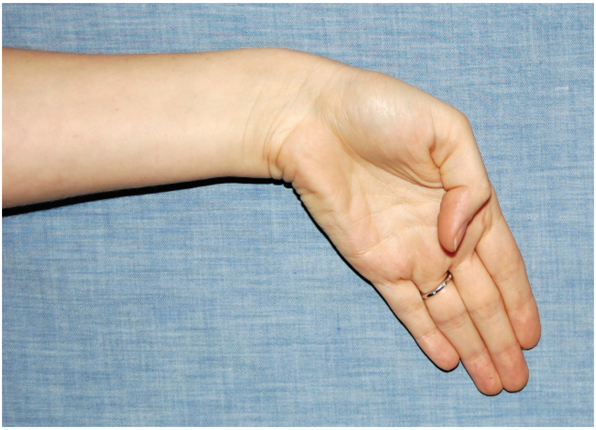


FIGURE 3.63. Finklestein's test. Active ulnar deviation.

Froment's Test

This is another method to test adductor pollicis and is often used to demonstrate ulnar nerve pathology. The patient is asked to hold a piece of paper between the thumb and index finger while the examiner applies gentle traction to withdraw the paper (Figure 3.64). If the adductor pollicis is normal the patient's

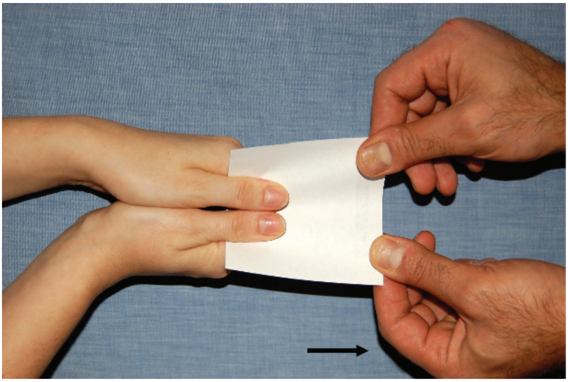
a


Figure 3.64a. Froment's test

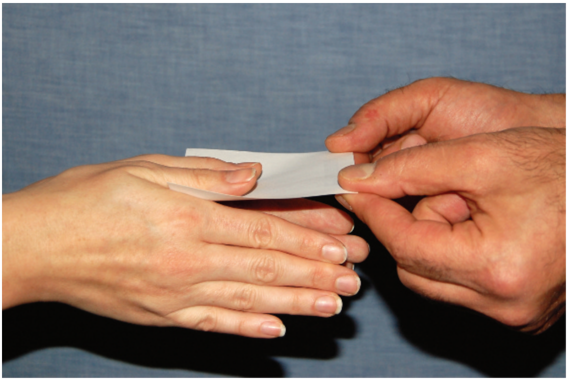
b


Figure 3.64b. Froment's test, side view.

thumb should remain flat. In weakness of the adductor pollicis, the patient recruits the FPL to hold on to the paper. This causes flexion of the IPJ (Figure 3.65).

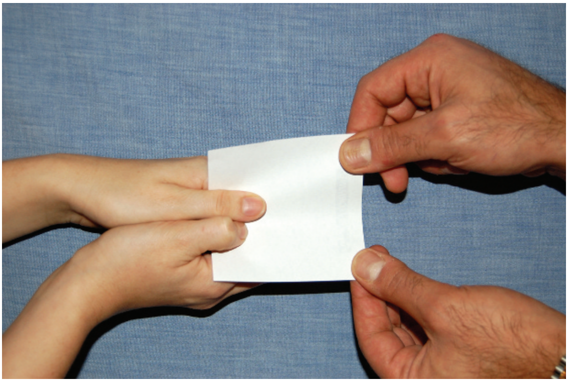


FIGURE 3.65. Positive Froment's test.

Kiloh-Nevin (The "O") Sign

This is a test for the anterior interosseous nerve. The patient is asked to make a nail to nail pinch and maintain the position (Figure 3.66). The examiner then assesses the strength of FPL and FDP by hooking his index finger inside the "O" and trying to pull them apart.

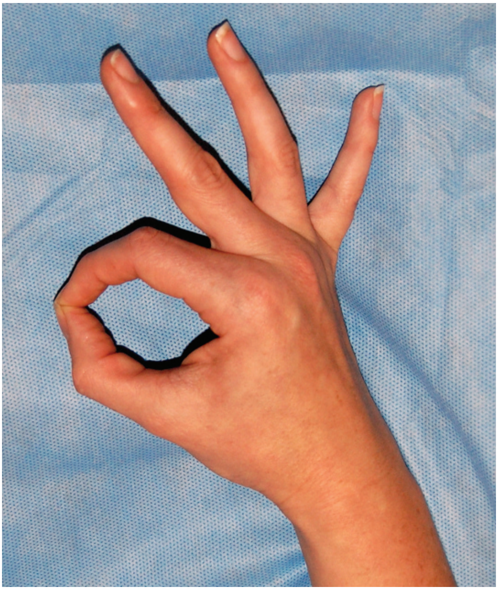


FIGURE 3.66. Kiloh-Nevin ("O") sign. Note the flexion of IPJ of thumb and DIPJ of index finger.

Kirk Watson Test

This is a test for scapholunate instability. The patient's forearm is pronated, with the wrist in ulnar deviation. The examiner presses the thumb over the distal pole of the patient's scaphoid and the fingers of the same hand over the distal radius, providing counter pressure. The examiner then brings the wrist to radial deviation (Figure 3.67). In scapholunate instability, the proximal pole of the scaphoid subluxes over the dorsum of the radius, which may be associated with a clunk. By releasing the pressure from the thumb, the scaphoid can pop back into the joint. It can be very painful.

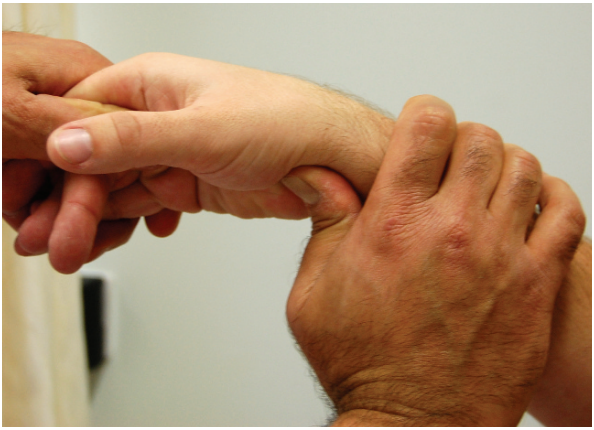


FIGURE 3.67. Kirk Watson Test.

FIGURE 3.68. Piano key test.

Piano Key Test

This is the test to elicit subluxation or arthritis of the radioulnar joint. The patient is asked to flex the elbow and pronate the forearm. To test the right side, the examiner holds the distal radius with his right thumb and index finger and moves the head of the ulna up and down (Figure 3.68). If the amount of translation is more than on the other side, instability is suspected. Pain or clicking during this maneuver is suggestive of arthritis of the radioulnar joint. It is typically associated with rheumatoid arthritis and caput ulnae.

Grind Test

This is the test to elicit arthritis in the CMCJ of the thumb. The examiner holds the metacarpal with his thumb and index finger and presses down to reduce the joint, then loads it axially and moves it in a circular movement. A diagnosis of arthritis is suspected if the manoeuvre reproduces the patient's pain.

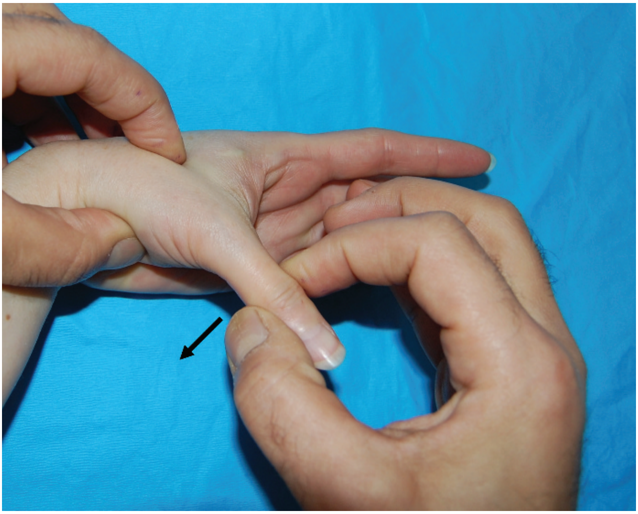


FIGURE 3.69. Assessment of ulnar collateral ligament stability. Note the direction of the force.

Ulnar Collateral Ligament (UCL) Stability

Stability of the ulnar collateral ligament of the thumb is vital for grip. The examiner holds the metacarpal of the thumb just below the joint. The phalanx should be flexed to relax the capsule. Then gentle abduction force is applied to the MCPJ (Figure 3.69). If the amount of abduction is significantly more than the normal side with no firm end point, rupture of the ulnar collateral ligament is suspected. Alternatively the patient can attempt to abduct the thumb with his index finger. The amount of laxity is compared with the opposite side.

Bunnell Test

This differentiates intrinsic from extrinsic tightness. The examiner hyperextends the MCPJ and measures the PIP flexion. The test is repeated with MCPJ flexed. In the presence of intrinsic tightness, the amount of flexion of PIP joints is less when MCPJs are hyperextended.

Chapter 4

Spine

THE CERVICAL/THORACIC SPINE

LISTEN

Patients with spinal problems usually complain of back/neck pain and/or limb pain with a resultant loss of function.

Mechanism of Injury (If Applicable)

Fall from height/road traffic accident → fractures/ligamentous injury

Twisting or lifting injury/fall from low height → cervical strain
→ herniated disc
→ fracture in osteoporotic patient

Age

- Children
  - Congenital /developmental disorders
  - Infection
  - Primary tumor
  - Trauma
- Adults
  - Herniated disc
  - Spondylolisthesis
  - Acute fractures
- Older adults
  - Spondylosis
  - Stenosis
  - Osteoporotic fractures
  - Metastatic disease

Pain

Site of pain

Neck/thoracic spine pain → degenerative disc disease
→ facet joint pathology
→ herniated disc
→ spinal deformity
→ infection
→ tumor

> **Pain Pattern in Facet Joint Pathology**
>
> C1-2 articulation → Suboccipital pain
> C2-3 facet → Upper neck pain radiate to head
> C3-4-5 facet → Mid neck pain
> C6-7-T1 facets → Lower neck pain radiate to scapula

Neck and arm pain → herniated disc
→ spinal stenosis
→ infection
→ tumor

Unilateral → herniated disc

Bilateral → metabolic/systemic disease
→ central disc prolapse

Type of pain

Aching pain → degenerative changes
→ stenosis
→ myofascial

Sharp radiating pain → herniated disc

Night/ Rest pain → usually not mechanical in origin. In patients with no history of trauma, other causes, such as primary or metastatic bone tumor, should be ruled out.

Onset of Pain

Sudden onset → herniated disc
→ infection
→ tumor

Gradual onset → stenosis
→ spondylosis
→ rheumatoid arthritis
→ inflammatory arthropathy

Relieving Factor

Pain relieved by activity → ankylosing spondylitis

Stiffness

Stiffness is common and nonspecific in many pathological conditions. However *prolonged* morning stiffness is seen in:

Rheumatoid arthritis
Ankylosing spondylitis
Other inflammatory arthropathies

Numbness or Paresthesia

May be associated with radiculopathy. Usually patient's complaint of numbness/paresthesia points to the dermatomal level of lesion

Neck → C3

Shoulder tip → C4

Deltoid and lateral elbow → C5

Thumb → C6

Middle finger → C7

Little finger → C8

Medial elbow → T1

Medial arm → T2

Axilla → T3

Nipple → T4

Chest wall → T5-8

Abdominal wall → T9-12 (umbilicus is T10)

Weakness of the Arms/Hands

Herniated disc
Cervical spondylosis/stenosis

Cervical stenosis produces ***lower motor neurone*** finding at the level of the lesion and ***upper motor neurone*** deficit below the lesion.

Deformity

Ankylosing spondylitis
Scheuermann's disease
Kyphosis
Scoliosis

Myelopathy

A myelopathy is a neurological disorder involving spinal cord or brain resulting in the upper motor neuron lesion. It affects both upper and lower limb.
Signs & Symptoms:

- unsteady gait
- limb weakness (upper>lower limb)
- sensory changes
- spasticity
- urinary dysfunction

Bowel or Bladder dysfunction → myelopathy

Difficulty with walking/balance → myelopathy due to cervical or thoracic spondylosis

Note: If myelopathy suspected, do not forget to look at the hands for Wartenberg's sign. Little finger spontaneously abducts due to weakness of intrinsic.

LOOK

Scars

Comments on
Location
Surgical or traumatic
Healed with primary or secondary intention

Skin Abnormalities

Dimple, or hair, tuft → spina bifida

Abnormal pigmentation → neurofibromatosis (up to 4 *café-au-lait* spots is normal)

Alignment

Stiff neck → patient keeps the neck in one position (often due to muscle spasm)

Causes

Disc lesions (tilt toward the lesion)
Inflammatory process
Cervical injury
Acute cervical strain
Torticollis → the chin is tilted upward and toward one side.

Causes of Torticollis

1. Infantile
2. Secondary due to
   - skin scaring and burns
   - herniated disc
   - infections including tuberculosis
   - ankylosing spondylitis

From behind

Level of the shoulders
Scapula for winging

From side

Lordosis of cervical spine, kyphosis of thoracic spine and lordosis of lumbar spine. Base of occiput rests directly above the sacrum.

Chest Wall Asymmetry (Pectus Excavatum, Pectus Carinatum)

Pectus Excavatum (funnel chest): the sternum is depressed giving a concave shape to chest.

Pectus Carinatum (pigeon chest): the sternum is protruded giving a convex shape to chest.

Kyphotic Curve

Differentiate between simple kyphosis, gibbus, and Dowager's hump. A curve at the C7/T1 junction is typical of ankylosing spondylitis, whereas if in the thoracic spine, it may indicate previous Scheuermann's disease or osteoporotic wedge fractures.

Kyphosis: normal and abnormal dorsal curvature of spine.

Gibbus: sharp posterior angulations due to collapse or wedging of one or more vertebrae.

Dowager's hump: abnormal dorsal curvature of the upper thoracic/cervical spine due to osteoporotic collapse commonly found in elderly women. "Dowager" means widow of British peer.

Abnormal Gaits

Shuffling Gait

The patient is unaware of position of swinging foot in the space and hence unable to determine the moment of heel strike.

Cause: Posterior cord syndrome (loss of proprioception below the lesion)

Foot Drop or Slap Foot Gait

The foot is either dragged on the ground during swing phase or it hit the ground on each step.

Causes:

- Posterior cord syndrome
- L4 nerve root compression

Ataxic Gait

Broad based and unsteady

Causes

- Alcohol abuse
- Myelopathy subsequent to significant cervical/central thoracic stenosis

FEEL

Spinous Process

- Palpate the tip of spinous processes along the length of the cervical and thoracic spine. Feel for any tenderness or abnormal step deformity (spondylolisthesis). Start at the top. The first you will feel is C2. The most prominent is C7 and can be distinguished from T1 as it glides on neck extension. C3 is at the level of hyoid and C4 is at the level of thyroid cartilage (Adam's apple).
- Localize the position of tender points to bony structure and surrounding muscles.
- Any shift in alignment may indicate facet dislocation or fracture.
- Are there any changes in temperature in the skin and feel for consistency of any lumps (bony, muscle spasm).
- Trachea, thyroid and esophagus should be palpated. Look for lymphadenopathy in patients with history of cancer.

Facet Joint

Ask the patient to relax the neck muscles. With posterolateral approach you could palpate the cervical facet joints about 2.5 cm from midline. Count from C7 up, to identify the painful facet joint(s). They are about a finger breadth apart from each other and arranged symmetrically. Often one or more is painful and reproduces patient's pattern of pain.

MOVE

Cervical Spine

Best assessed by actively instructing the patient on the movement required.
Deficits in flexion/extension/lateral bend and rotation need to be noted. Most of the conditions result in a global reduction of neck movements.

Flexion
"Chin to chest"(Figure 4.1): Observe the patient for any pain during flexion. Midrange pain is due to instability. Normal: 75°
Flexion is limited and/or painful in:
- Spondylosis (Osteoarthritis)
- Herniated disc
- Rheumatoid arthritis

FIGURE 4.1. Flexion of cervical spine.

Extension

"Look up at the ceiling" (Figure 4.2). Normal: 60°

Extension is limited and/or painful in:

Facet joint degeneration

Herniated disc

Rheumatoid arthritis

Fixed scoliosis/kyphosis

FIGURE 4.2. Extension of cervical spine.

Lateral Flexion

"Put your ear on shoulder"(Figure 4.3): Patient with limited movements, may bring the shoulder to ear! Normal: 20°–45°

Lateral flexion is limited and/or painful in:

- Cervical radiculopathy with lateral flexion to the contralateral side.
- Lymphadenopathy
- Torticollis

FIGURE 4.3. Lateral flexion of cervical spine.

Lateral Rotation

"Put your chin on your shoulder" (Figure 4.4). Normal :70°–90°

Limited rotation and /or painful in:

Rheumatoid arthritis
Spondylosis
Cervical sprain

FIGURE 4.4. Lateral rotation of cervical spine.

Thoracic Spine

Flexion and Extension

Flexion and extension in the thoracic spine is limited. The patient is asked to sit on a straight-backed chair (to reduce the lumbopelvic movement) and then instructed to bend forward and then backward.

Normal flexion: 20°–45°
Normal extension: 25°–45°

Rotation

With the patient in a sitting position, ask him to cross the arms or place the hands on opposite shoulders and then rotate to right and left (Figure 4.5).

FIGURE 4.5. Assessing the rotation of the thoracic spine.

Chest Expansion

With the patient in a standing position, a tape measure is placed at the level of the nipples (4th intercostal space). Take the measurement at maximum exhalation (Figure 4.6). Then the patient is asked to inhale as much as possible and hold the breath while a second measurement is taken. Usually the difference between the two readings should be above 5 cm. Chest expansion is said to be decreased if it is less than 2.5 cm, which may be a sign of ankylosing spondylitis.

FIGURE 4.6. Measurement of chest expansion.

Muscle Testing

Examination of the muscles is done to determine the involved nerve root level.

C5 Nerve Root

Exits between C4-5 vertebrae.
Deltoid muscle is tested.
The patient is asked to abduct the arm to 60–90° and maintain this position while the examiner exerts downward pressure on the elbow (Figure 4.7)

C5 Nerve Root Compression

C4-5 disc herniation or other pathology

Sensory deficit
- Upper lateral arm and elbow

Muscle weakness
- Deltoid
- Biceps (variable)

Reflex changes
- Biceps

FIGURE 4.7. Assessing the deltoid.

C6 Nerve Root

Exits between C5-6 vertebrae.

Biceps and writs extensors are tested.

To test the biceps, patient is asked to flex the elbow to 90° and maintain the position. The examiner supports the elbow with one hand and holds the wrist with the other hand and attempts to extend the elbow (Figure 4.8).

To test the wrist extensors, the patient is asked to extend the wrist and flex the elbow to 90° while the arm is held tightly at the side. The examiner stabilizes the forearm with one hand and exerts downward pressure with the other hand (Figure 4.9).

FIGURE 4.8. Assessing the power of biceps.

FIGURE 4.9. Assessing dorsiflexors of the wrist.

C6 Nerve Root Compression

C5-6 disc herniation* or other pathology

Sensory deficit
- Lateral forearm, thumb and index finger

Muscle weakness
- Biceps
- Wrist extensors

Reflex changes
- Brachioradialis

*Most common

C7 Nerve Root

Exits between C6-7 vertebrae.

Wrist flexors, long finger extensors and triceps are tested.

To test the wrist flexors, the patient is asked to flex the wrist and flex the elbow to 90° while the arm is held tightly at the side. The examiner stabilizes the forearm with one hand and exerts pressure to extend the wrist with other hand (Figure 4.10).

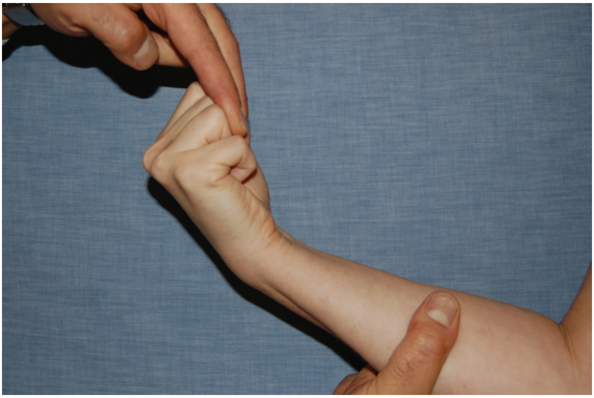


FIGURE 4.10. Assessing flexors of the wrist.

To test the long finger extensors, the patient is asked to extend the fingers and maintain the position with the wrist in neutral. The examiner stabilizes the forearm with one hand and exerts pressure just distal to the metacarpophalangeal joints to flex the fingers (Figure 4.11).

FIGURE 4.11. Assessing long finger extensors.

FIGURE 4.12. Assessing the triceps.

To test the triceps, the patient is asked to flex the elbow to 90° and maintain the position. The examiner supports the elbow with one hand and holds the wrist with the other hand and attempts to flex the elbow (Figure 4.12).

C7 Nerve Root Compression

C6-7 disc herniation or other pathology

Sensory deficit
- Middle finger

Muscle weakness
- Triceps
- Wrist flexors
- Long finger extensors

Reflex changes
- Triceps

C8 Nerve Root

Exits between C7-T1 vertebrae.
Digital flexors are tested.
To test the digital flexors, the examiner places his index, middle and ring finger in the patient's palm and asks the patient to make a fist and squeeze as tightly as possible.

C8 Nerve Root Compression

C7-T1 disc herniation or other pathology

Sensory deficit
 Little and ring finger, ulnar border of palm and medial orearm

Muscle weakness
 Finger flexors

Reflex changes
 None

T1 Nerve Root

Exits between T1–T2 vertebrae.
Interosseous muscles as a group, or first dorsal interosseous are tested.
To assess the interosseous muscles, the patient is asked to spread the fingers and hold the position. The examiner then exerts pressure to the index and little fingers to push them back together (Figure 4.13).

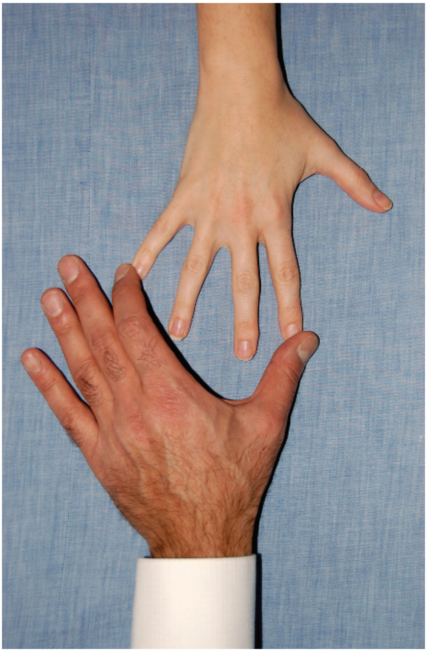


FIGURE 4.13. Assessing the interosseous muscles.

FIGURE 4.14. Assessing the first dorsal interosseous.

Alternatively to test the first dorsal interosseous, the examiner presses his index finger against the radial border of the patient's index while with the other hand he feels for the muscle contracture (Figure 4.14).

T1 Nerve Root Compression

T1–T2 disc herniation or other pathology

Sensory deficit
- Medial arm

Muscle weakness
- Dorsal interossei
- Abductor digiti minimi

Reflex changes
- None

Sensory Testing

The sensory distribution of upper limbs and trunk should be tested. Remember there is wide area of overlap between the dermatomes and varies between individuals.

- C3 dermatome: neck
- C4 dermatome: shoulder tip
- C5 dermatome: middle of deltoid and lateral epicondyle
- C6 dermatome: thumb
- C7 dermatome: middle finger
- C8 dermatome: little finger
- T1 dermatome: medial elbow
- T2 dermatome: medial arm
- T3 dermatome: axilla
- T4 dermatome: nipple
- T5-8 dermatome: chest wall
- T9-12 dermatome: abdominal wall (umbilicus is T10)

Reflexes

Biceps Reflex for C5 Nerve Root

The examiner hold patient's elbow while placing his thumb on the patient's biceps tendon. Patient's forearm should rest on examiner's forearm. The examiner then taps his thumb with the hammer (Figure 4.15). Contracture of the biceps is felt and often seen.

FIGURE 4.15. Eliciting biceps reflex.

Brachioradialis Reflex for C6 Nerve Root

The patient's forearm rests on the examiner's forearm in a neutral rotation, hence the radial border of the forearm is facing upward. The examiner then taps about 5 cm above the radial styloid (Figure 4.16). Contracture of the brachioradialis produces quick upward movement of the forearm.

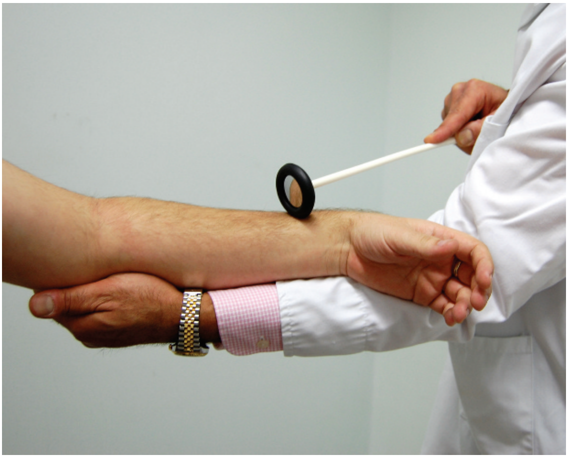


FIGURE 4.16. Eliciting brachioradialis reflex.

Triceps Reflex for C7 Nerve Root

The patient is in a position of 90° shoulder abduction and 90° of elbow flexion while examiner supports the arm and patient is asked to relax completely. The examiner then taps the triceps tendon just above the olecranon (Figure 4.17). A visible contraction of the triceps is usually associated with slight extension of the elbow.

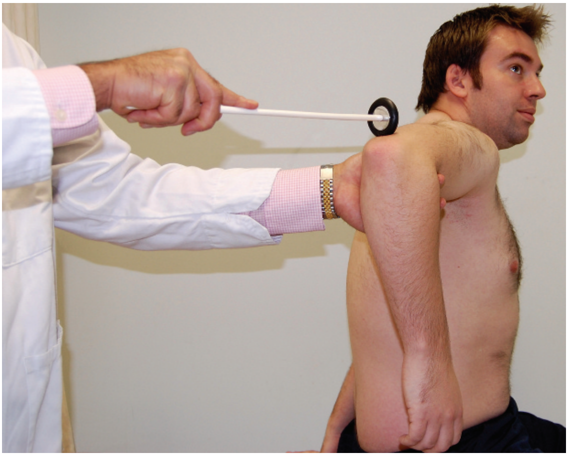


FIGURE 4.17. Eliciting triceps reflex.

Special Testing

Superficial Skin Reflexes

- Abdominal reflex – performed to assess reflexes of T7-L1 segments. Light stroke of quadrant of abdomen contracts underlying muscle (Figure 4.18). For T7–T10 stroke above umbilicus and for T10-L1 stroke below umbilicus. Normally umbilicus moves toward quadrant. Absence of this reflex may indicate upper motor neurone lesion or thoracic radiculopathy (unilateral loss).
- Anal reflex (S2-4) – light touch or pin prick of perianal skin contracts external anal sphincter.
- Bulbocavernosus reflex (S3-4) – squeeze glans/clitoris or traction on catheter contracts external anal sphincter. It heralds the end of spinal shock.

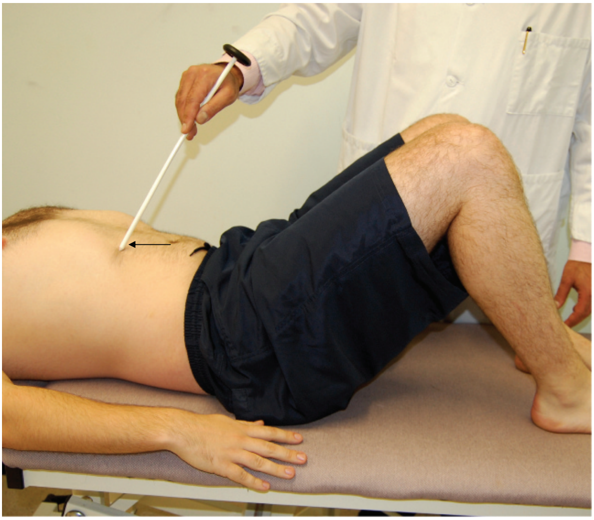


FIGURE 4.18. Eliciting the abdominal reflex. Note the direction of the stroke.

Spurling's Maneuver (Foraminal Compression Test)
This maneuver attempts to narrow the intervertebral foramen, which may lead to radicular symptom. Test is done by axial cervical compression with slight extension, side bending and rotation to the side of complaint (Figure 4.19). In a positive test, the patient notes pain radiating in the arm toward which the head is side flexed during compression. Axial pain alone is considered a negative test. This test should not be performed if there is suspicion of bony injury or instability.

FIGURE 4.19. Spurling's maneuver

Babinski Test (Plantar Reflex)

A common test for myelopathy. The examiner strokes the lateral border of sole of the foot firmly and observes the toes (Figure 4.20).

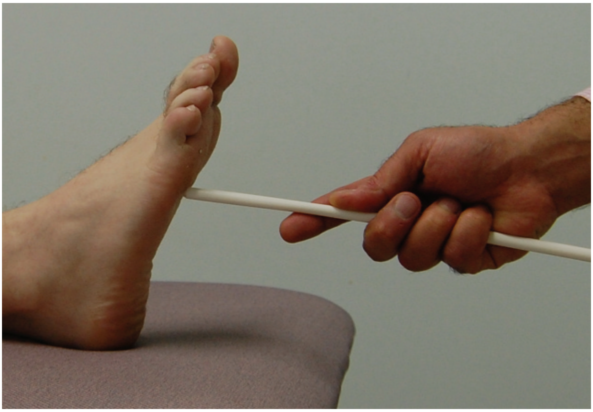


FIGURE 4.20. Eliciting the Babinski (plantar) reflex.

Positive Babinski's reflex → big toe extends and the other toes fan out

Negative Babinski's reflex → all toes flex

In foot amputee patients, the examiner holds the distal subcutaneous part of the patient's tibia firmly between index and thumb and run his hand upward on the tibia. Contracture of tensor fascia lata is considered as a positive test.

Clonus

Clonus is a sign of myelopathy. Clonus is a repetitive, rhythmic contraction of a muscle when attempting to hold it in a stretched state. It is a strong, deep tendon reflex that occurs when the CNS fails to inhibit it. With patient seated on the edge of exam table, examiner will grab the forefoot and do an active dorsiflexion in a quick stroke. If positive, foot contracts more than 3 times in a rhythmic plantar flexion which is called clonus. 3 contractures or less is considered normal.

Hoffmann's Sign

Specific test for of cervical myelopathy. A flick to the pulp of the index finger to extend the DIPJ is followed by flexion of the thumb and index finger in a positive test.

L'hermitte's Sign

Although less specific, it is also used for diagnosis of cervical myelopathy. With the patient in seated position, the neck and hip are flexed simultaneously (Figure 4.21). Positive test is an electric shock sensation down the spine to the lower limb.

Figure 4.21. L'hermitte's sign.

Roos Test

A test for thoracic outlet syndrome. It is performed with the patient positioning his shoulders in abduction and external rotation of 90° with elbow flexion at 90°. The patient then opens and closes his hands for one minute (Figures 4.22 and 4.23). Reproduction of symptoms during the test or progressive numbness and heaviness is considered a positive test for thoracic outlet syndrome.

FIGURE 4.22. Roos test.

FIGURE 4.23. Roos test. The patient opens and closes the hands for one minute.

Adson's Test

This test is performed to differentiate cervical radicular pain and thoracic outlet syndrome. Test is performed with the patient in seated position and hands on thighs. The examiner palpates the radial pulse as the patient is instructed to inhale and hold his breath, hyperextends the neck and turn the head toward the affected side. Examiner may abduct (15°), extend and external rotate the arm for confirmation of result. If the radial pulse on that side is markedly or completely obliterated, the test is positive and suggests the diagnosis of thoracic outlet syndrome. If a cervical rib is suspected feel the supraclavicular fossa and listen for a bruit.

THE LUMBAR SPINE

LISTEN

Mechanism of Injury (If applicable)

Fall from height/road traffic accident → fractures/ligamentous injury

Twisting, bending or lifting injury → back strain
→ herniated disc
→ fracture in osteoporotic patient

Age

Children
Congenital /developmental disorders → spondylolysis
→ spondylolisthesis
→ primary tumor

Adults
Herniated disc
Spondylolisthesis
Segmental instability
Acute fractures
Strains

Older Adults
Stenosis
Spondyloarthropathy
Facet syndrome
Metastatic disease

Pain

Site of Pain

Back pain, leg pain, or both. Ask specifically which pain is predominant.

- Back pain > leg pain:
  - Back strain
  - Segmental instability
  - Spondyloarthropathy
- Infection
- Tumor

Leg pain > back pain
- Herniated disc
- Stenosis

Unilateral → prolapse disc

Bilateral → central disc prolapse
→ metabolic/systemic disease

> In spondylolisthesis, a combination of radicular and claudication symptoms are seen.

Type of Pain

Aching pain → degenerative changes, stenosis

Sharp radiating pain → herniated disc

Night/rest pain → usually not mechanical in origin. In patients with no history of trauma, other causes, such as bone tumor, should be ruled out.

Onset of Pain

Sudden onset → herniated disc
→ infection
→ tumor

Gradual onset → stenosis
→ spondylosis
→ rheumatoid arthritis
→ inflammatory arthropathy
→ spondylolisthesis

Aggravating Factors:

Coughing, sneezing (↑intrathecal pressure)→herniated disc

Activity/brisk walking→stenosis, vascular claudication

Differentiating Between Neurological and Vascular Claudication

Activity	Neurological claudication	Vascular Claudication
Walking	Thigh, calf pain, heaviness of whole leg	Calf pain
Symptoms	Pain+ paraesthesia	Pain only
Relieving position	Sitting/flexion	Standing still

Relieving Factors

Pain relieved by activity→ankylosing spondylitis

Pain relieved by sitting/flexion→spinal stenosis

Numbness or Paresthesia

May be associated with radiculopathy. It gives clue to the level of nerve root lesion:

Inguinal→L1

Groin/medial thigh→L2

Anterior thigh→L3

Anteromedial leg→L4

Lateral leg/dorsum foot→L5

Sole /lateral foot→S1

Back of thigh→S2

Buttock→S3

Weakness of Legs

Herniated disc
Stenosis

Difficulty in walking→herniated disc
→stenosis
→myelopathy

Deformity
ankylosing spondylitis
scoliosis
spondylolisthesis

Bowel or Bladder Dysfunction → cauda equina syndrome, myelopathy

Note: Cauda equina syndrome is a large central disc prolapse that may compress several root of the cauda equina. L4-5 disc prolapse is often the offending structure. It is one of the few orthopedic emergencies.

Cauda Equina Syndrome

Mode of onset: acute, insidious
Pain: perianal, back of the thighs and legs
Motor deficit: legs and feet
Motor loss: bladder (retention), bowel incontinence
Sensory deficit: Perianal (saddle anesthesia)
Reflex loss: cremasteric

LOOK

Skin Abnormalities

Dimple,or hair tuft → spina bifida

Abnormal pigmentation → neurofibromatosis (up to 4 *café-au-lait* spots are normal)

Back/posterior trunk/limbs muscle wasting.

Scars

Comments on location
Surgical or traumatic
Healed with primary or secondary intention

Alignment

From Behind
Shoulder and iliac crest level, if asymmetric → scoliosis

If patient deviated to one side → list due to herniated disc

If patient stands with one leg flexed → herniated disc on that side
→ limb length discrepancy

List: lateral deviation of spine

Scoliosis: triplanar deformity with lateral, anteroposterior and rotational component. Lateral curvature is more easily apparent.

In a well compensated scoliosis the examiner should also look at the spinous processes.

Forward Bending (Adam's Test): This maneuver makes the deformity easier to detect. The examiner asks the patient to bend forward as far as possible (Figure 4.24). This maneuver maximizes the rib prominence (rib hump). The rib hump is reflection of the rotational component of scoliosis and it appears on the convex side of the curve.

The examiner also should observe the alignment of the spine while the patient is seated. In a sitting position, the structural scoliosis could still be seen whereas compensatory or postural scoliosis disappears.

Figure 4.24. Forward bending (Adam's test).

From Side

Normal: lordosis of cervical spine, kyphosis of thoracic spine and lordosis of lumbar spine. Base of occiput rests directly above the sacrum.

Hyperlordosis → fixed flexion deformity of hips
→ spondylolisthesis
→ primary thoracic kyphosis

Decreased lordosis → disc lesions (muscle spasm)
→ spondylitis
→ ankylosing spondylitis
→ Flat-back syndrome; following a long thoracolumbar fusion for scoliosis (with older instrumentation which corrected only coronal deformity)

Gibbus → collapse of vertebra due to
tuberculosis
tumor
fracture (rare)

Abnormal Gaits

Stooped Gait → kyphosis deformity or central stenosis

Most lumbar stenosis patients tend to ambulation with stooped forward gait which increases the spinal canal diameter and relieves symptoms.

Antalgic Gait → radiculopathy

Patient puts as little weight as possible on the affected side. A patient with sciatica tend to walk with hip more extended and knee more flex to reduce the tension on the nerve root.

Foot Drop or Slap Foot Gait → L5-S1 disc lesion

The feet are either dragged on the ground during swing phase or it hit the ground on each step.

Ataxic Gait → broad based unsteady

Myelopathy subsequent to cervical /thoracic stenosis,
Alcohol abuse
Vestibular and cerebellar pathology

It would be very useful if you ask the patient to walk on his heels and then on tip toes. Heel walking tests the power of dorsiflexors of the ankle, especially the tibialis anterior muscle. Inability to perform this test indicates weakness of the tibialis anterior (L4 root), which may be caused by L3-4 disc prolapse. Toe walking test the power of gastrocsoleus complex (Figure 4.25). Inability to toe walk indicates weakness of the gastrocsoleus complex (S1 root), which may be caused by L5-S1 disc prolapse.

FIGURE 4.25. Assessing the power of the gastrocsoleus complex by toe walking.

FEEL

Standing Position

Spinous Process

- Palpate the tip of spinous processes along the length of the spine. Feel for any tenderness or abnormal step deformity (spondylolisthesis). As a guide, an imaginary line between the two iliac crest passes between L4–L5 spinous processes.
- Localize the position of tender points to bony structure and surrounding muscles.
- Feel for temperature in the skin and for consistency of any lumps (bony, muscle spasm).

Prone Position

Facet Joints

Ask patient to relax the lumbar muscles. Lateral to the spinous processes on either side, facet joints are located deep to the muscle. In patients with spinal deformity, the tip of convexity and point of convexity often demonstrate tender facets.

Sacroiliac Joint

It is a complex joint and the posterior joint (syndesmosis) is palpable in prone position.

Sacrum and Coccyx

Extending the examination of lumbar spine caudally, sacrum could be palpated easily. The spinous processes are less distinct distally and S2 lines up with the two posterosuperior iliac spine (PSIS) (posterior dimples). The most caudate aspect of the sacrum is the sacral hiatus which is easy to palpate in thin adults or pediatric population. Distal to it, is the sacrococcygeal joint and the coccyx bones (fused).

MOVE

Best assessed by actively instructing the patient on the movement required. Deficits in flexion/extension/lateral bend needs to be noted.

Flexion and Extension

Flexion

"Touch your toes." Note level reached (knees/shin/toes). Normally finger tips reach to within 10cm of the floor. During flexion the normal lumbar lordois should be obliterated or even go into slight kyphosis. If lumbar flexion is limited, the hip would compensate and flex instead.

Schober's test is used to quantify lumbar flexion. A horizontal line is drawn at the level of the PSIS and a second line 10 cm above this (Figures 4.26 and 4.27). Flexion should increase the distance by at least 5 cm. Most of the lumbar pathologies cause reduction in amount of flexion.

Examiner must observe how patient returns to upright position. Some patients develop sudden pain associated with jerky movment half way to upright position. Patient describes it as "catching." This, if present, indicates segmental instability.

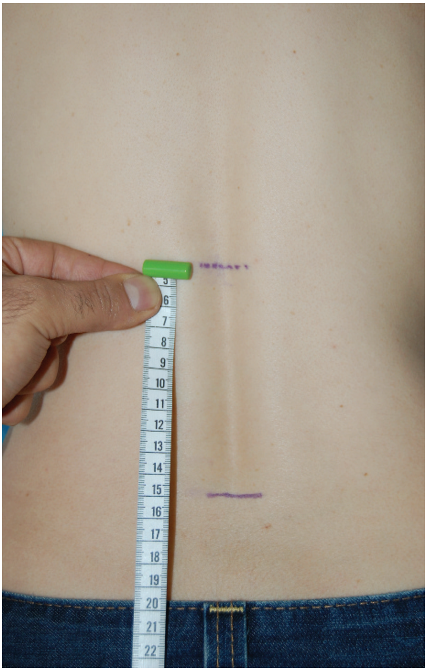


FIGURE 4.26. Schober's test. Initial marking.

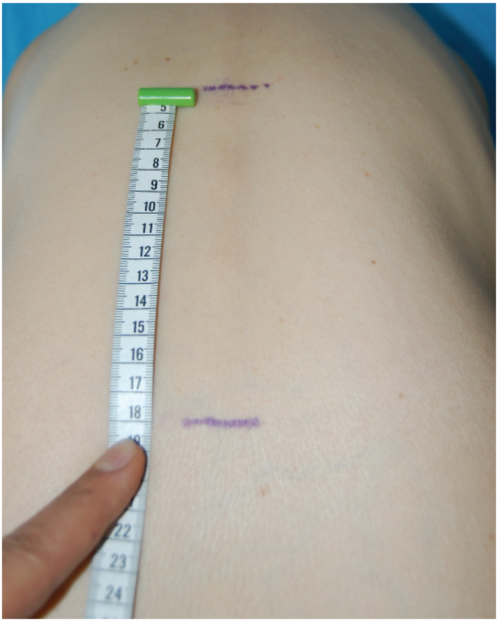


FIGURE 4.27. Schober's test. Patient bends forward and measurement is taken.

Extension

"Lean backward" (support from behind to prevent fall). Quantify the degree of extension by estimating the angle between trunk and vertical line. Normal 30°. Extension is limited and/or painful in:

Facet joint arthropathy
Spondylosis
Tumor/infection of posterior structure

Lateral Flexion

"Slide your hand down the outside of your leg." Note level reached (Figure 4.28) (mid-thigh/knee). Lateral bending is limited and/or painful in herniated disc (bending toward the lesion)

FIGURE 4.28. Lateral flexion.

Muscle Testing

Examination of the muscles is done to determine the involved nerve root level.

Note: In lumbar spine the nerve root transverse the respective disc space ***above*** *the named vertebral body. It exits the respective foramen under the pedicle (Figure 4.29). Usually herniated discs impinge on the* ***traversing*** *nerve root.*

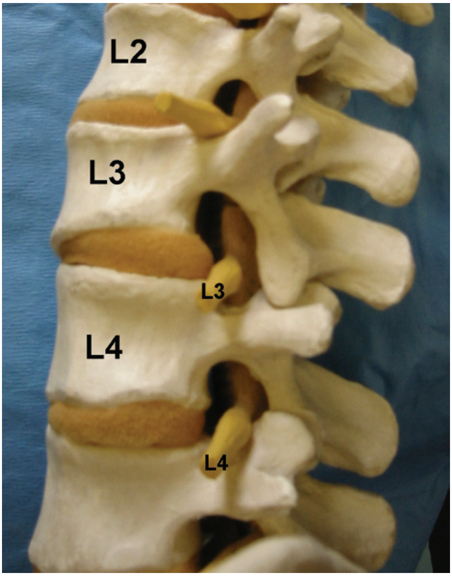


FIGURE 4.29. Exiting nerve roots.

L2 Nerve Root

Exits between L2-3 vertebrae.

Indicates herniated disc (rarely) at L1-2 or pathological condition localized to the L2 foramen.

Iliopsoas muscle is tested.

While the patient is seated at the side or end of the examination table with the knees at 90° of flexion. The patient is asked to lift off the knee while examiner exerts pressure over the knee (Figure 4.30).

Alternatively while patient is supine, flex the knee and hip to 90° and ask the patient to flex the hip further while you apply resistance to the knee.

L2 Nerve Root Compression

L1-2 herniated disc (rare). Fracture, infection, tumor localize to L2 foramen

Sensory deficit
- Anteromedial thigh

Muscle weakness
- Iliopsoas

Reflex changes
- None

FIGURE 4.30. Assessing the power of iliopsoas.

L3 Nerve Root

Exits between L3-4 vertebrae.

Indicates L2-3 herniated disc or pathological condition localized to L3 foramen.

Quadriceps muscle is tested. In supine positions, put your forearm under the knee joint and with the other hand apply resistance while patient is instructed to extend the knee.

In sitting position: Stabilize the thigh with one hand and then apply resistance while patient is instructed to extend the knee (Figure 4.31). Feel for the contracture of the muscle with your stabilizing hand.

L3 Nerve Root Compression

L2-3 herniated disc or other pathology localize to L3 foramen

Sensory deficit
- Anterior thigh

Muscle weakness
- Quadriceps

Reflex changes
- None

FIGURE 4.31. Assessing the power of quadriceps.

L4 Nerve Root

Exits between L4-5 vertebrae.

Indicates L3-4 herniated disc or pathological condition localize to L4 foramen.

The tibialis anterior muscle is tested.

Hold the heel. Put the foot in inversion and dorsiflexion and ask the patient to maintain this position. Then try to evert and plantar flex the foot by pressure over the first metatarsal head and shaft (Figure 4.32). If the muscle is profoundly weak, you must feel for muscle contracture.

Alternatively, in supine position, ask the patient to pull his toes toward his nose and hold the position. The examiner then presses down on the foot trying to planter flex the ankle. Another method is to ask the patient to heel-walk; inability to perform on symptomatic side as a sign of weakness in L4 myotome.

L4 Nerve Root Compression

L3-4 disc herniation or other pathology localize to L4 foramen

Sensory deficit
- Anteromedial leg

Muscle weakness
- Tibialis anterior

Reflex changes
- Patella tendon

FIGURE 4.32. Assessing the power of tibialis anterior.

L5 Nerve Root

Exits between L5-S1 vertebrae.

Indicates L4-5 herniated disc or pathological condition localize to L5 foramen.

The extensor hallucis longus muscle is tested.

Hold the heel. Ask the patient to dorsiflex the big toe and maintain this position while the examiner applies opposite force by placing a finger on the nail and tries to plantar flex the big toe (Figure 4.33).

L5 Nerve Root Compression

L4-5 disc herniation* or other pathology localize to L5 foramen

Sensory deficit
- Lateral leg and dorsum foot/big toe

Muscle weakness
- Extensor hallucis longus
- Gluteus medius

Reflex changes
- Medial hamstring

*Most common

FIGURE 4.33. Assessing the power of extensor hallucis longus.

S1 Nerve Root

Exits at S1 foramen.
Indicates L5-S1 herniated disc or pathological condition localize to S1 foramen.
Gastrocsoleus complex is tested.
Hold the heel. Ask the patient to plantar flex the ankle and maintain this position while the examiner applies opposite force to the metatarsal heads and tries to dorsiflex the ankle.
Alternatively ask the patient to toe-walk and look for inability to perform on the symptomatic side as a sign of S1 myotome weakness.

S1 Nerve Root Compression

L5-S1 disc herniation or other pathology localise to S1 foramen

Sensory deficit
- Posterior calf, lateral side and plantar foot

Muscle weakness
- Gastrocsoleus complex
- Gluteus maximus

Reflex changes
- Achilles tendon

S2, 3, 4 Nerve Roots

These nerves may be compressed or injured by fractures or tumors of the sacrum. A spinal cord injury at higher level most commonly affects these nerve roots. These nerves supply the bowel and bladder. Urinary retention is a common finding.
Motor testing for these nerves are done by performing a rectal examination. If normal tone is present, a resistance is felt as the sphincter yields. On instruction the patient should be able to squeeze the examiner's finger with the external anal sphincter.
Perianal area is tested for sensory deficit.

Sensory Testing

The sensory distribution of lower limbs and trunk should be tested.
Remember there is wide area of overlap between the dermatomes and varies between individuals.

- L1: inguinal
- L2: anteromedial thigh
- L3: anterior thigh
- L4: anteromedial leg
- L5: lateral leg and dorsum foot/big toe
- S1: posterior calf, lateral malleolus, dorsal foot
- S2: posterior thigh
- S3: buttocks
- S4: perineum
- S5: perianal

Reflexes

Patella Tendon Reflex for L4 Nerve Root

Sit the patient at the edge of the examination table with legs hanging off the edge. The examiner taps the middle of patellar tendon while the other hand rests on the quadriceps muscle to feel the contracture (Figure 4.34).

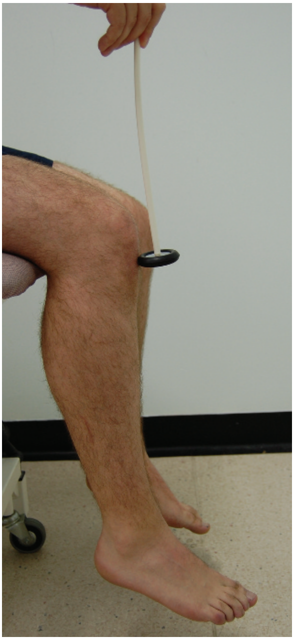


FIGURE 4.34. Eliciting the patella tendon reflex.

Medial Hamstring Reflex for L5 Nerve Root

In prone position, patient is instructed to flex the knee to about 60° while examiner holds the knee and places the thumb over the semitendinosus tendon and asks the patient to relax the leg in examiners forearm. The examiner then taps the thumb with neurological hammer (Figure 4.35). The contracture of muscle can be felt by thumb and often slight flexion of knee can be seen.

FIGURE 4.35. Eliciting medial hamstring reflex.

Achilles' Tendon Reflex for S1 Nerve Root

Dorsiflex the ankle passively and then tap the tendon gently with the neurological hammer (Figure 4.36). Sudden involuntary plantar flexion of the foot is taken as positive.

Alternatively, the examiner dorsiflexes the ankle with his fingers placed on the metatarsal region on the sole of the patient's foot. Then the examiner taps his own fingers (Figure 4.37). This induces the same response with a normal tendon reflex.

FIGURE 4.36. Eliciting the Achilles' tendon reflex.

FIGURE 4.37. Alternative method for eliciting the Achilles' tendon reflex.

Anal Reflex (S2-4)

Light touch or pin prick of perianal skin contracts the external anal sphincter.

If absent → cauda equina

Cremasteric Reflex

This reflex is elicited by lightly stroking the superior and medial part of the thigh in a downward direction. The normal response is a contraction of the cremaster muscle that pulls up the scrotum and testis on the side stroked. Assesses T12.

Absent in:

- Cauda equina
- Spine injury of T12, L1, L2

In case of acute spinal injury only

Bulbocavernosus Reflex (S3-4)

The external anal sphincter contracts on squeezing the glans penis / clitoris or traction on catheter. It heralds the end of spinal shock and detectable in 24 or 48 hours after injury.

Proprioception

It is tested by repeated change of the joint position in the lower extremity. Ask patient to close his eyes. Hold the proximal phalanx of great toe from sides and move the distal phalanx up or down a few times and stop randomly (Figure 4.38). Ask the patient to identify the direction to which the toe has been moved.

FIGURE 4.38. Proprioception.

Coordination

Assess the gait. Can expose central cause, chronic alcohol abuse, infarct, cord compression. If myelopathy suspected the following tests should be performed.

Babinski Test

The examiner strokes the lateral border of sole of the foot firmly and observes the toes.

Positive Babinski's reflex → big toe extends and the other toes fan out

Negative Babinski's reflex → all toes flex

In foot amputee patients, the examiner holds the distal part of the patient's shin firmly between index and thumb and run his hand upward. subcutaneous part of the patient's tibia firmly between index and thumb and run his hand upward on the tibia. Contracture of tensor fascia lata is taken as a positive test.

Clonus

Clonus is a repetitive, rhythmic contraction of a muscle when attempting to hold it in a stretched state. It is a strong, deep tendon reflex that occurs when the CNS fails to inhibit it. With the patient seated on the edge of the examination table, the examiner holds the foot and does an active dorsiflexion in a quick stroke. If positive, the foot contracts more than three times in a rhythmic plantar flexion which is called clonus. Fewer than three contractures are considered normal.

Special Tests

Straight Leg-Raising Test (SLR)

A test to identify lumbar nerve root irritation. With both legs relaxed and knees extended, the examiner will lift one leg straight up supporting the heel with the palm of the hand (Figure 4.39). Test is considered positive if pain radiates below the knee joint. The angle between the leg and the examination table is then measured.

FIGURE 4.39. Straight leg-raising test.

FIGURE 4.40. Lasègue's test.

Once positive, slowly decrease in angle of leg elevation until pain disappears. At this time, dorsiflex the foot (Figure 4.40) and symptoms will redevelop confirming the nerve tension (Lasègue's test).

This test is important if the patient's symptoms exacerbates in 30–70° of leg elevation. Pain generated over 70° of leg elevation in most cases is not a radicular pain.

Alternatively, it can be done in a sitting position. It is performed with the patient sitting upright on the examination table and knees flexed on the edge. Active knee extension in this position often reproduces nerve root tension and pain.

Crossed Straight Leg Raising Test

The examiner performs the SLR test on the asymptomatic side. The test is positive if patient's pain exacerbated in the symptomatic side. It is highly sensitive and specific test for L4-5 disc prolapse.

Femoral Stretch Test

This is to assess the compression on L2, L3 or L4 nerve roots. While the patient prone and knee flexed to 90°, the examiner lifts the patient's thigh to extend the hip (Figure 4.41). Reproduction of radicular pain in anterior thigh is positive.

Alternatively it can be done in lateral position. Patient needs to lie on unaffected side with straight back, slight flexed hips and knees. Examiner will extend the knee on the affected side, and then extend the hip for 15° followed by full flexion of the knee to stretch the femoral nerve. Pain in the anterior thigh is a positive test.

FIGURE 4.41. Femoral stretch test.

FIGURE 4.42. FABER maneuver (Patrick's Test).

FABER Maneuver (Patrick's Test)

Performed to differentiate lumbar radiculopathy versus intrinsic hip pathology.

The patient is placed in a supine position and asked to put the hip in a figure four position (**F**lexion +**AB**duction+ **E**xternally **R**otation). The examiner stabilizes the opposite ASIS while gently pressing down on the contralateral knee (Figure 4.42). Location of the pain points toward the pathology:

Anterior groin pain → hip arthritis
→ Iliopsoas pathology

Posterior hip pain → sacroiliac pathology

Abdominal Examination

Feel for masses (distended neurogenic bladder or abdominal aortic aneurysm which may cause back pain and associated vascular claudication) and PR for sensation, anal tone, and prostate.

Vascular: Feel all peripheral pulses to exclude intermittent vascular claudication which can mimic symptoms of spinal disorder.

Waddel's Signs: Inappropriate signs and symptoms are important to know while examining a patient. A group of five signs first described by Waddell may indicate nonorganic component to the pain but cannot exclude an underlying organic pain.

Signs of functional overlay:

1. Nonanatomical tenderness with light touch
2. Unable to straight leg raise but can sit up on couch with knees extended
3. Pressure on top of head (axial load) or spinal rotation or superficial stimulation of lumbar skin (pinching) increases back pain
4. Widespread (regional) weakness / stocking anesthesia
5. Overreaction

Chapter 5
Hip

LISTEN

Mechanism of Injury (If Applicable)

Certain mechanisms of injury result in characteristic patterns of structural damage.

Common Examples

Direct force to the flexed knee (dashboard injury) → posterior dislocation of the hip
→ central fracture dislocation

Severe abduction/rotation force → anterior dislocation of the hip

Fall on the greater trochanter → fractured neck of femur

Pain

Site of Pain

Groin and the front of the thigh → hip pain

Lateral aspect of the thigh → trochanteric bursitis

Pain in the buttock → referred pain from spine

Pain felt generally in the knee → referred pain from the hip

Causes of Groin Pain in Adults

Osteoarthritis
Avascular necrosis
Stress fracture
Adductor tendinitis
Traumatic osteitis pubis

What activity brings on the pain?
What are the relieving factors?

Type of Pain

Aching pain → degenerative arthritis

Pain during activity → structural abnormality

Pain after activity → inflammatory arthropathy, tendinosis,

Night pain → usually not mechanical in origin. In patients with no history of trauma, other causes, such as primary or metastatic bone tumor, should be ruled out.

Does the pain cause any restriction to activity?
Quantify (in meters, blocks, miles or kilometers) how far the patient can walk.
Does the pain wake the patient from sleep? At night the protective muscle spasm is removed and hence movements can cause severe pain.

Limp

Most commonly due to:
- Limb length discrepancy
- Abductor weakness
- Instability
- Hip pain

Stiffness

Common and nonspecific in many pathological conditions.
Prolonged morning stiffness is seen in:
- Rheumatoid arthritis
- Ankylosing spondylitis
- Other inflammatory arthropathies

Clicking (Snapping)

Patient may report that the hip slips out of the joint. This is seldom, if ever, the case.

Causes:
- Slipping of the iliotibial band over the greater trochanter
- Psoas bursitis
- Detachment of acetabular labrum

LOOK (PATIENT STANDING)

Facing Patient

Position of Shoulders and Trunk

Position of hip, knee, and ankle
On standing, an imaginary line should pass through the center of the hip, center of the patella, and through the second toe.

Common Patterns of Posture

Flexion, abduction, external rotation → synovitis of the hip
→ effusion of the hip

Flexion, adduction and internal rotation → arthritis

External rotation → Coxa vara

Position of the ASIS (Anterior Superior Iliac Spine)

ASIS lower than other side → abduction deformity (leg appears long)

ASIS higher than other side → adduction deformity (leg appears short)

Short Limb Stance

If one leg is shorter, equinus of the ankle joint on the affected side and flexion of the knee on the opposite side help to balance the inequality.
Are the lower limbs symmetrical in length and girth?

From the Side (Looking at the Affected Side)

Lumbar Spine

Increased lumbar lordosis → fixed flexion deformity of the hips

Buttocks

Atrophy of buttocks → neurological disorders such as poliomyelitis

Position of the Knees

From Behind

Position of the Shoulders

Asymmetry in level of shoulders → scoliosis
→ limb length discrepancy
→ fixed deformities of the hip

Is the Spine Straight?

If scoliosis is present, comment on the direction of the convexity of the curve.

Buttock Creases

Popliteal Creases

Muscle Bulk: Thighs/Legs

Atrophy → poliomyelitis

Charcot-Marie-Tooth

Hypertrophy → muscular dystrophy

Skin Condition

Scars

Comment on:
- Location
- Surgical or traumatic
- Healed by primary or secondary intention

Gait

Antalgic gait (best viewed from the side): If the hip is the cause of pain, patient tends to reduce the time of weight bearing on the affected hip. Hence the stance phase is short on the painful hip.

Short limb gait: The short side dips regularly and evenly.

Trendelenburg gait: The shoulder on the affected side dips down, the body lurches toward the affected hip. Patient exhibits a waddling gait if bilaterally present.

Broad based and unsteady gait → ataxia

Drop foot, slap foot, or stepping gait: Patient attempts to clear toes from catching on the ground. Patient is also, unable to control plantar flexion, resulting in foot "slapping" against the ground.
- Causes
  - Weak or absent dorsiflexion.
  - Loss of proprioception

Trendelenburg sign:
This is the test for postural stability when the patient stands on one leg.

In a normal individual, the pelvis is pulled up by the abductors of the weight bearing leg. The pelvis drops on the unsupported side if the weight bearing hip is unstable (Figure 5.1). The patient has to lurch toward the weight bearing side to shift the center of gravity over the foot and avoid falling. This is called Trendelenburg lurch.

FIGURE 5.1. Weakness of abductors of the left hip.

To perform the test, face the patient. To assess the left hip, place your right hand against the left shoulder (to prevent lurching) and offer your left hand to give support (Figure 5.2). Ask the patient to lift his right leg (opposite leg to the test side) by bending the knee (Figure 5.3).

FIGURE 5.2. Position of the examiners hand for Trendelenburg test.

FIGURE 5.3. Trendelenburg test, assessing the left hip.

In a positive test, the examiner feels pressure on his supporting hand as the patient tries to prevent himself from falling over.

Positive Trendelenburg test → weakness of abductors
→ dislocation / subluxation of the hip
→ shortening of the femoral neck
→ any painful disorder of the hip

LOOK (PATIENT LYING SUPINE)

Skin

Scars

Swelling

Wasting

Limb Attitude

External rotation, lateral border touching the bed (Figure 5.4)
→ extracapsular fractured neck of femur

External rotation, lateral border NOT touching the bed (Figure 5.5)
→ intracapsular fractured neck of femur
→ malaligned hip replacement

Flexion, adduction, internal rotation → posterior dislocation of the hip

Flexion abduction, external rotation → anterior dislocation of the hip

FIGURE 5.4. Extracapsular fractured neck of left femur.

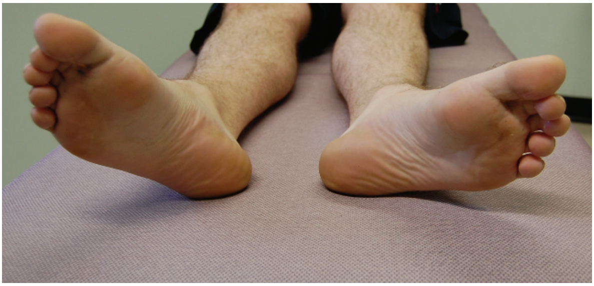


FIGURE 5.5. Intracapsular fractured neck of left femur.

Limb Length

Look at the level of heels/ankles to detect any limb length discrepancy (Figure 5.6) and comment on the attitude of the lower limb.

Figure 5.6. Limb length discrepancy.

Galeazzi Test

This is the test which differentiates between tibial and femoral length discrepancy.
Patient in supine position with knees flexed to 90° and heels together (Figure 5.7). Look from the side at the level of the knee joint. If there is discrepancy in the femur, one femur is shorter than the other (Figures 5.8 and 5.9). Likewise, the shorter tibia is readily seen (Figure 5.10).

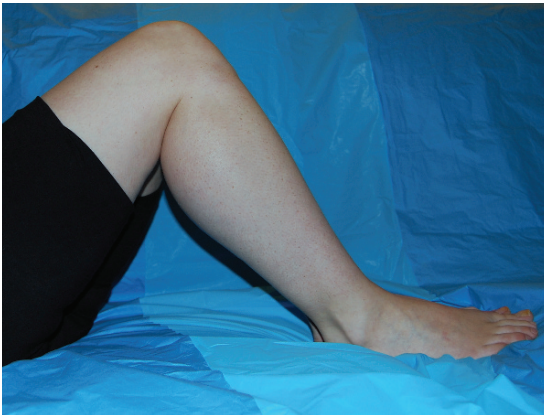


Figure 5.7. Galeazzi test.

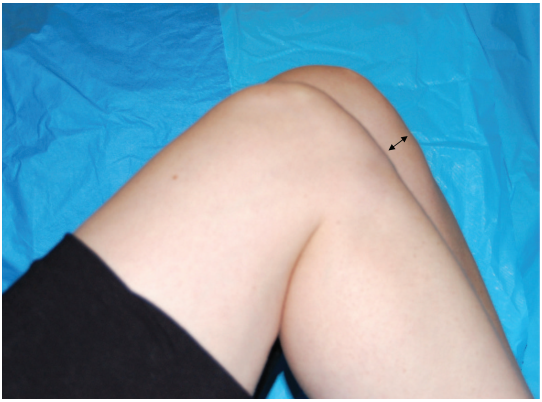


Figure 5.8. Femoral shortening.

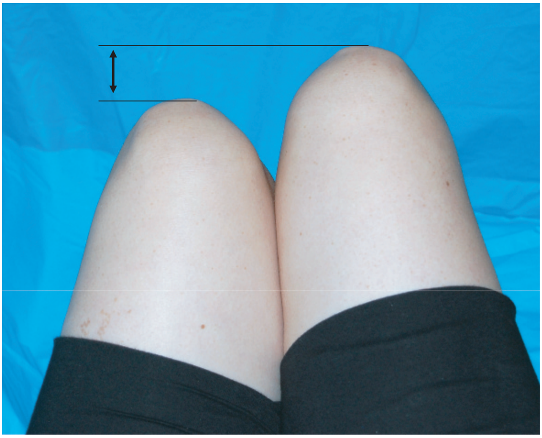


Figure 5.9. Femoral shortening can be also seen form the top end of the examination table.

Figure 5.10. Tibial shortening.

FEEL

ASIS

The length of the iliac crest can be palpated entirely. The anterior end of the iliac crest is the anterior superior iliac spine. Alternatively the examiner can run his finger laterally on the inguinal ligament. The first bony protrusion is the ASIS.

If painful → Avulsion of sartorius

Pubis Symphysis

Patient in supine position, the examiner palpates the lower anterior abdominal wall to feel the pubis symphysis on the midline and pubic tubercle just medial to the symphysis.

Inguinal Ligament

This runs between the ASIS and the pubic tubercle. Pulsation of the femoral artery is felt at the midpoint of the inguinal ligament. The artery lies over the head of the femur and hence in a dislocated hip it is difficult to feel the pulse.

Greater Trochanter

To find the greater trochanter, the examiner palpates the lateral surface of the thigh from distal to proximal. The examiner can feel the bony resistance under the finger as he palpates upward. The end of the bony resistance is the tip of the greater trochanter. To facilitate palpation, the examiner can rotate the hip, which makes the greater trochanter move under the finger.

In anterior dislocation of the hip, the tip of the greater trochanter moves posteriorly, due to external rotation of the femur, and hence is felt further away from the ASIS. In posterior dislocation of the hip, the tip of the greater trochanter moves closer to the ASIS due to internal rotation of the femur.

If painful → trochanteric bursitis
→ piriformis syndrome

Bryant's Triangle

The Bryant's triangle is formed by the ASIS, the greater trochanter and the vertical line dropped from the ASIS to the examination table (Figure 5.11). With the patient in supine position, feel the ASIS with your thumb and the tip of the greater trochanter with your middle finger. The distance between the tip of the greater trochanter and the imaginary line is measured for comparison. Any proximal movement of the greater trochanter causes shortening of the line.

Causes of relative shortening

- Fracture of the neck of the femur
- Dislocations of the hip

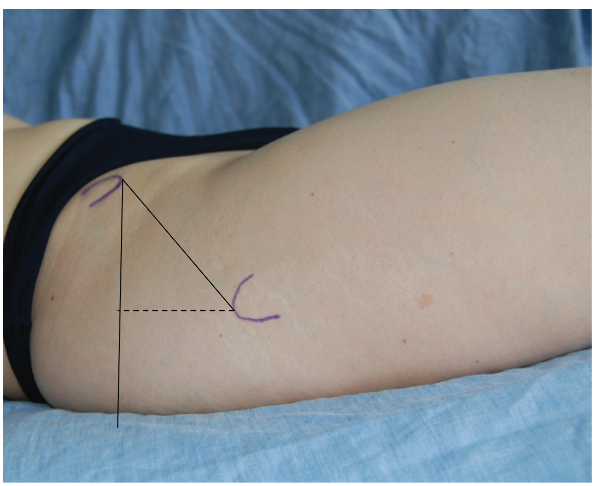


FIGURE 5.11. Bryant's triangle.

Length Measurement

Apparent Length Measurement

Patient in supine position and lying in repose. Measurement is done from the xiphisternum to the medial malleolus on each side (Figure 5.12).

FIGURE 5.12. Apparent length measurement.

True Length Measurement

To obtain true measurement, the pelvis should be squared, such that both ASIS are horizontal and at the same level.

In fixed adduction deformity, the ASIS of the affected side is higher than the normal hip. To square the pelvis in this situation, the examiner should move the leg of the affected hip in the direction of adduction (cross the leg).

Likewise, in fixed abduction deformity, the ASIS of the affected side is lower than the normal hip. To square the pelvis in this situation the examiner should move the leg of the affected hip in the direction of abduction.

Since the deformities are fixed, when testing for abduction and adduction of the leg no movement occurs at the hip joint and leg movement translates itself to pelvic tilt, which moves the ASIS up or down.

Once the pelvis is squared, measurement is undertaken from the ASIS to the medial malleolus on each side. The limbs should be in an identical position in relation to the pelvis.

If there is a true shortening/lengthening, the examiner must determine whether it is due to discrepancy in the tibia or the femur or both. The limb discrepancy in the femur can be either below, or above, the trochanter.

Range of Movement

Flexion

In a supine position, the patient is asked to flex the hip in a straight line with the knee flexed to relax the hamstring (Figure 5.13). The examiner can assist the patient and observe the line of flexion.

Normal flexion: 135°

If the hip rolls into external rotation with flexion → slipped proximal femoral epiphysis
→ Retroverted femoral neck

FIGURE 5.13. Flexion of the right hip.

Abduction

With the patient in a supine position and the pelvis squared, spread the fingers of one hand over both of the ASIS, ensuring the pelvis is horizontal, and to check for any movement. Then abduct the leg and measure the range of abduction (Figure 5.14). Examiners with delicate hands can place one hand over the opposite ASIS to detect any movement.

An alternative method of testing is to put one leg over the edge of the bed to ensure the pelvis is stabilized and then to measure the range of abduction in the opposite hip (Figure 5.15).

FIGURE 5.14. Abduction of the right hip.

FIGURE 5.15. Abduction of the right hip.

An experienced examiner can stand at the foot end of the examination table and hold both legs at the same time and check for the range of movement simultaneously. Any rocking of the pelvis is felt in the opposite leg. This is often a subtle movement to detect.

Normal range: 0–45°

Adduction

With the patient in a supine position and the pelvis squared, place the leg of the opposite side you want to examine over the edge of the bed to stabilize the pelvis and make room for manoeuvre of the leg you want to assess for adduction. Feel both ASIS with one hand and then bring the leg into adduction and note the measurement.

Normal range: 0–30°

Rotation

With the patient supine, the examiner grasps both the ankles and rotates the legs inward and outward to measure the internal and external rotation of the hip by looking at the patella (an imaginary line from the center of the patella) (Figure 5.16).

FIGURE 5.16. Internal rotation of the hips.

FIGURE 5.17. Measuring the rotation of the left hip in flexion.

Repeat the test for rotation with the knee and hip held in 90° of flexion. The tibia is used as a goniometer (Figure 5.17).

Normal range
- IR: 0–30°
- ER: 0–50°
- ↑IR + ↓ER → excessive anteversion of the femur
- Painful IR in flexion → degenerative changes in the hip

Sectoral Sign

If internal rotation is restricted with the hip in flexion but is full in extension, pathology in the anterosuperior part of the femoral head is suspected.

Extension: With the patient in a prone position, the examiner stabilizes the pelvis with one hand, while the leg is brought into extension. The test can also be done in a lateral position (tested side up).

Normal range 0–30°

MOVE

Muscle Testing

Iliopsoas (Femoral Nerve L2, L3, L4)
Primary hip flexor, assisted by rectus femoris and sartorius. The patient sits on the edge of the examination table and is asked to raise the thigh, with the knee flexed, while the examiner applies resistance to the distal thigh to assess the power (Figure 5.18). If the patient is able to lift his thigh off the table, the power is at least 3.

FIGURE 5.18. Assessing the power of iliopsoas.

Gluteus maximus (Inferior Gluteal Nerve S1, 2)

Primary hip extensor, assisted by hamstrings. Patient in prone position, asked to bend the knee and lift off the thigh from the examination table while the examiner applies downward force to the distal thigh to push the thigh to the table.

Gluteus Medius (Superior Gluteal Nerve L5, S1)

Primary abductor of the hip, assisted by gluteus minimus and tensor fascia lata.

Patient in lateral position, (lying on the unaffected side). The examiner instructs the patient to abduct the leg and maintain the position while downward pressure is applied to the distal thigh (Figure 5.19).

FIGURE 5.19. Assessing the power gluteus medius.

Adductors

Adductor longus, brevis and magnus, and gracilis (obturator nerve L2, 3, 4)

(Tested as a group.) Patient in supine position. The examiner abducts the leg with the knee in extension and maintains the position. The patient is asked to bring the leg toward the midline (Figure 5.20).

FIGURE 5.20. Assessing the power of adductors.

Sensation

The only nerve specific to the hip joint to be tested is the lateral femoral cutaneous nerve. It enters the thigh 1–2 cm medial to the ASIS. It supplies the skin over the proximal to middle portion of the anterolateral thigh.

Compression of the nerve near the ASIS is called *meralgia paresthetica*. The nerve cannot be palpated but a positive Tinel's sign may confirm the diagnosis.

The complete neurological examination of the lower limb is covered in spine chapter.

Pulses

Popliteal Artery

Deep structure in the middle of the popliteal fossa. With flexion of the knee and deep palpation, the pulse can be felt.

Dorsalis Pedis

To palpate, ask the patient to extend the big toe and observe the extensor hallucis longus tendon. It can be felt just lateral to the EHL and proximal to the prominence of the metatarsocuneiform joint.

Special Tests

Thomas' Test

This is the test to determine the flexion deformity of the hips. In the presence of flexion deformity at the hip joint, exaggerated lumbar lordosis brings the hip level to the ground and maintains an upright position.

To perform the test, with the patient in a supine position, the examiner places his hand under the lumbar spine. Then the patient is asked to flex both hips as far as possible (Figure 5.21). The lumbar lordosis is now eliminated, and the examiner feels the

FIGURE 5.21. Thomas' test. Note obliteration of the lumbar lordosis (the examiner's hand is not shown in this picture).

lumbar spine pressing on his hand, which is under the lumbar spine. The patient is asked to hold one knee fully flexed with both hands to maintain the flexion at the hip joint. The other leg is now brought down to the table. If a flexion deformity is present, the leg cannot reach the table and the angle between the posterior aspect of the thigh and the examination table is read as the angle of flexion deformity (Figure 5.22). The test is then repeated for the other hip.

Flexion deformity of each hip is assessed separately by the above method. Each hip may be in a different degree of deformity.

If the patient is unable to flex both hips at the same time, the examiner flexes one hip and asks the patient to hold the knee with both hands to maintain the flexion of the hip joint. The other hip is brought to about 60° degrees of flexion and then lowered down toward the examination table for measurement of the flexion deformity.

If there is fixed flexion of the knee joint, the examiner should bring the patient down the examination table so the knees are off the table and then the test can be performed in the usual manner.

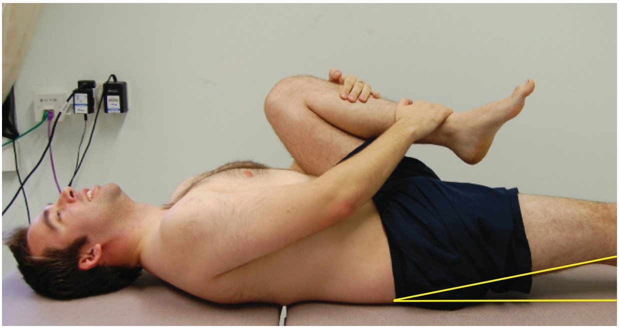


FIGURE 5.22. Thomas' test. The angle of flexion deformity is shown.

FABER Maneuver (Patrick's Test)

Performed to differentiate lumbar radiculopathy versus intrinsic hip pathology. The patient, in a supine position, is asked to put the hip in a figure four position (**F**lexion +**AB**duction+ **E**xternal **R**otation). The examiner stabilizes the opposite ASIS, while gently pressing down on the contralateral knee (Figure 5.23). Location of the pain points toward the pathology:

Anterior groin pain → hip arthritis
→ iliopsoas pathology

Posterior hip pain → sacroiliac pathology

FIGURE 5.23. FABER maneuver (Patrick's test).

Ely's Test

This test is to assess the rectus femoris for tightness. With the patient in a prone position, the examiner flexes each knee in turn (Figure 5.24). If rectus femoris tightness is present, the hip on the same side flexes, which is seen as lifting of the buttock.

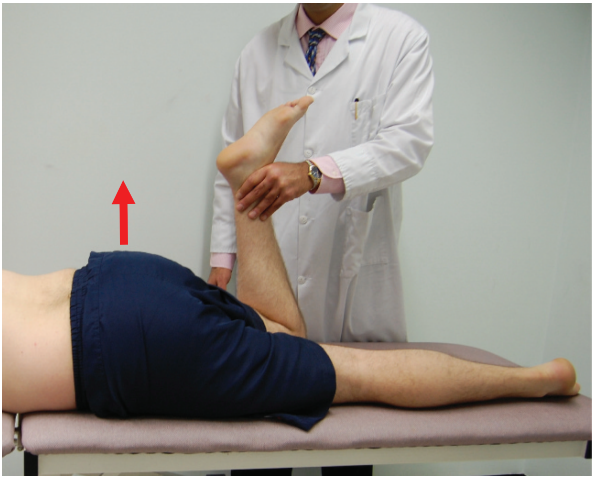


FIGURE 5.24. Ely's test.

Ober's Test

This test is to assess the tensor fascia lata (iliotibial band) for contracture. The patient is in the lateral position, with the affected side up and flexion of the hip and knee on the other side to increase stability. The examiner then abducts and extends the upper leg and slowly lowers the limb (Figure 5.25). In the presence of a contracture, the leg does not fall to the examination table and remains abducted.

FIGURE 5.25. Ober's test.

Labral Test

With the patient in a supine position, the hip is flexed beyond 90° and then adducted and internally rotated.

If painful, an anterior tear of the acetabular labrum is suspected.

Piriformis Test

With the patient in a lateral position, with the affected side facing up, the examiner flexes the knee to 90° and the hip to 45°. He then pushes the knee toward the examination table (internal rotation) while stabilizing the pelvis with the other hand (Figure 5.26).

If painful → piriformis tendinitis

Development of radiating pain → piriformis syndrome

FIGURE 5.26. Piriformis test.

Stinchfield's Test

This test is for assessment of hip joint pathology. The patient in supine position is asked to straight leg rise with the knee in extension.

Inability to perform the test (with preceding trauma) → fractured neck of femur

Pain during the test → hip joint pathology

Chapter 6

Knee

LISTEN

Mechanism of Injury (If Applicable)

Patients usually remember the position of their limbs/feet at the time of injury. Certain mechanisms of injury result in characteristic patterns of structural damage.

Common Examples

Valgus force → medial collateral ligament rupture. If the force continues, medial meniscus injury and, with further force, anterior cruciate ligament (ACL) rupture

Varus force → lateral collateral ligament

Hyperextension force → ACL

Fall on to flexed knee/ dashboard injury → posterior cruciate ligament (PCL)

Forceful internal rotation → lateral meniscus injury

Forceful external rotation → medial meniscus injury

Hyperflexion (squatting) → meniscus injury (posterior horn)

Could the patient walk immediately after the injury?

The patient is unlikely to be able to walk in the following conditions:

Most fractures
ACL tear
Peripheral detachment of meniscus

Pain

Site of Pain

Localized pain (to which the patient can point with a finger) → meniscus injury

Generalized pain → degenerative changes
→ patellofemoral joint degeneration

What activity brings on the pain?
Relieving factors

Type of Pain

Aching pain → degenerative changes

Sharp pain/catching pain → meniscus injury
→ loose body

Note: Sharp pain and aching pain can exist together. This is usually indicative of a degenerative meniscal tear in combination of degenerative arthritis.

Pain during activity → structural abnormality (meniscal, ACL)
→ patellar maltracking

Pain exacerbated by twisting → meniscal pathology

Pain worse going up slopes → tibiofemoral pathology

Pain worse going down slopes → patellofemoral pathology

Pain after activity → inflammatory arthropathy
→ tendinosis
→ meniscal pathology

Morning pain → inflammatory arthropathy

Rest/night pain → usually not mechanical in origin, however sometimes seen in advanced osteoarthritis. In patients with no history of trauma, other causes, such as bone tumor, should be considered.

Does the pain cause any restriction to activity? Quantify (in meters, blocks, miles, or kilometers) how far the patent can walk. Does the pain wake the patient from sleep? At night the protective muscle spasm is removed and hence movements can cause severe pain.

Swelling

Generalized

If it developed immediately (within minutes) after a trauma → hemarthrosis
- Causes
  - ACL tear
  - Intra-articular fracture
  - Patellar dislocation/subluxation
  - Periarticular fractures
  - Peripheral meniscus tear

If it developed the next day (within hours) after a trauma → serous effusion
- Causes
  - Meniscus tear
  - Articular cartilage injury

With no preceding trauma
- Causes
  - Osteoarthritis
  - Inflammatory arthritis, including rheumatoid arthritis
  - Septic arthritis
  - Chondrocalcinosis
  - Loose body
  - Pigmented villonodular synovitis (PVNS)

Explore the first time pain or swelling occurred: it may be many years prior to recent complaint.

Localized

Anterior aspect of the knee
- Prepatellar bursitis: The bursa is over the anterior portion of patella
- Infrapatellar bursitis: The bursa is over the infrapatellar tendon.

Lateral aspect of the knee
- Lateral meniscal cyst

Posteromedially
- Semimembranosus bursitis

Posteriorly
- Baker cyst
- Popliteal aneurysm (rare cause)

Other causes for swelling
- Ganglion
- Neuroma
- Lipoma

Osteophytes
Osgood–Schlatter's disease

Stiffness

After Activity

Arthritis
Meniscal tear
ACL tear

Rest Stiffness/Early Morning Stiffness

Rheumatoid arthritis and other inflammatory arthropathy
Osteoarthritis

Locking /Catching

Loose body
Meniscal tear
Patellar instability
In true "locking" the patient can flex the knee from the angle of locking but is unable to extend. Structures causing loss of extension (loose body, displaced torn menisci) tend to be jammed in the intercondylar notch.
In pseudo locking, the patient is unable to either extend or flex the knee.

Giving Way

Is the patient able to run/change direction during running?

- Causes
  - ACL tear
  - Patellar instability
  - Pain due to any cause in the knee joint

LOOK

Alignment

Ask the patient to stand facing you (patellae facing forward). In this position the patient should be able to keep the knees and feet together (Figure 6.1).

Normally there is physiological valgus present which measures 5° in men and 7° in women on a radiograph. The following variations may be unilateral or bilateral:

In a varus knee, the feet are together but the knees are apart (Genu Varum)

Causes

- Osteoarthritis and collapse of medial compartment
- Angular deformity following old fracture femur or tibia
- Blounts disease

FIGURE 6.1. Normal alignment.

In a valgus knee, the knees are together but the feet stay apart (Genu Valgum).

Note: In obese people, the thighs can sometimes not be brought together, which may produce false excessive valgus.

Causes

- Arthritis (usually rheumatoid arthritis) and collapse of lateral compartment
- Angular deformity following old fracture of femur or tibia

Flexion (Must Be Viewed from the Side)

The patient stands with knee in various degree of flexion.
In slight flexion, the knee joint's capacity to accommodate fluid is maximal.

Hyperextension (Must Be Viewed from the Side)

If present, one should note whether it is unilateral or bilateral (Figure 6.2).

FIGURE 6.2. Hyperextension of the knee joints.

This is often seen in women with generalized ligamentous laxity.
Pathological
posterolateral capsular injury
Larsen's syndrome

Position of Hip and Ankle

When standing, an imaginary line should pass through the center of the hip, center of the patella and through the second ray of the foot.

Skin Condition

Redness → inflammation intra or extra articular. The periphery of the discoloration needs to be marked.

Loss of hair → neurological involvement

Scars

Comment on
Position
Surgical or traumatic
Healed with primary or secondary intention

Swelling/Bursa

Generalized
Localized
Anterior aspect of the knee
Prepatellar bursitis
Infrapatellar bursitis
Lateral aspect of the knee
Lateral meniscal cyst
Posteromedially
Semimembranosus bursitis
Posteriorly
Baker's cyst
Popliteal aneurysm (rare cause)
Other causes for swelling
Ganglion
Osteophytes
Osgood–Schlatter's disease Swelling/tenderness at the tibial tuberosity

Muscle wasting of thighs/legs
Vastus medialis is the first muscle to atrophy following injury or inactivity and the last muscle to recover following rehabilitation.

Popliteal fossa
- Scars
- Swelling

Patella position
Normally the patellae are facing in 40° of external rotation. The examiner should look at the patella first, then at the hip and foot and check for external rotation of the tibia.

Squinting patella: when the patellae are facing each other.

Causes

Excessive external rotation of the tibia:

With normal femoral anteversion, the lower limb goes into external rotation with the feet externally rotated. Usually the patient tries to walk with internal rotation of the hip to make the feet face forward and hence conceal the deformity. This produces squinting patella.

Excessive femoral anteversion: The lower limb goes into external rotation. To conceal the deformity patients walk with internal rotation of the hip. In turn, this causes internal rotation of the feet. Secondary external rotation of the tibia may make the feet point forward.

Patellar height: The patient should sit on the edge of the examination table, with the knees facing the examiner. In 90° of flexion the patella should face directly forward (Figure 6.3).

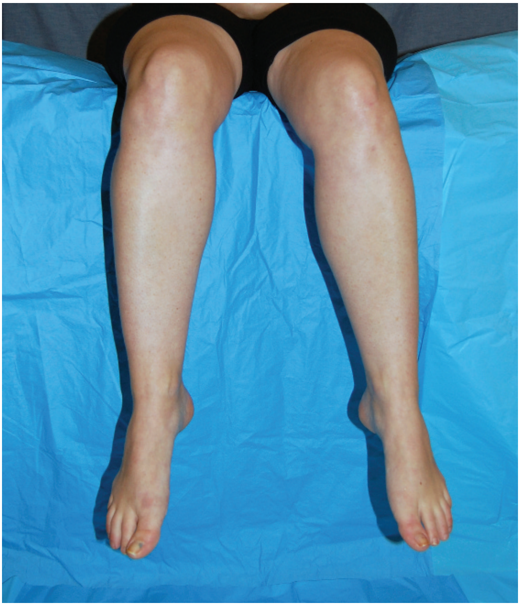


FIGURE 6.3. Assessing the patella height.

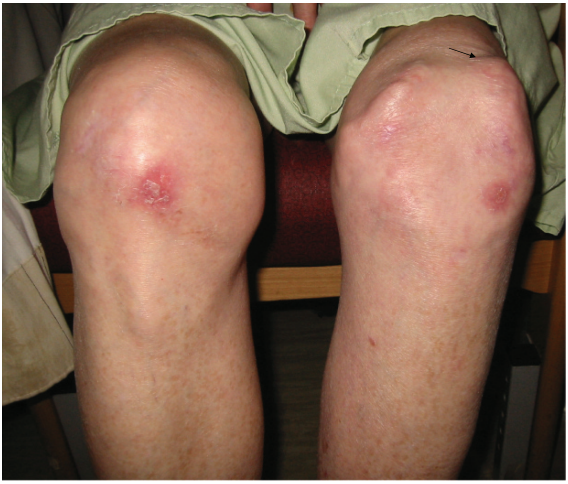


FIGURE 6.4. Patella alta in an untreated rupture of patellar tendon.

Patella alta: The patella faces at an angle toward the ceiling (Figure 6.4).
  Causes
    Long patellar tendon
    Acute rupture of patellar tendon

Patella baja (infra): The patella is lower than usual. Difficult to assess unless very severe, but comparison to the normal side is helpful.
  Causes
    Trauma
    Surgery

Patella size

Patella magna: very large patella. This can be either a normal variation or caused by excessive osteophyte formation due to osteoarthritis.
Patella parva: very small patella.
Patella shape: Irregularity may be due to trauma or a bipartite patella.

Gait

Varus Thrust
The knee goes into increased varus on weight bearing as the opposite foot is in lift off position.

Causes

Advanced arthritis of the knee, with collapse of the medical compartment

Posterolateral ligament complex injury (varus recurvatum thrust)

ACL injury

Vaglus Thrust

The knee goes into increased valgus on weight bearing as the opposite foot is in lift off position.

Causes

Advanced arthritis and collapse of lateral compartment

Antalgic Gait (Best Viewed from the Side)

If the knee is the cause of the pain, the patient tends to reduce the time of weight bearing on the affected knee. Hence the stance phase is quick on the painful knee.

Stiff Knee Gait (Best Viewed from the Side)

The knee is kept in extension during the whole gait cycle. Since the functional length of the limb is longer with the knee in extension, the affected limb swings outward and the body shuffles during the swing phase.

Causes

Pain in the tibiofemoral articulation or patellofemoral joint

Weak or paralyzed quadriceps (e.g.: old poliomyelitis)

Note: In severe weakness or paralysis of the quadriceps, patients push the knee into hyperextension or recurvatum in order to prevent it from collapsing during the stance phase.

Flexed Knee Gait (Best Viewed from Side)

The knee is kept in a certain degree of flexion during the gait cycle. Since the functional length of the limb is shorter in flexion, the affected limb can take shorter strides and, instead of heel first, the foot hits the ground flat. The gait has a characteristic up and down movement.

Cause

Flexion contracture of the knee

Q Angle

The quadriceps angle or, in short, the "Q angle" is the angle between the longitudinal axis of quadriceps muscle and the patellar tendon and reflects the angle of quadriceps muscle force.

The patient should be facing the examiner in a standing position, with both hip and foot in neutral position. A line is then drawn from the anterior superior iliac spine (ASIS) to the center of the patella and a second line from the center of the patella to the tibial tubercle (Figure 6.5). The angle between the two lines represents the Q angle.

Alternatively, and with experience, one can place the goniometer on the center of the patella and adjust the limb of goniometer to point to the direction of the ASIS and tibial tubercle.

Normal values

- 14° in men
- 17°in women
- Average 15° in normal individual

FIGURE 6.5. Q angle.

Causes of increased Q angle
- Genu valgum
- Excessive femoral anteversion
- Excessive external tibial torsion
- Lateral displacement of tibial tubercle

Causes of decreased Q angle
- Habitual subluxation of patella
- Patella alta

Range of Movement

While the patient is on the examination table, ask him to lift his leg off the bed. In so doing, you have tested the active extension of the knee. If the patient is able to extend the knee fully off the table, the power is at least 3 in the MRC grade. If the patient is unable to extend fully, note the degree of flexion the knee is in and how much this is short of full extension. Then try to passively extend the knee.

If you can bring the knee to full extension, the difference between active and passive extension is expressed as "**extension lag**."

Age and extensor mechanism lesions
- Tibial Tubercle: 10
- Patellar tendon: 20s
- Patella: 30s
- Quadriceps tendon: 50s
- Quadreceps muscle:70s

Causes of extension lag
- Pain
- Weakness of quadriceps or rupture
- Rupture of the extensor mechanism can result in an inability to straight leg raise. The weakest point along the mechanism from tibial tubercle to quadriceps muscle is age-related (tubercle 10y patella tendon 20y patella 30y quadriceps tendon 50y quadriceps muscle 70y) Tender palpable gaps may be felt following direct or indirect injury (Figure 6.6).

FIGURE 6.6. Bilateral quadriceps rupture.

If full passive extension is not possible, then flexion deformity is fixed and expressed as **fixed flexion deformity**. From this point ask the patient to flex the knee as far as possible and compare to the other side.

Causes of flexion deformity

- Pain
- Swelling
- Arthritis
- Mechanical block (lesion in intercondylar notch)
- Displaced meniscus tear
- Loose body
- Stump of torn ACL

Another method to assess flexion deformity: The examiner asks the patient to lie in a supine position, and lifts the feet by holding the heels. Note whether both knees are at the same level or not. Alternatively, ask the patient to try to trap the examiner's hand behind the knee against the couch to detect subtle fixed flexion. Hyperextension is normal in many individuals, especially if symmetrical.

If flexion deformity is in doubt, the prone hanging test can be preformed.

The patient lies down in a prone position at the end of the table while the knees are beyond the edge of the table. The examiner measures the difference between the heights of the heels (Figure 6.7). Each 1 cm difference roughly corresponds to 1° of knee flexion deformity.

Flexion: First ask the patient to flex the knee as far as possible. Then try to passively flex the knee if the range of flexion is not full. Always compare to the other side.

Note: At some point it is useful to put your hand over the knee during one cycle of flexion and extension and feel for crepitus, which is usually present in arthritis.

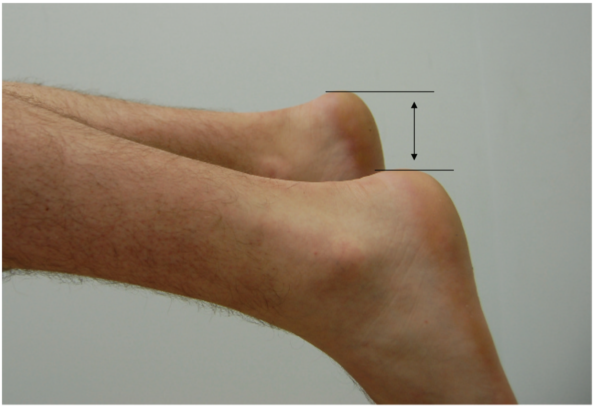


FIGURE 6.7. Measurement of fixed flexion deformity.

FEEL

Skin Temperature

Run the back of your fingers from mid calf to mid thigh. In this way an examiner can compare the temperature of normal skin and feel the rise of temperature if present.

Causes of rise in temperature
- Septic arthritis
- Bursitis
- Acute attack of gout

Effusion/Swelling

An effusion is an increase in the amount of fluid inside the joint. The most commonly performed tests for effusion are:

Cross Fluctuation

Patient in supine position. The examiner compresses and empties the suprapatellar poach with the contralateral hand while the other hand straddles the front of the joint below the patella. The examiner then squeezes with each hand alternately (Figure 6.8). In a positive test, the fluid impulse transmitted across the joint is felt (for large effusion).

FIGURE 6.8. Cross fluctuation.

Patellar Tap

Patient in supine position with the knee extended. The examiner compresses and empties the suprapatellar poach with one hand while with the index finger of other hand pushes the patella sharply posterior toward the femur (Figure 6.9). In a positive test the patella can be felt striking the femur and bouncing off again (for moderate and large effusions).

FIGURE 6.9. Patellar tap.

Patellar Hollow Test

The patient is sitting at the edge of the examination table with the knee in 90° of flexion. In the normal knee, a hollow appears lateral to the patellar ligament (Figure 6.10) and disappears with further flexion. With presence of excess fluid, the hollow fills and disappears at a lesser angle of flexion. (For minimal effusion)

Figure 6.10. Normal hallow lateral to the patellar ligament.

Synovial Thickening

The supra patellar pouch has a horseshoe shape. Run the tip of your fingers over the edge of the pouch (Figure 6.11). If synovial hypertrophy is present, the fold of thickened synovium at the edge can be rolled under the fingers and feels like a cord-like structure.

FIGURE 6.11. Boundary of suprapatellar pouch.

In gross synovial thickening, a boggy or spongy swelling can be felt around the knee joint, especially either side of and just above the patella and may make it difficult to "pick up the patella" between the examiner's thumb and index finger (Figure 6.12).

A large tense effusion may appear similar to excessive synovial hypertrophy.

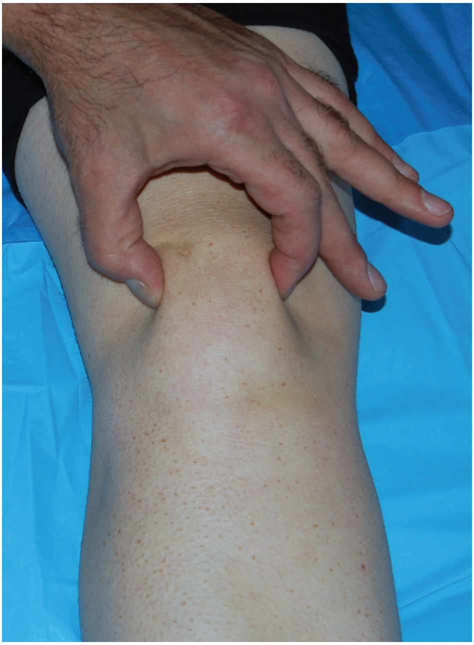


FIGURE 6.12. Picking up the patella is difficult in synovial hypertrophy.

Medial Side

Medial Joint Line

Patient is on the examination table with the knee in 90° of flexion. This causes the femur to roll back on the tibia and makes the anterior joint line more accessible. With the tip of the index finger, palpate the joint line anteriorly and press repeatedly toward the posterior aspect along the medial rim of the tibia. The medial meniscus becomes more prominent with internal rotation of the tibia.

Tenderness of the medial joint line is often symmetrical in normal knees. Unilateral tenderness is more likely to represent a pathological cause.

Anterior Joint Line Tenderness

The anterior joint line tenderness is non specific. Probably the only exception to this occurs in a locked knee due to displaced bucket handle tear of meniscus.

Medial and posterior joint line tenderness → meniscus pathology
→ medial compartment osteoarthritis

Medial compartment joint line tenderness exacerbated by

- varus stressing when flexing the knee (Heatley agony test) → medial compartment osteoarthritis
- flexion and tibial rotation → medial meniscal injury

Medial Collateral Ligament

Feel the medial epicondyle (the femoral attachment of MCL) and palpate distally and obliquely toward its tibial attachment. It crosses the medial joint line and hence tenderness at this point can be due to either MCL or medial meniscus injury.

Opening of the medial joint line by applying valgus force in:

- 30° of flexion → isolated MCL injury (painful in acute injuries)
- full extension → MCL and ACL tear

Semitendinosus (ST), Gracilis, and Semimembranosus(SM)

All 3 tendons are situated posteromedially. To palpate them, knee should be in flexion.

Semitendinosus: Most posterior and inferior, more prominent in resisted flexion (Figure 6.13). Round tendon.

Gracilis: Anterior and medial to ST, more prominent in resisted internal rotation. Round tendon.

Semimembranosus: Deep and between ST and Gracilis, remains muscular to its insertion.

Bursitis of this tendon is more prominent in knee extension and disappears in flexion.

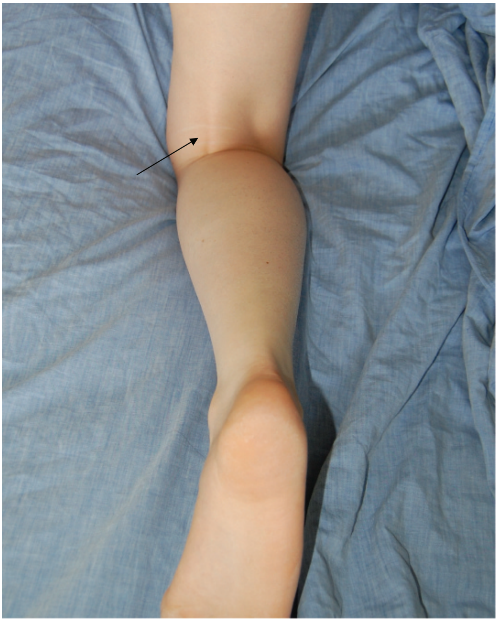


FIGURE 6.13. Semitendinosus tendon.

Lateral Side

Lateral Joint Line

Patient is on the examination table with the knee in 90° of flexion. This causes the femur to roll back on the tibia and makes the anterior joint line more accessible. With the tip of the index finger or thumb, palpate the joint line anteriorly and press repeatedly toward the posterior aspect along the lateral rim of the tibia (Figure 6.14).

Anterior joint line tenderness → Nonspecific

Lateral and posterior joint line tenderness → meniscus pathology
→ lateral compartment osteoarthritis

Lateral compartment joint line tenderness exacerbated by

Valgus stressing when flexing the knee → Lateral compartment osteoarthritis

Flexion and tibial rotation → Lateral meniscal injury

Note: Valgus stress while flexing from full extension causing pain medially is indicative of medial ligament synovitis and often indicates a medial meniscal tear or partial medial ligament injury.

FIGURE 6.14. Palpation of the lateral joint line.

Lateral Collateral Ligament

Ask the patient to put the leg in a figure four position. The LCL is easily palpable between the lateral femoral epicondyle and the head of the fibula (Figure 6.15)

FIGURE 6.15. Lateral collateral ligament.

Biceps Femoris Tendon

With flexion of the knee, the biceps femoris tendon becomes prominent and it can be felt near the fibular head. Ask the patient to flex against the resistance while palpating the tendon. Biceps tendinitis is occasionally a cause of pain in the lateral aspect.

Popliteal Fossa

Patient in prone position on the examination table with knee in flexion.

Popliteal or Baker's Cyst

Usually a painless and mobile swelling, veering to the medial side of the fossa. More prominent with the knee in extension. Sometimes it is possible to empty the contents of the cyst into the knee joint with gentle and uniform pressure.

Occasionally pulsatile swellings (Popliteal aneurysm) and tumors arising from the neurovascular structure are felt in this area.

Cysts may also be felt adjacent to the posterior knee tendons.

Patella

Patient is in supine position. With knee extended and quadriceps fully relaxed, the patella is usually quite mobile for further examination.

Mobility

Normally the patella should move half of its width medially and one third of its width laterally (Figure 6.16).

a

b

FIGURE 6.16. *(a)* Medial displacement of the patella. *(b)* Lateral displacement of the patella.

FIGURE 6.17. Palpation of the medial facet.

Medial Facet

With one thumb, move the patella medially and, with the index finger of the other hand, palpate the under surface of the medial facet (Figure 6.17).

Lateral Facet

With one thumb, move the patella laterally and, with the index finger of the other hand, palpate the under surface of the lateral facet.

Pathological Medial Plica

This is sometimes the source of pain in the medial/anteromedial side of the knee joint. With the patient supine and the knee in 30° of flexion, it may be palpated as a band or simply a tender area running between the patella and medial femoral condyle.

MOVE

Muscle Testing

Quadriceps (Femoral Nerve L2, L3, L4):
In a supine position: Put one forearm under the knee joint and, with the other hand, apply resistance while the patient is instructed to extend the knee.

In a sitting position: Stabilize the thigh with one hand and then apply resistance, while the patient is instructed to extend the knee (Figure 6.18). Feel for the contracture of the muscle with your stabilizing hand.

FIGURE 6.18. Assessing the quadriceps.

Hamstrings (BF, SM, ST: Sciatic nerve L5, S1, S2) and Gracilis (Obturator nerve L2-L3)

Tested as a group.
In a supine position: Hold the hip at 60° of flexion and stabilize the knee with one hand. With the other hand, hold the leg above the malleoli and apply resistance, while the patient is instructed to flex the knee.
In a prone position: The patient is instructed to flex the knee and hold the flexed position at about 60° while the examiner applies resistance with one hand. The other hand should be placed on the muscle to feel the contracture (Figure 6.19).

FIGURE 6.19. Assessing the hamstrings.

Muscle Wasting
Measure the thigh circumference. In a supine position, mark a point 15 cm above the superior pole of the patella on both thighs and measure the circumference of both thighs at this point with a tape.

Sensation

The only nerve specific to the knee joint to be tested is the infrapatellar nerve (infrapatellar branch of saphenous nerve). It runs medial to lateral just inferior to the patella but its course is highly variable. It often gets injured in longitudinal midline incisions and leaves an anesthetic patch lateral to the surgical scar (Figure 6.20). Occasionally it is also injured by a direct fall on to the knee.

The neurological examination of the lower limb is covered in spine chapter.

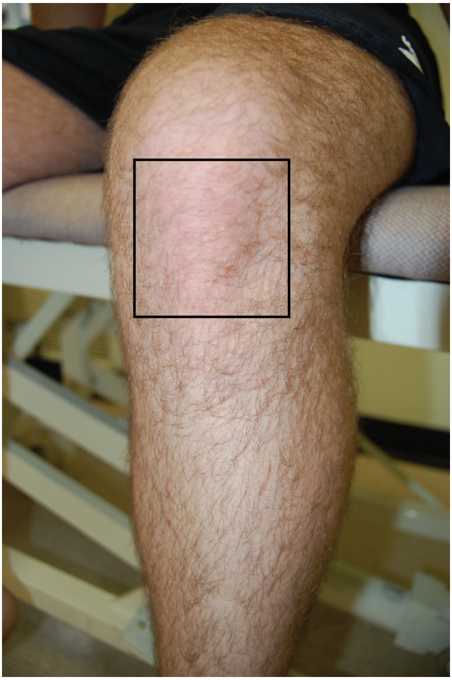


FIGURE 6.20. Sensory distribution of the infrapatellar nerve.

Pulses

Popliteal Artery

Deep structure in the middle of the popliteal fossa. With flexion of the knee and deep palpation, the pulse can be felt.

Dorsalis Pedis Artery

Ask the patient to extend the big toe and observe the extensor hallucis longus tendon. It can be felt just lateral to the EHL and proximal to the prominence of the metatarsocuneiform joint.

Special Tests

Meniscal Test

McMurray's Test

Patient in supine position flexes the knee as far as possible. One hand supports the knee in such a way that the thumb and index finger are on the medial and lateral joint lines respectively. The other hand grasps the foot.

To test the medial meniscus, external rotation force is applied to the foot, with varus stress to the knee joint to close the medial compartment and then the knee is passively extended (Figure 6.21). If the patient complains of pain or a click is heard (rare), the test is considered positive for a medial meniscal tear.

FIGURE 6.21. McMurray's test. Assessing the medial meniscus.

To test the lateral meniscus, internal rotation force is applied to the foot, with valgus stress to the knee joint in order to close the lateral compartment and then the knee is passively extended (Figure 6.22). If the patient complains of pain or a click is heard (rare), the test is considered positive for a lateral meniscal tear.

If full flexion is not possible, McMurray's test can still be performed but lesions of the posterior horn of meniscus can not be tested.

FIGURE 6.22. McMurray's test. Assessing the lateral meniscus.

Steinmann's first test

Sudden external rotation of the foot with the knee in 90° of flexion can cause pain in the medial compartment, which is suggestive of a medial meniscal tear (Figure 6.23).

Sudden internal rotation of the foot with the knee in 90° of flexion can cause pain in the lateral compartment, which is suggestive of lateral meniscal tear.

FIGURE 6.23. Steinmann's first test for medial meniscus.

Anterior/Posterior Instability

First the examiner must ascertain that there is no posterior sag on the affected knee. With the patient supine, flex the knees to 90° while keeping the knees and ankles together. The examiner can then observe the tibial tubercles from the side. Both tibial tubercles should be at the same level. In the case of posterior cruciate ligament rupture, the tibia sags posteriorly and the tibial tubercle appears less prominent and posterior to the normal side.

Anterior Drawer Test

The patient should be supine with knees flexed to 90°. The feet are stabilized in a neutral position and the examiner sits at the forefeet of the patient.

Ask the patient to relax. With the index fingers of both hands, feel the hamstring tendons and check if the muscles are relaxed before you manipulate the knee.

Grasp the knee with both hands; the tip of your thumbs should be just below the joint line (Figure 6.24). Then pull the tibia forward. The amount of anterior translation of tibia and quality of end point is assessed.

FIGURE 6.24. Anterior drawer test.

Normal knee → A few millimetera of anterior translation with a firm end point (stops suddenly)

ACL rupture → 5 mm or more of anterior translation with a soft end point

Always compare the affected side with the normal side.

False negative test
- Spasm of hamstring muscle due to pain
- Torn posterior horn of medial meniscus (wedged against femoral condyle)
- Hemarthrosis

False positive test
- Undetected PCL rupture

Lachman's Test

This is a very sensitive test for ACL rupture. The patient is in a supine position. The examiner grasps the thigh with one hand and with the other hand grasps the tibia at the level of the tibial tubercle and brings the knee to 30° of flexion (Figure 6.25). The hand on the thigh both stabilizes it and also feels for the hamstring tightness. Once the thigh is stabilized, the hand holding the tibia pulls it forward and the amount of anterior translation of tibia on the femur is measured and the quality of the end point is noted.

FIGURE 6.25. Lachman's test.

Pivot Shift Test

With the patient in supine position with their leg relaxed in full extension, the examiner should hold the foot with his ipsilateral hand and exert an internal rotation and axial force to the ankle (Figure 6.26). The examiner then exerts an anterior and medial directed force to the fibula head with his contralateral hand, generating a valgus strain on the knee and subluxing the lateral tibial plateau forward (Figure 6.27). The gentle displacing forces on the tibia are maintained as the knee is slowly flexed. If the lateral tibial plateau has been subluxed, indicating ACL deficiency and rotational instability, it will slip (or clunk) back into its normal position as the knee flexes thus demonstrating a positive test. Most patients will tolerate the demonstration of a positive test in the clinic as long as gentle forces are used initially and slowly increased.

FIGURE 6.26. Pivot shift test. Starting position.

FIGURE 6.27. Pivot shift test. See text.

Posterior Drawer Test

The starting poison is the same as for the anterior drawer test. Patient in supine position, with knees flexed to 90°. The foot is in neutral position and the examiner sits at the forefoot of the patient to stabilize it. Grasp the knee with both hands; the tip of your thumbs should be just below the joint line. Then push the tibia backward. The amount of anterior translation of the tibia and the quality of the end point is assessed.

Normal knee → No posterior translation

PCL rupture → Posterior translation (may be very subtle translation); usually associated with *firm* end point

Posteromedial/Posterolateral instability

Slocum Test

It is convenient to do the Slocum test immediately after the anterior drawer test.

After completion of the anterior drawer test, put the foot in 15° of external rotation and repeat the anterior drawer test and compare it with the anterior translation of the tibia with the foot in a neutral position. Then put the foot in 30° of internal rotation and repeat the anterior drawer test and compare it with the anterior translation of the tibia with the foot in a neutral position.

Anterior translation greater when the foot in external rotation → Posteromedial injury

Anterior translation greater when the foot in internal rotation → Posterolateral injury.

Dial Test

This is another method for the demonstration of posterolateral instability.

The patient is in a supine or prone position (this test can be done after inspection of popliteal fossa as patient is already in prone position), with knees in 30° of flexion and knees and feet together. Examiner then externally rotates both feet passively and compares the amount of external rotation (Figure 6.28).

Increased external rotation → Posterolateral instability

FIGURE 6.28. Dial test.

Varus/Valgus

The measurement of varus/valgus deformity (if present), should be done now with the help of a goniometer.

Place the limbs of the goniometer on the thigh along the axis of the femur and of the tibia and read the angle. Also check if deformity is fixed or correctable. Apply the opposite force to direction of deformity (i.e. valgus force to varus deformity and varus force to valgus deformity).

If the deformity is correctable, the knee can be brought to neutral alignment. Keep in mind that deformity may be correctable in full or partially and both can co-exist together.

Varus /Valgus Instability Test

This is to check the integrity of the medial and lateral collateral ligament.

The patient is relaxed in a supine position. The examiner holds the leg in his axilla, with the knee in 20° of flexion. With both hands, the tibia is held firmly in such a way that the thumbs are on either side of the patellar tendon and the index fingers are placed on the femoral attachments of the medial and lateral femoral condyles (Figure 6.29). Then valgus force (for MCL) and varus force (for LCL) is applied and the amount of opening is noted.

FIGURE 6.29. Varus and valgus stability test.

Patellar Tracking

J Sign

The patient is sitting at the edge of the examination table and can freely flex and extend the knee. The examiner faces the patient and observes the movement of the patella as the patient flexes and extends the knee repeatedly. Quadriceps contraction in full extension may cause lateral subluxation of the patella and a reduction in the Q angle in patients with a tendency to subluxation or patella dislocation is referred to as the J sign. This indicates lateral patellar tracking. In some cases, putting a dot at the center of the patella is useful.

Patellar Apprehension (Fairbank's) Test

This test demonstrates patellar instability under controlled conditions. The patient is in a supine position and relaxed. The patella is pushed as laterally as possible by the examiner (Figure 6.30) and the patient is asked to flex the knee slowly. With a positive history of subluxation or dislocation, the patient is unwilling to flex the knee beyond a certain angle and it creates an apprehension in the patient that the kneecap is going to dislocate, or the patient may feel that the leg is going to break.

FIGURE 6.30. Apprehension test. Starting position.

Patellar Grinding

Hold the patella with the thumb and index finger and gently press it down and move it medially and laterally. At the same time look at the patient's face to see in which direction, medial or lateral, pain is produced. This usually demonstrates a defect in the articular cartilage of the patellofemoral joint.

This test might be painful and is best done at the end of examination.

Clark's Test

Stabilize the patella gently by putting your index finger over the superior pole of the patella (Figure 6.31). Ask the patient to contract the quadriceps by pushing the knee down. If pain is produced, it is suggestive of arthritis of the patellofemoral joint with concomitant synovitis in the suprapatellar pouch.

This test might be painful and is best done at the end of examination.

FIGURE 6.31. Clark's test.

Wilson Test

This is a test for osteochondritis dissecans.

A patient in a supine position is asked to flex the knee to 90°. The examiner then holds the foot and internally rotates the leg and gently extends the knee completely. If a classic lesion of osteochondritis dissecans (located on the lateral aspect of the medial femoral condyle adjacent to the intercondylar notch) is present, it impinges against the ACL and produces pain as the internally rotated knee reaches terminal degrees of extension. External rotation of the knee should eliminate the pain.

Chapter 7

Foot and Ankle

LISTEN

Mechanism of Injury (If Applicable)

Patient usually remembers their position at the time of injury. Certain mechanisms of injury result in characteristic patterns of structural damage.

Common Examples

Inversion → anterior talofibular ligament
→ calcaneofibular ligament
→ 5th metatarsal base fracture
→ fracture of the anterior process of the calcaneus

Eversion → deltoid ligament
→ syndesmosis ligaments

Hyperdorsiflexion → talar fracture
→ dislocation of peronei tendon

Hyperplantar flexion → Fracture of lateral tubercle of the posterior process of the talus

Pain

Site of Pain

Localized pain (to which the patient can point with a finger)

Medial side → deltoid ligament injury
→ fracture of medial malleolus
→ tibialis posterior tendinitis

Lateral side → calcaneofibular ligament injury
→ fracture of lateral malleolus

Generalized pain → degenerative changes
→ osteochondritis dissecans
→ nerve injury (e.g. superficial peroneal nerve traction injury)
→ complex regional pain syndrome

What activity brings on the pain?

Pain Increased

Weight bearing → arthritis, fractures

Wearing footwear → bunion, fixed deformities/hallux rigidus

Walking on uneven ground → subtalar involvement, peroneal tendons

Walking on even ground → any part of the foot can cause this

Walking uphill/ going upstairs → anterior impingement

Walking downhill/ going down stairs → posterior impingement

Reliving Factors

Wearing boot or brace reduces the pain → instability, fractures

Type of Pain

Aching pain → degenerative changes

Sharp/catching pain → mechanical pain, ligament sprain, loose body

Pain during activity → structural abnormality (ligament sprain), arthritis

Pain after activity → inflammatory arthropathy, tendinosis, arthritis

Rest pain → usually not mechanical in origin, however sometimes seen in advanced arthritis. Peripheral nerve injury, lumbar spine or complex regional pain syndrome are other possibilities. In patients with no history of trauma, other causes, such as bone tumor, should be ruled out.

Does pain cause any restriction on activity? Quantify (in meters, blocks, miles or kilometers) how far the patient can walk.
Does the pain wake the patient from sleep? At night the protective muscle spasm is removed and hence movements can cause severe pain.

Swelling

Generalized Swelling

If it developed within minutes after a trauma
- Fracture
- Ligament sprain
- Contusion

If developed within hours after a trauma or if the patient first notices it the next day
- Articular cartilage injury
- Ligament sprain

With no trauma
- Osteoarthritis
- Inflammatory arthropathy, including rheumatoid arthritis
- Septic arthritis
- AVN of talus/ navicular
- Cardiovascular (e.g., congestive heart failure)
- Deep venous thrombosis
- Lymphatic condition
- Tumor (including abdominal tumor compressing vena cave or iliac vessels)

Localized Swelling

Medial side → deltoid ligament injury
→ fracture of medial malleolus
→ tibialis posterior tendinitis

Lateral side → calcaneofibular ligament injury
→ fracture of lateral malleolus
→ peroneal tendons

Stiffness

After activity → arthritis

Rest stiffness/early morning stiffness → rheumatoid arthritis and other inflammatory arthropathy
→ osteoarthritis

LOOK

The patient should remove shoes and socks and trousers should be rolled up to the knee joint. Ideally the hip joint should be visible.

Alignment

Ask the patient to stand facing you.
Normally the foot is in slight external rotation from the sagittal axis of the body (Figure 7.1). This is called the Fick angle (Normal range 5°–18°).
Rotation abnormalities can arise from various locations: (Adapted from Tachdjian)

FIGURE 7.1. Fick angle.

Causes of Toe in

Foot-ankle → pronated feet
→ metatarsus varus
→ talipes varus and equinovarus

Leg-knee → tibia vara (Blount's disease) and developmental genu varum
→ excessive internal tibial rotation
→ genu valgum with compensatory internal rotation of tibia to shift the center of gravity medially

Femur-hip → excessive femoral anteversion
→ spasticity of internal rotators of the hip (cerebral palsy)

Causes of Toe out

Foot-ankle → pes valgus (contracture of triceps surae)
→ talipes calcaneovalgus
→ congenital convex pes planovalgus

Leg-knee → excessive external tibial rotation
→ congenital absence / hypoplasia of fibula

Femur-hip → excessive femoral retroversion
→ flaccid paralysis of internal rotators of the hip

Now look at the foot and ankle from the front (patient is standing)
Big toe: Normally this should be pointing directly forward.
Hallux valgus: Big toe deviates away from body midline (Figure 7.2).

FIGURE 7.2. Hallux valgus.

FIGURE 7.3. Pronation of the big toe.

Other associated features
Great toe pronation: The medial side of toenail is closer to the floor (Figure 7.3).
Medial bunion: this may be inflamed and is often painful
Clawing of second toe (crossover toe) (Figure 7.3).

Hallux Varus

Big toe deviates toward the midline. Deformity usually occurs at the 1st metatarsophalangeal joint.

Causes

- Traumatic
- Iatrogenic
- Complication of hallux valgus operations
- Complication of lateral sesamoidectomy

Lesser Toes

Hammer Toe

Flexion of proximal interphalangeal joint (Figure 7.4). The position of the distal interphalangeal joint is irrelevant and it may be straight, flexed of hyperextended. Callus usually found on dorsal PIP joint (Figure 7.5).

FIGURE 7.4. Hammer toe.

FIGURE 7.5. Callus formation on the dorsum of PIP joint of the second toe.

Causes
- Footwear (most common)
- Inflammatory arthritis
- Neuromuscular diseases (Charcot-Marie-Tooth disease, Friedreich's ataxia, cerebral palsy, myelodysplasia, multiple sclerosis, and degenerative disc disease)
- Foot compartment syndrome
- Idiopathic

Mallet Toes

Flexion deformity of distal interphalangeal joint (Figure 7.6). Corn or callus may be seen on the tip of the toe or dorsal DIP joint.

FIGURE 7.6. Mallet toe. Also note the low medial longitudinal arch. *(a)* Mallet toes.

a


FIGURE 7.6. Cont'd.

FIGURE 7.7. Curly 4th toe.

Causes
- Footwear
- Idiopathic
- In children, mallet toe is secondary to a tight flexor (curly toe Figure 7.7)

Claw Toes

Hyperextension of metatarsophalangeal joint and flexion of proximal and distal interphalangeal joints.
Usually multiple toes in both feet, can be rigid or flexible with callus formation on dorsal PIP joint.
Causes
- Muscle imbalance between the intrinsics and extrinsics Weakness or paralysis of interosseus and lumbrical muscles)
- Metabolic diseases (diabetes most common)
- Neuromuscular diseases
- Associated with pes cavus
- Idiopathic

View the Ankle and Foot from Side

Normally the ankle should be at a right angle with the tibia. The weight distribution is usually between the calcanium, the 1st and the 5th metatarsal.

Pes Cavus

Pes cavus is a condition in which the medial longitudinal arch is unduly high (Figure 7.8).

Causes:

- Neuromuscular
- Muscular dystrophy
- Charcot-Marie-Tooth disease
- Polyneuritis
- Spinal tumor
- Congenital
  - Arthrogryposis
  - Residual club foot
- Idiopathic
  - Trauma
  - Crush injury
  - Residual compartment syndrome
  - Malunion of fractures of the foot

FIGURE 7.8. Pes cavus

Pes Planus

Pes planus or flat foot is a condition in which the medial longitudinal arch is depressed or collapsed (Figure 7.6).

Causes

- Congenital
  - Flexible → tendoachilles tightness
  - Rigid → tarsal coalition
  - Vertical talus (rocker bottom foot)
  - Arthrogryposis
- Acquired
  - Tibialis posterior dysfunction
  - Rheumatoid arthritis
  - Charcot's neuroarthropathy(Rocker bottom foot) (Figure 7.9)
  - Trauma

FIGURE 7.9. Rocker bottom foot.

From Behind

Hindfoot Alignment

Angle is formed by drawing a line bisecting the calf and another line bisecting the heel (Figure 7.10).
Normal angle → 5° to 10° of Valgus

FIGURE 7.10. Hindfoot alignment.

Increased Valgus angle (Figure 7.11)
- Advanced degenerative or rheumatoid arthritis
- Posterior tibial tendon dysfunction
- Ankle or pilon fracture malunion
- Charcot's arthropathy
- Valgus talar tilt secondary to failed deep deltoid ligament
- Tarsal coalition

FIGURE 7.11. Valgus heels.

Varus inclination (Figure 7.12)
- Idiopathic (most common)
- Malunited calcaneus/ankle fractures
- Clubfoot
- Neurological disorder
- Charcot-Marie-Tooth
- Poliomyelitis

FIGURE 7.12. Varus heel.

"Too Many Toes" Sign

Only one or two toes should be visible from behind. If more are seen it is said that the too many toes sign is present (Figure 7.13)

Causes

- Forefoot abduction secondary to
  - Tibialis posterior dysfunction
  - Lisfranc injury
  - Charcot arthropathy of the midfoot

FIGURE 7.13. Too many toes are visible on the right.

Look at the sole
- Callosities
- Ulceration → diabetic foot (Figure 7.14a)
- Neurological condition including Charcot's foot
- Swellings (Figure 7.14b)

FIGURE 7.14. *(a)* Ulceration of the sole of the foot. *(b)* Unusually large rheumatoid nodule. *(c)* Psoriasis. Note the nail changes.

Skin Condition (Figure 7.14c)
Callosities
Corn
Color changes/ischemia
Loss of hair → neurological involvement


b


c

FIGURE 7.14. Cont'd.

Scars

Comment on

Position

Surgical or traumatic

Healed with primary or secondary intention

Ankle swelling

Generalized

Inflammatory arthropathies (including rheumatoid arthritis), osteoarthritis

osteochondral lesion

pigmented villonodular synovitis (PVNS) and other tumors

hemorrhagic

crystal-induced arthropathies (including gout)

Localized

Anterior aspect → tibialis anterior tendon pathology

Anterolateral aspect → anterior talofibular ligament injury
→ soft tissue tumor (including ganglion, lipoma)

All of the above are causes of generalized ankle swelling.

Lateral aspect → Fractures, including residual swelling from old injuries
→ lateral collateral ligament sprain

Medial aspect ankle → sprain of deltoid ligament
→ fractures, including residual swelling from old injuries
→ thrombophlebitis
→ posterior tibial tendon dysfunction

Posterior aspect → retrocalcaneal bursitis

Look at either side of Achilles tendon just proximal to its insertion. When swelling is present, you see fullness on either side of the tendon (Achilles *tendinitis*).
In Achilles *tendinosis* nodule or fusiform enlargement of midsubstance of tendon is seen which is usually associated with tendon degeneration.

Posterolateral ankle

Peroneal tendon pathology

Posterior impingement (os trigonum, posterior talus injury)

Causes for Dorsal Foot Swelling

Stress fracture
Arthritic conditions
Ganglion cyst
Osteophytes
Tumor

Muscle Wasting of Legs/Size of the Foot

Muscle wasting of legs is best seen from behind by comparing the girth of the calves. If different, measure around both sides 20 cm above the medial malleolus.

Gait

Antalgic Gait (Best Viewed from the Side)

If the ankle is the cause of the pain, the patient tends to reduce the time of weight bearing on the affected ankle. Hence the stance phase is quick on the painful ankle.

Drop Foot, Slap Foot, or Stepping Gait

Patient attempts to clear toes from catching on the ground. Also, patient unable to control plantar flexion resulting in foot "slapping" against the ground.
Cause
- Weak or absent dorsiflexion
- Loss of proprioception

Stiff Knee Gait (Best Viewed from the Side)

The ankle is kept in a fixed angle during all the gait cycle. The affected limb swings outward and body shuffles during the swing phase.
Causes
- Pain in the tibiofemoral articulation or patellofemoral joint
- Weak or paralyzed quadriceps (old poliomyelitis)

Note: In severe weakness or paralyses of quadriceps, a patient pushes the knee into hyperextension or recurvatum in order to prevent it from collapsing during stance phase.

Flexed Knee Gait (Best Viewed from the Side)

The knee is kept in a certain degree of flexion during the gait cycle. Since the functional length of the limb is shorter in flexion, the affected limb can take shorter strides and, instead of heel first, the foot hits the ground flat. The gait has a characteristic up and down movement.

Cause
 Flexion contracture of the knee

FEEL

Patient is seated on the edge of the examination table.

Skin Temperature

Run the back of your fingers from dorsum of the foot to mid calf. In this way an examiner can compare the temperature of normal skin and feel the rise of temperature if present.

Causes of rise in temperature:
- Septic arthritis
- Bursitis
- Crystal induced arthropathies
- Cellulitis
- Charcot arthropathy

Anterior aspect

Tibialis anterior tendon

Ask the patient to dorsiflex the ankle. Tibialis anterior can be seen and palpated at the level of ankle as it crosses the joint. It is the largest and most medial tendon at the joint level.

Medial Cuneiform

Trace the tibialis anterior tendon to its insertion at the base of the first metatarsal and first cuneiform.

Extensor Hallucis Longus Tendon

This is the next big tendon over the dorsum of the foot and at the level of the ankle joint. Ask the patient to extend the big toe, the tendon becomes prominent just lateral to the tibialis anterior tendon (Figure 7.15).

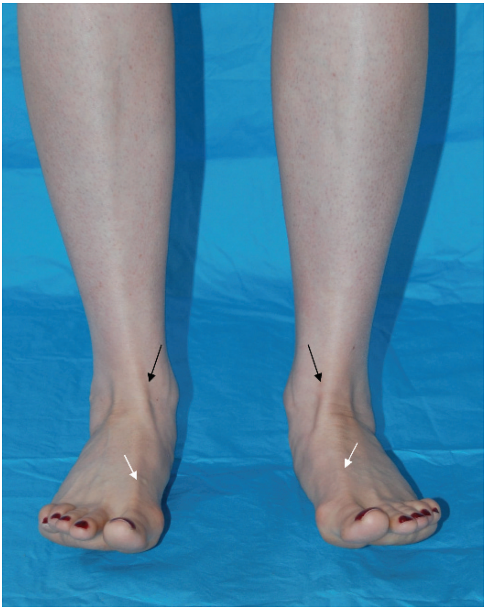


FIGURE 7.15. Tibialis anterior tendon *(black arrows)*; Extensor hallucis longus tendon *(white arrows)*.

Dorsalis Pedis Artery

This is a continuation of the anterior tibial artery which, after crossing the ankle joint, becomes the dorsalis pedis. To palpate, ask the patient to extend the big toe and observe the extensor hallucis tendon. It can be felt just lateral to the EHL and proximal to the prominence of the metatarsocuneiform joint (Figure 7.16).

FIGURE 7.16. Palpation of dorsali pedis artery.

Extensor Digitorum Longus Tendon

Ask the patient to dorsiflex the toes. It becomes prominent at the ankle joint lateral to the EHL tendon.

Medial Side

Medial Malleolus

It is the most prominent structure on the medial side of the ankle joint. Check for tenderness (fracture/nonunion) of the medial malleolus.

Deltoid Ligament

Broad structure attached to the tip of the medial malleolus, which runs inferiorly and both anteriorly and posteriorly. It is often difficult to define the edges but tenderness (especially upon eversion of the calcaneus) may be due to sprain/rupture of the ligament.

Within the depression between the medial malleolus and the Achilles tendon posteriorly lie the following structures: tibialis posterior tendon, flexor digitorum longus tendon, posterior tibial artery and nerve, and flexor hallucis longus tendon (the order can be remembered with the mnemonic: **T**all **D**octors **A**re **N**ever **H**ungry).

Tibialis Posterior Tendon

This is the largest tendon behind the medial malleolus. It becomes more prominent with plantar flexion and inversion of the foot (Figure 7.17).

FIGURE 7.17. Tibialis posterior tendon *(black arrow)*. Tibialis anterior tendon *(white arrow)* is also visible.

Flexor Digitorum Longus Tendon

This is the next tendon to the tibialis posterior tendon. It becomes more easily palpable when applying resistance to the toes which you have asked the patient to flex. Movement of the tendon is felt if either side of the Achilles tendon is held between the thumb and index finger.

Note: In the case of synovitis of the tendons behind the medial malleolus, palpation may give a clue as to the origin of the pain. Apart from the tibialis posterior tendon, the other tendons are difficult to palpate.

Flexor Hallucis Longus

This has the lowest-lying muscle belly of the extrinsics. Notice that when the foot is held dorsiflexed, the range of dorsiflexion of great toe diminishes as the FHL muscle belly is forced into the tendon sheath where it is vulnerable to tendinitis (Thomasen's sign).

Posterior Tibial Artery

The pulse can usually be palpated by gentle pressure roughly half way between the posterior border of the medial malleolus and the Achilles tendon while the foot is relaxed. It can be difficult to find at times, but persevere before you conclude it is not palpable. It is the main blood supply of the foot. Its absence usually indicates arterial insufficiency.

Tibial Nerve

This lies behind the posterior tibial artery and follows its course to the foot. It divides into a calcaneal branch and the medial and lateral plantar nerves. Although it can be difficult to palpate as an isolated structure, its course has clinical significance; if entrapped behind the flexor retinaculum direct pressure over the nerve just behind the medial malleolus is produced and direct percussion over the nerve (Tinel's test) may be positive.

Tarsal Tunnel Syndrome

Causes
- Swelling and inflammation
- Ankle deformities
- Severe pes planus
- Valgus deformity of the heel
- Mass effect: lipoma, ganglion cyst, Varicosities

Sustentaculum Tali

This can be palpated one finger breath plantarward from the distal end of the medial malleolus. Spring ligament attaches to the Sustentaculum tali.

Lateral Plantar Nerve

Entrapment of the first branch of the LPN between the deep fascia of the abductor hallucis and quadratus plantae may lead to chronic heel pain on the medial side (Baxter's nerve syndrome). Pain can be elicited in the entrapped nerve by palpating about 2.5 cm below the medial malleolus over the proximal aspect of the abductor hallucis muscle belly (Figure 7.18).

FIGURE 7.18. Site of entrapment of lateral plantar nerve.

Medial Head of Talus

This can be easily palpated 1 cm distal to the anterior edge of the medial malleolus in line with the first metatarsal. Abduction and adduction of the forefoot make the gap between the talus and navicular palpable.

Medial Navicular Tubercle

This is distal to the head of the talus if palpated from proximal to distal. Abduction and adduction of the forefoot make the gap between the talus and navicular palpable.

Medial Plantar Nerve

Can be entrapped at master knot of Henry (where the flexor hallucis longus and flexor digitorum longus tendons cross over) giving rise to pain on the medial side of the arch (jogger's foot). Pain can be elicited from the entrapped nerve by palpating the region of Henry's knot (plantar to the 1st TMT joint) (Figure 7.19).

FIGURE 7.19. Site of entrapment of medial plantar nerve.

Head of the First Metatarsal

This forms the ball of the foot. It articulates distally with the phalanx of the great toe to form the metatarsophalangeal joint.
It is often painful in gout and bunions.
If the 1st metatarsal is traced proximally, the metatarsocuneiform (or 1st tarsometatarsal) joint can be palpated. Forward and backward movement of the joint makes palpation easier

Lateral Side

Lateral Malleolus

This forms the distal end of the fibula, and extends distal and lies posterior to the medial malleolus

Anterolateral Dome of Talus

Place your thumb over the anterior part of the lateral malleolus and then plantar flex the foot. You can feel the anterolateral portion of the talus move under your thumb.

Sinus Tarsi

Sinus tarsi is the space between the lateral talus and the calcaneus. It is situated one finger breath anterior to the tip of the lateral malleolus. Contraction of the extensor digitorum brevis can be felt if the patient extends his toes.

Anterior Inferior Tibiofibular Ligament

Run your finger about 1 cm above and medial to the lateral malleolus at the level of the ankle joint. The ligament cannot be felt as a distinct structure but it is often tender with injuries to the tibiofibular syndesmosis.

Anterior Talofibular Ligament

The ligament cannot be felt distinctly but tenderness is often elicited over the sinus tarsi, especially upon inversion of the foot.

Calcaneofibular Ligament

This runs from the tip of the lateral malleolus posteriorly to the lateral wall of the calcaneus. Again, it is not palpated as a distinct structure easily but it becomes tender in severe ankle sprain after rupture of the anterior talofibular ligament.

Posterior Talofibular Ligament

This is attached to the posterior edge of the lateral malleolus and passes posteriorly to the lateral tubercle on the posterior edge of the talus. Again, this ligament cannot be felt distinctly but tenderness especially upon inversion is due to the sprain or rupture.

Peroneus Longus and Brevis Tendons

These pass behind the lateral malleolus, the brevis tendon being closer to the bone. Peroneus longus passes plantar to the cuboid in the cuboid tunnel (where an os peroneal may be present) to insert in the plantar base of the first metatarsal. Peroneus brevis inserts into the base of the 5th metatarsal. Both tendons become more prominent upon resisted eversion of the foot. The tendons can dislocate anteriorly, which is palpable and, at times, audible.

5th Metatarsal Base and Head

Palpate the base of 5th metatarsal for tenderness. Trace the shaft of the 5th metatarsal distally. Inflammation of the bursa overlying the lateral aspect of the 5th metatarsal is called tailor’s bunion.

Sole of the Foot

Sesamoid Bones

Passively dorsiflex the big toe and press firmly on the first metatarsal. Sesamoid bones may not be felt distinctly, however tenderness may be evident.

- Causes of tenderness
  - Fracture
  - Sesamoiditis
  - Arthritis

Metatarsal Heads

Place your thumb over the plantar surface and your index finger over the dorsum of the metatarsal head. Movement of the each toe makes the palpation of the joint easier.

- Causes of tenderness
  - Sinovitis → instability
  - Inflammatory conditions
  - Dorsal subluxation/dislocation
  - Freiberg's disease → tenderness of the second metatarsal head is most common

Morton's Neuroma

Pain from Morton's neuroma is in the **plantar forefoot**. The neuroma is most commonly located between the 3rd and 4th metatarsal heads (80% to 90%) or 2nd and 3rd metatarsal heads. The pain is often worsened by footwear and relieved by removing the shoe. Other symptoms include numbness or paresthesia in the toe(s) and the sensation that the patient is walking on a pebble or crumpled sock. Tenderness to compression (Mulder's sign) in the second or third web space can be due to a painful neuroma.

Plantar Fascia

Feel the plantar fascia, which is a tough structure extending from metatarsal heads to the calcaneal tuberosity. Dorsiflexion of the big toe makes the medial band of the fascia taut and easier to palpate. Pain at its insertion to the calcaneal tuberosity can be associated with plantar fasciitis.

FIGURE 7.20. Nodules over the plantar fascia.

Nodule on the sole of the foot may be due to benign fibromatosis (Figure 7.20)

Heel

The Achilles' tendon inserts to the posterior tuberosity of the calcaneus.

Subcutaneous (Pre-Achilles) Bursa

This lies between overlying skin and the insertion of the Achilles tendon. Pinch and lift the skin at the insertion and the bursa is between your fingers. Inflammation of this bursa is one of the causes of pain in this area.

Retrocalcaneal Bursa

The retrocalcaneal bursa is situated between the posterior tuberosity of the calcaneus and the anterior surface of the Achilles tendon. Tenderness over the insertion as well as on both sides of the Achilles tendon may be due to bursitis.

If pain is elicited only at the insertion, insertional tendinosis of the Achilles tendon may be the cause. Note: often tendinosis and bursitis coexist.

Haglund's Deformity

This is a prominence over the dorsoposterior calcaneal tuberosity (Figure 7.21) that can lead to retrocalcaneal bursitis with rubbing against the heel counter of a shoe.

FIGURE 7.21. Haglund's deformity.

Range of Movement

With the patient standing facing you, ask him to stand on tiptoes (Figure 7.22), on the heel (Figure 7.23), on the outer (Figure 7.24), and then on the inner border of the foot (Figure 7.25) and compare the range of movement with the other side. This is active range of movement.

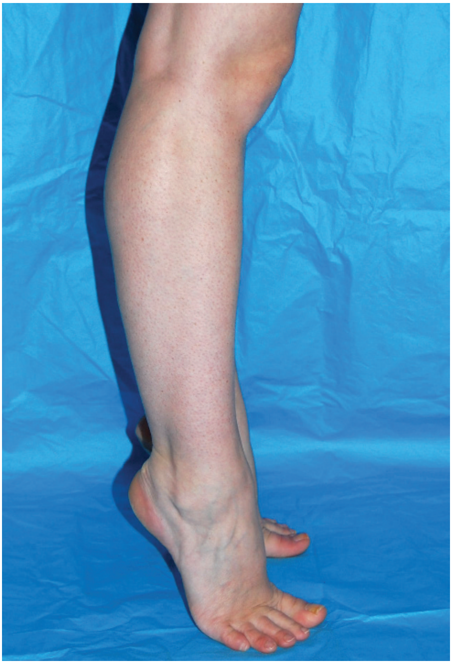


FIGURE 7.22. Active plantarflexion.

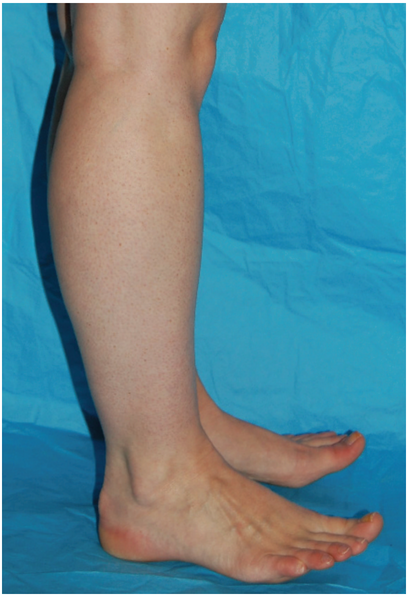


FIGURE 7.23. Active dorsiflexion.

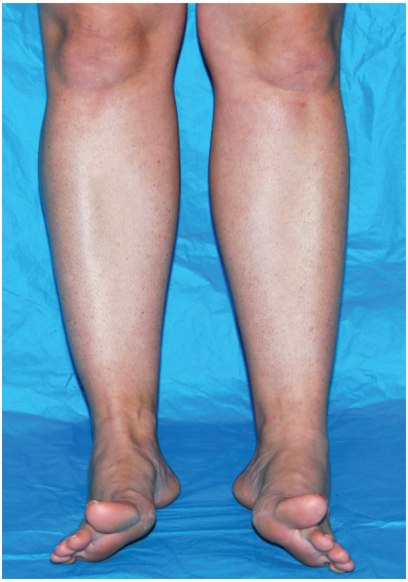


FIGURE 7.24. Active inversion.

FIGURE 7.25. Active eversion.

With the patient sitting on the examination table, check the passive range of movement:

Dorsiflexion and plantar flexion occur at the ankle joint primarily and the subtalar joint secondarily.

Inversion and eversion occur at the subtalar joint, talonavicular joint, and calcaneocuboid joint.

Abduction and adduction occur at the transverse-tarsal joints (Talonavicular and calcaneocuboid).

Dorsiflexion

Hold the heel in the neutral position and the forefoot in inversion and dorsiflex the foot to the maximum degree (Figure 7.26)

- Normal dorsiflexion: 20°
- Causes of reduction of dorsiflexion
  - Contracture of posterior structures:
  - Gastrocnemius
  - Soleus
  - Impingement
    - Osteophytes over the anterior rim of the tibia/ neck of talus
    - Inflamed synovium or other soft tissue

FIGURE 7.26. Passive dorsiflexion.

Injury to tibiofibular syndesmosis
Prolonged immobilization in equinus
Ankle sprain/fracture

Note: To differentiate between contractures of the gastrocnemius and soleus, repeat dorsiflexion of the ankle with the knee in full extension and with the knee in 90° of flexion.

With gastrocnemius contractures→more dorsiflexion of the ankle is possible with the knee in flexion

With soleus contractures→the position of the knee does not affect the amount of dorsiflexion

Plantar Flexion

Hold the heel in the neutral position and the forefoot in inversion and plantar flex the foot to the maximum degree (Figure 7.27).

Normal plantar flexion is 50°.
Causes of reduced plantarflexion
Contracture of the anterior capsule
Following ankle fracture/trauma
Posterior impingement
Ankle instability
os trigonum

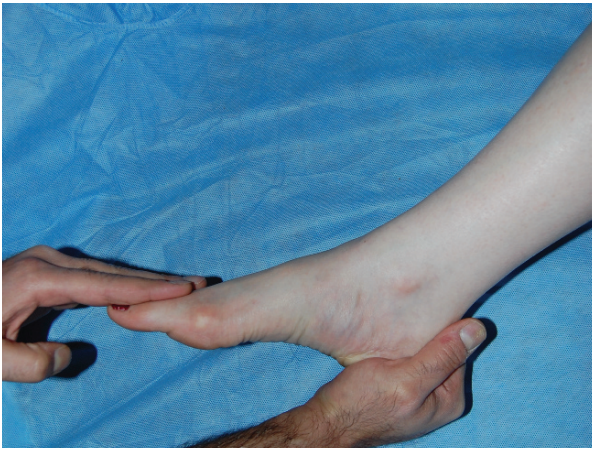


FIGURE 7.27. Passive plantarflexion.

Abduction and Adduction of Forefoot

Hold the midfoot with one hand and move the forefoot medially and laterally (Figures 7.28 and 7.29). 5° of movement in each direction is normal.

FIGURE 7.28. Adduction of the forefoot.

FIGURE 7.29. Abduction of the forefoot.

Great toe

Metatarsophalangeal joint: The examiner holds the foot with one hand and with the other hand passively dorsiflex and plantar flexes the big toe (Figures 7.30 and 7.31).

Normal range:

Dorsiflexion 70°

Plantarflexion 40°

FIGURE 7.30. Dorsiflexion of the big toe.

FIGURE 7.31. Plantarflexion of the big toe.

Hallux Rigidus

Degenerative arthritis of the 1st MTP joint usually produces a dorsal and/or lateral osteophytes which limits the movements. Hallux limitus implies loss of motion of the 1st MTP joint without arthritic change.

Interphalangeal Joint

The examiner holds the proximal phalanx of the big toe with one hand and then move the distal phalanx with the other hand.

Normal range:

Dorsiflexion 0° (to neutral)

Plantarflexion 90°

Lesser Toes

The range of movement is measured in the similar way used in the big toe.

Normal range:

	Dorsiflexion	Plantar flexion
MTPJ	40°	40°
PIPJ	0°	30°
DIPJ	30°	60°

Muscle Testing: Quick Functional Tests

Ask patients to walk on their:

Heels → dorsiflexor: tibialis anterior muscle

Tip toes → plantar flexors: gastrocnemius and soleus complex

Lateral border → foot invertors: tibialis posterior

Medial border → foot evertors: peronei

Individual muscle testing

Ankle dorsiflexors

Tibialis anterior

Extensor Hallucis Longus

Extensor Digitorum Longus

With the patient is in a sitting position

Tibialis anterior (Deep peroneal nerve L4)

Hold the heel. Put the foot in inversion and dorsiflexion and ask the patient to maintain this position. Then try to evert and plantar flex the foot by applying pressure over the first metatarsal head and shaft (Figure 7.32). If the muscle is profoundly weak, you must feel for muscle contracture.

Causes of weakness

- Lumbar radiculopathy (L4)
- Poliomyelitis
- Common peroneal nerve palsy
- Deep peroneal nerve palsy
- Laceration of the tendon

FIGURE 7.32. Tibialis anterior. The tendon is visible at the ankle joint *(arrow)*.

Extensor Hallucis Longus (Deep peroneal nerve L5)

Hold the heel. Ask the patient to dorsiflex the big toe and maintain this position while the examiner applies opposite force by placing a finger on the nail and trying to plantar flex the big toe (Figure 7.33)

To assess the extensor hallucis brevis as well as EHL, place you finger proximal to the interphalangeal joint and apply opposing force to extension (Figure 7.34).

FIGURE 7.33. Assessment of Extensor hallucis longus.

FIGURE 7.34. Assessment extensor hallucis brevis and EHL.

Causes of weakness
- Lumbar radiculopathy (L5)
- Common peroneal nerve palsy
- Deep peroneal nerve palsy
- Laceration of the tendon
- Poliomyelitis

Extensor digitorum longus (Deep peroneal nerve L5)

Hold the heel. Ask the patent to dorsiflex the toe and maintain this position while the examiner applies opposite force by placing his fingers on the toes and trying to plantar flex them (Figure 7.35). The contracture of Extensor Digitorum Brevis, which is active along with the EDL, can be felt in the sinus tarsi.

Causes of weakness
- Lumbar radiculopathy (L5)
- Common peroneal nerve palsy
- Deep peroneal nerve palsy
- Laceration of the tendon
- Poliomyelitis

Plantar flexors
- Gastrocnemius complex
- Flexor hallucis longus
- Flexor digitorum longus

Gastrocnemius complex (tibial nerve S1)

Hold the heel. Ask the patient to plantar flex the ankle and maintain this position while the examiner applies opposite force to the metatarsal heads and tries to dorsiflex the ankle.

FIGURE 7.35. Assessment of extensor digitorum longus.

Causes of weakness
Lumbar radiculopathy (S1)
Sciatic nerve palsy
Tibial nerve injury

Flexor hallucis longus (tibial nerve L4 through S3) and flexor digitorum longus (tibial nerve L4 through S3)

These two muscles are tested together, due to tendinous cross-connections.

Hold the heel. Ask the patient to curl up the toes and maintain this position while the examiner tries to dorsiflex the toes with his fingers.

Causes of weakness
Lumbar radiculopathy (S1)
Sciatic nerve palsy
Tibial nerve injury

Invertors of the foot
Tibialis posterior
Tibialis anterior
Flexor digitorum longus
Flexor hallucis longus

Tibialis posterior (Tibial nerve L5)

Hold the heel. Ask the patient to plantar flex and invert the foot as much as possible and maintain this position. Apply eversion force to the medial side of the first metatarsal (Figure 7.36). With the thumb of the other hand, the tendon should be palpated behind the medial malleolus.

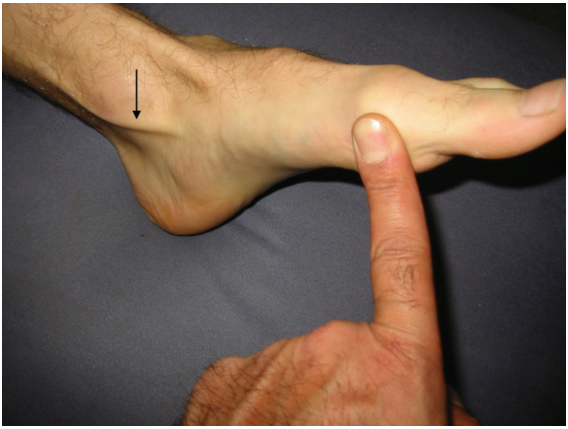


FIGURE 7.36. Tibialis posterior tendon *(arrow)*.

Alternatively, stand behind the patient and ask him to stand on tip toes (offer support to maintain the balance) and observe the calcaneus. With normal tibialis posterior function and subtalar joint, the calcaneus should invert as the patient stands on his tiptoes (Figures 7.37 and 7.38).

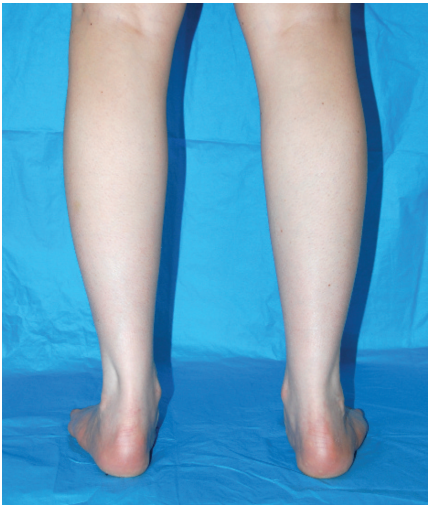


FIGURE 7.37. Assessment of tibialis posterior tendon. See text.

FIGURE 7.38. Assessment of tibialis posterior. See text.

Causes of weakness
Tendinitis
Rupture
The other muscles have been already covered in this chapter.

Evertors of the Foot

Peroneus brevis (superficial peroneal nerve S1) and peroneus Longus (superficial peroneal nerve S1)

These two muscles are tested together.

Hold the heel. Ask the patient to plantar flex and evert the foot as much as possible and maintain this position. Apply inversion force to the base and lateral border of the 5th metatarsal (Figure 7.39). With the thumb of the other hand, the tendon should be palpated behind the lateral malleolus.

Caused of weakness
Lumbar radiculopathy L5
Injury to superficial peroneal nerve

FIGURE 7.39. Assessment of peroneus longus and peroneus brevis.

Muscle Wasting

Check the leg circumference. In the supine position, mark a point 25 cm above the medial malleolus on both legs and measure the circumference of the legs at this point with a measuring tape.

Sensation

The sensory distribution of the foot and ankle and lower leg should be tested.

L4 dermatome: Medial side of the foot, medial malleolus and medial side of the leg and medial side of the knee
L5 dermatome: dorsum of the foot, lateral side of the leg
S1 dermatome: Lateral side of the foot and lateral malleolus
The peripheral distributions are as follows (Figure 7.40):

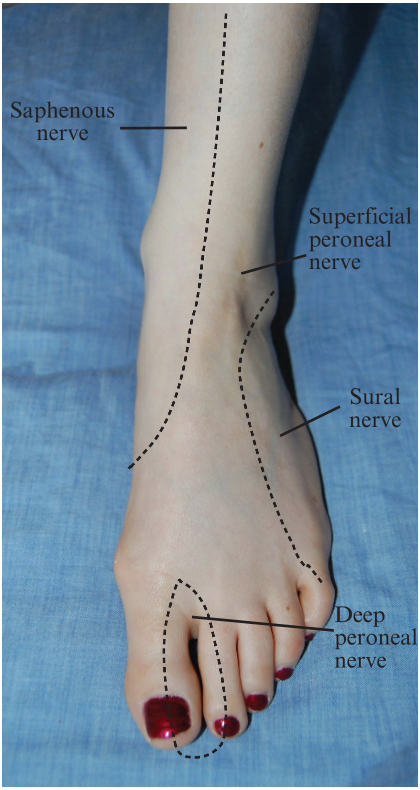


FIGURE 7.40. Sensory distribution of the foot.

Saphenous nerve: medial side of the foot, medial malleolus and medial side of the leg and medial side of the knee
Superficial peroneal nerve: dorsum of the foot (Except the first web space, which is supplied by the deep peroneal nerve)
Sural nerve: lateral side of the foot and lateral malleolus

Reflexes

Achilles Tendon Reflex (S1)
Dorsiflex the ankle passively and then tap the tendon gently with the neurological hammer. Sudden involuntary plantar flexion of the foot is taken as positive.

Another method is to dorsiflex the ankle with your fingers placed on the metatarsal region on the sole of the patient's foot. Then tap with your own finger (Figure 7.41). It induces the same response with a normal tendon reflex.

FIGURE 7.41. Ankle reflex.

Special Tests

Anterior Drawer Test

Patient sitting on the edge of the table with the foot relaxed. Hold the heel while the other hand stabilizes the leg just above the ankle joint. Dorsiflex and planter flex the ankle to make sure the ankle joint is relaxed. Then pull the heel forward and feel the amount of translation (Figure 7.42). If the difference between anterior translation of the normal and the injured side is more than 5 mm, the anterior talofibular ligament is likely to be injured.

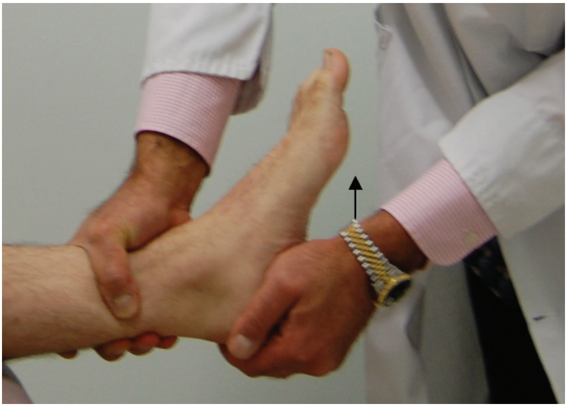


FIGURE 7.42. Anterior drawer test. *Arrow* shows the direction of force.

Jack Test

This is a test to differentiate between a flexible and rigid flat foot.

While the patient is standing, note the medial arch. Dorsiflex the big toe (Figure 7.43) and note if there is any difference in the height of the medial arch:

In flexible flatfoot, dorsiflexion of the big toe results in reconstitution of the medial arch.

In rigid flat foot dorsiflexion of the big toe does not have any effect on the height of medial arch.

FIGURE 7.43. Jack test.

Thompson's Test

This is a test to confirm the diagnosis of Achilles tendon rupture.

Patient in prone position with the feet off the end of the table or kneeling on a chair with the feet off the end of the chair (Figure 7.44). Then squeeze the calf on the normal side and note the amount of plantar flexion. The absence of plantar flexion on the injured side indicates a rupture of the Achilles tendon. A palpable gap is often felt about 5 cm above the insertion of the Achilles tendon.

FIGURE 7.44. Thompson's test.

Drawer Test of Lesser MTP Joints

This test is performed to examine for instability of the lesser MTP joints; an often-overlooked cause of forefoot pain. Place the thumb and index finger, dorsal and plantar respectively, over the metatarsal neck. Then grip the proximal phalanx in similar fashion with the opposite hand. Translate the proximal phalanx dorsally, while stabilizing the metatarsal with the other hand. Comparisons with other MTP joints on the same and opposite foot are helpful. Pain associated with laxity that reproduces the patient's symptoms is likely to be secondary to instability.

Squeeze Test

A test for distal ankle syndesmosis injury. Squeeze the tibia and the fibula together at the midshaft. If pain is reproduced at the level of the distal ankle syndesmosis, then injury is suspected

External Rotation Test

A test for distal ankle syndesmosis injury. The examiner stabilizes the leg with the knee flexed at 90 degrees, while externally rotating the foot. If pain is reproduced at the level of the distal ankle syndesmosis, then injury is suspected. It is found to have the highest inter-rater correlation.

Mulder's Sign

This is a test for painful Morton's neuroma. Grasp the forefoot just behind the head of the 1st and 5th metatarsals and place the index finger and thumb of the opposite hand dorsal and plantar to the web space respectively (as if to pinch it) Then, compress the forefoot with modest force (Figures 7.45 and 7.46). A palpable and, at times, an audible "click" may be elicited (Mulder's "click").

FIGURE 7.45. Mulder's sign. First step.

FIGURE 7.46. Mulder's sign. Final step.

Index