THE RADIOULNAR JOINT

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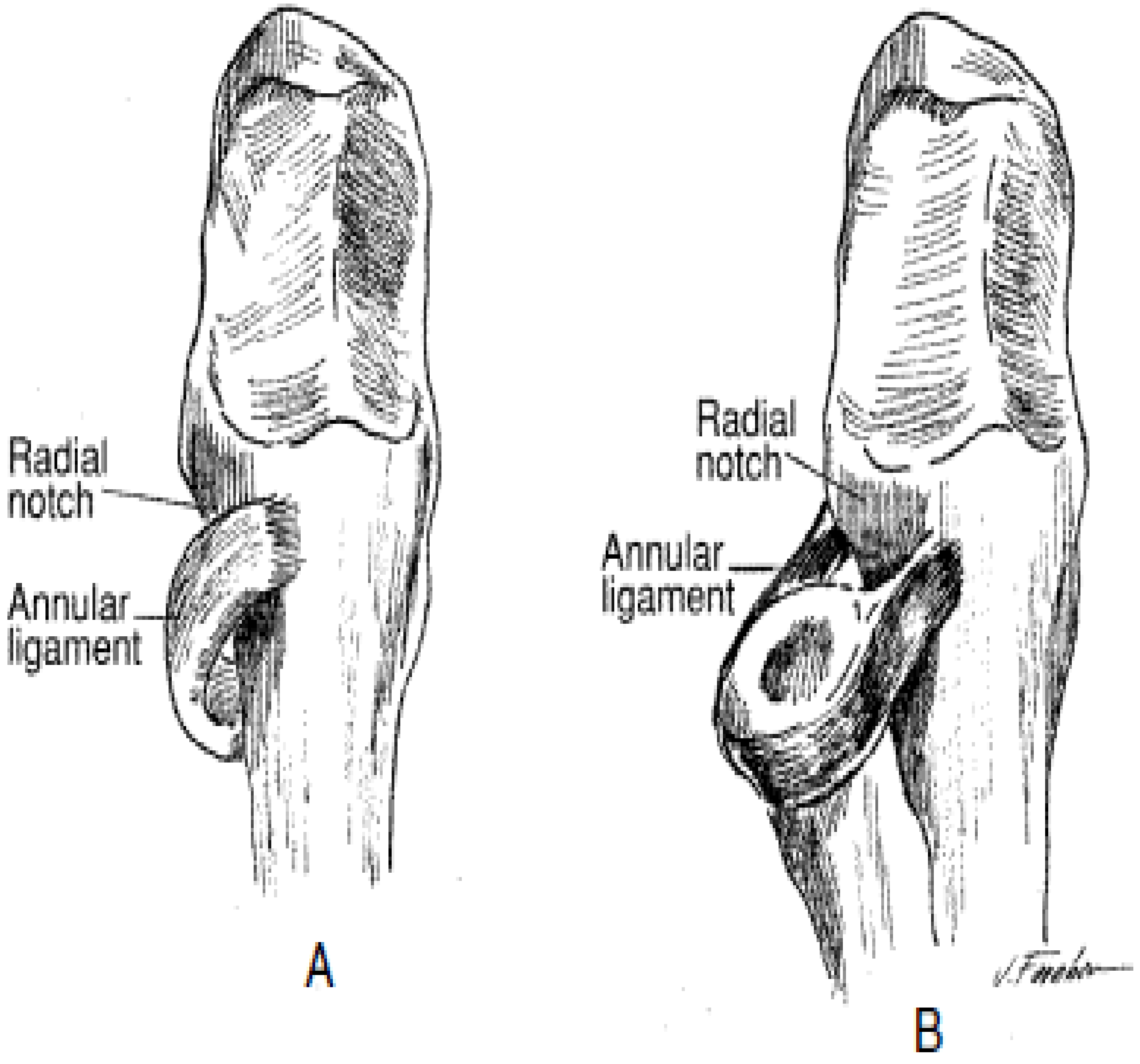
PROXIMAL (SUPERIOR) RADIOULNAR JOINT

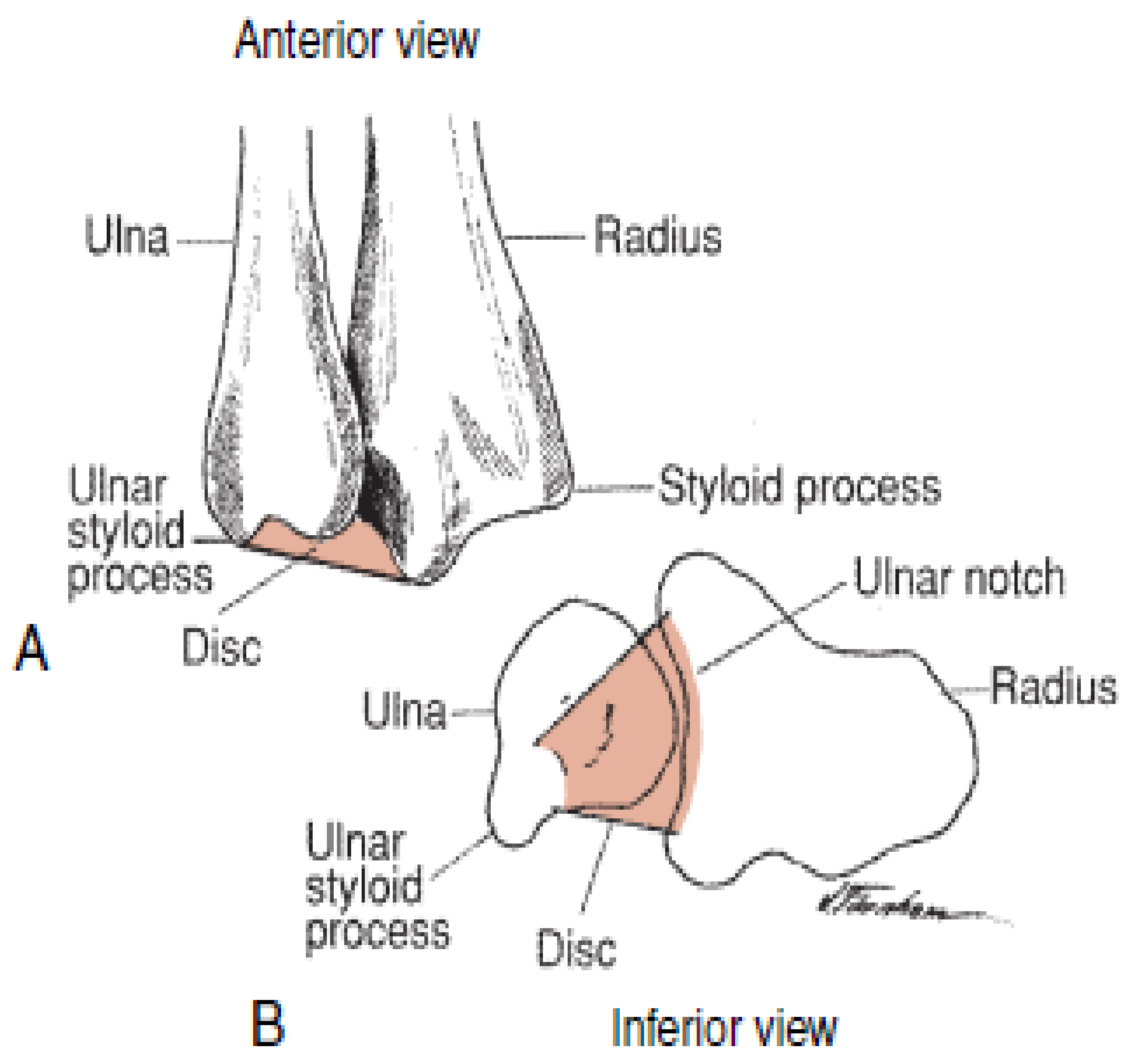
- The articulating surfaces of the proximal radioulnar joint include the ulnar radial notch, the annular ligament, head of the radius, and the humeral capitulum.
- The **ulnar radial notch** is located on the lateral aspect of the proximal ulna directly below the trochlear notch.

- The surface of the radial notch is concave and covered with articular cartilage.
- A circular ligament called the **annular ligament** is attached to the anterior and posterior edges of the notch.
- The annular ligament encircles the rim of the radial head, which is also covered with articular cartilage.



DISTAL (INFERIOR) RADIOULNAR JOINT

- The articulating surfaces of the distal radioulnar joint include the ulnar notch of the radius, the articular disc, and the head of the ulna.
- The **ulnar notch of the radius** is located at the distal end of the radius along the interosseous border.



- The base of the articular disc is attached to the distal edge of the ulnar notch of the radius.
- The apex of the articular disc has two attachments. One attachment is to the fovea on the ulnar head. The other is to the base of the ulnar styloid process.

ARTICULATIONS

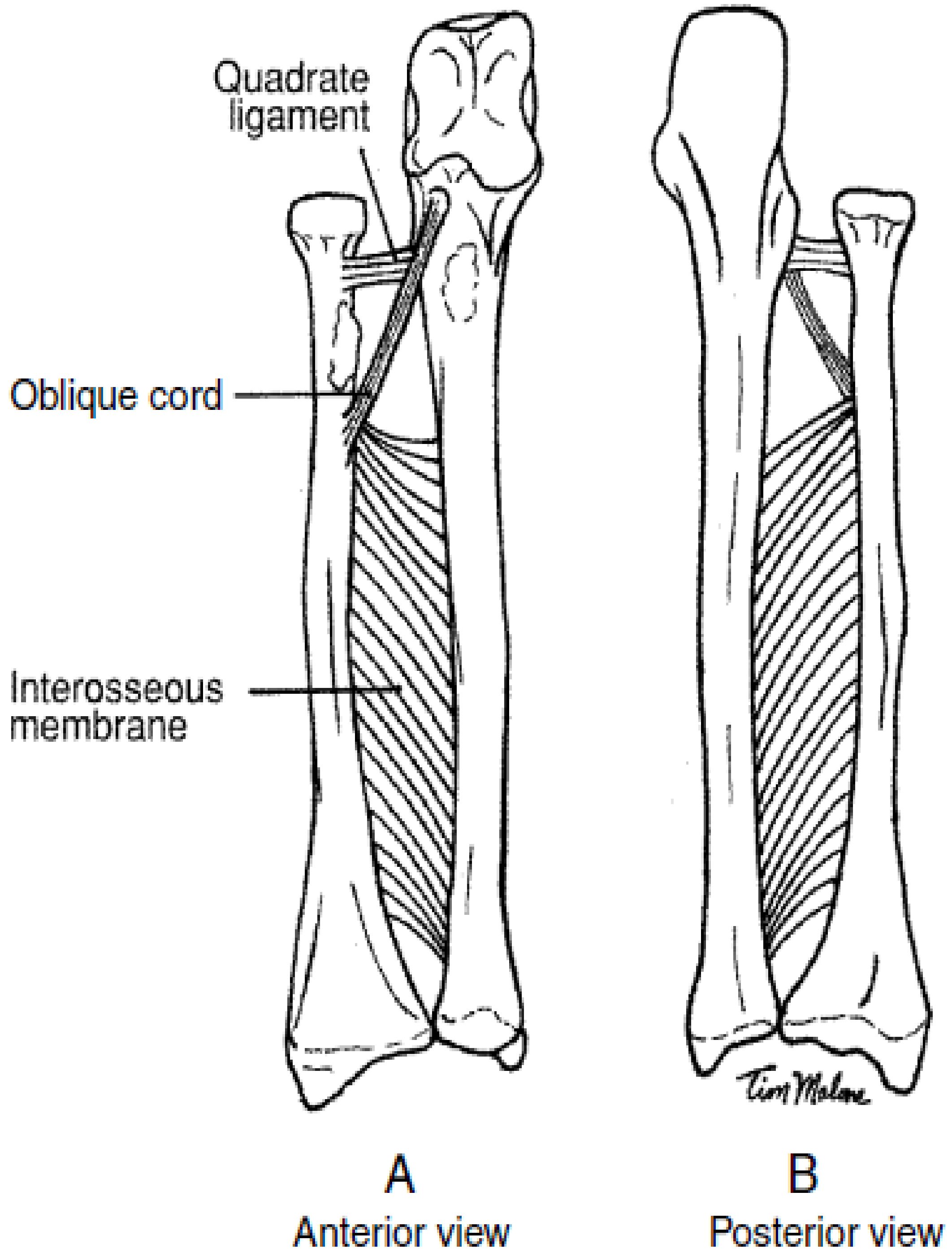
- The proximal and distal radioulnar joints are mechanically linked; therefore, motion at one joint is always accompanied by motion at the other joint.
- The distal radioulnar joint is also considered to be functionally linked to the wrist in that compressive loads are transmitted through the distal radioulnar joint from the hand to the radius and ulna.
- Pronation of the forearm occurs as a result of the radius's crossing over the ulna at the superior radioulnar joint.

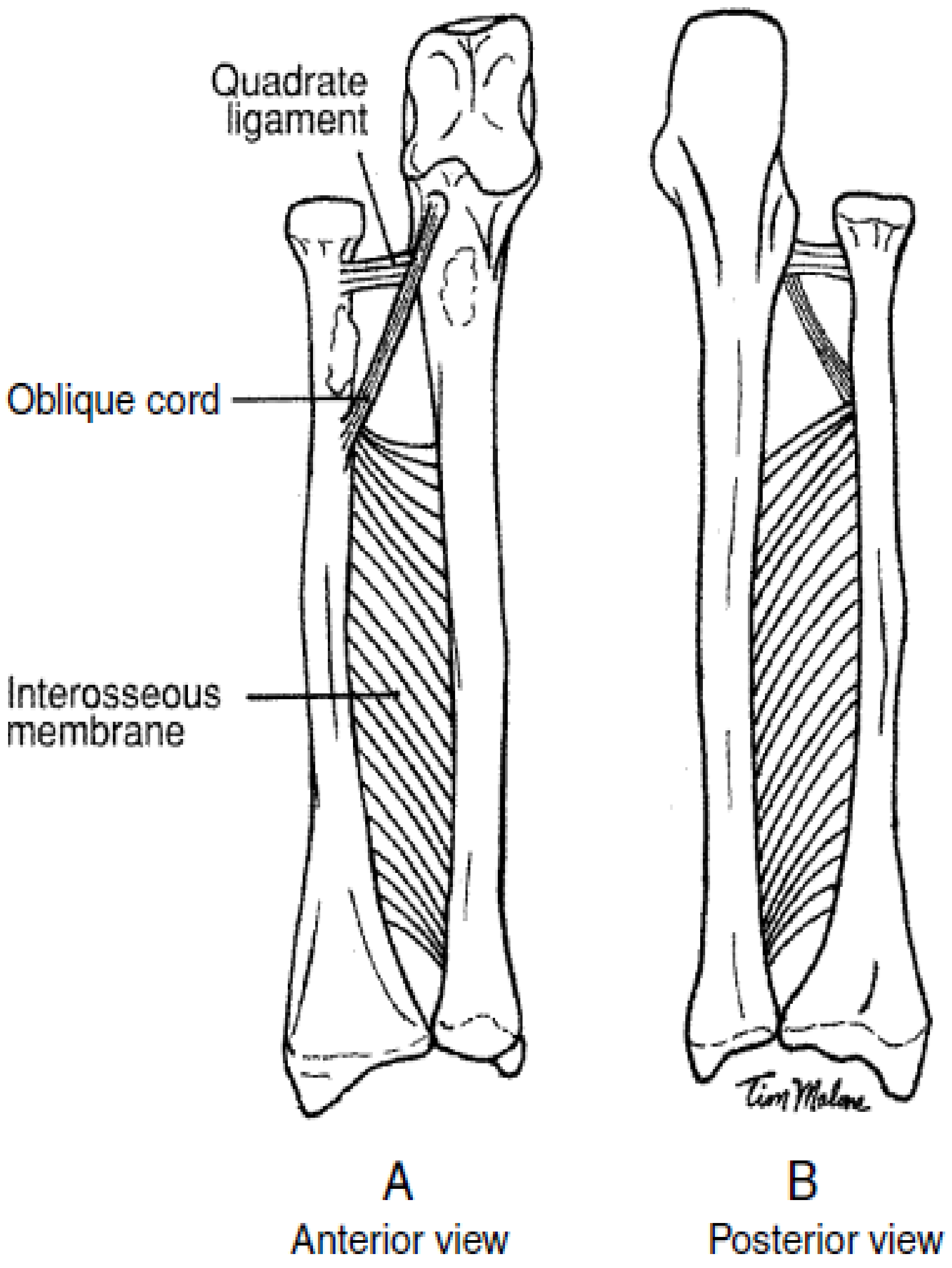
- During pronation and supination, the rim of the head of the radius spins within the osteoligamentous enclosure formed by the radial notch and the annular ligament.
- At the same time, the surface of the head spins on the capitulum of the humerus.
- At the distal radioulnar joint, the concave surface of the ulnar notch of the radius slides around the ulnar head.

LIGAMENTS

- The three ligaments associated specifically with the proximal radioulnar joint are **the annular and quadrate ligaments and the oblique cord.**
- The **annular ligament** is a strong band that forms four fifths of a ring that encircles the radial head.
- The inner surface of the ligament is covered with cartilage and serves as a joint surface. The proximal border of the annular ligament blends with the joint capsule, and the lateral aspect is reinforced by fibers from the lateral collateral ligament.

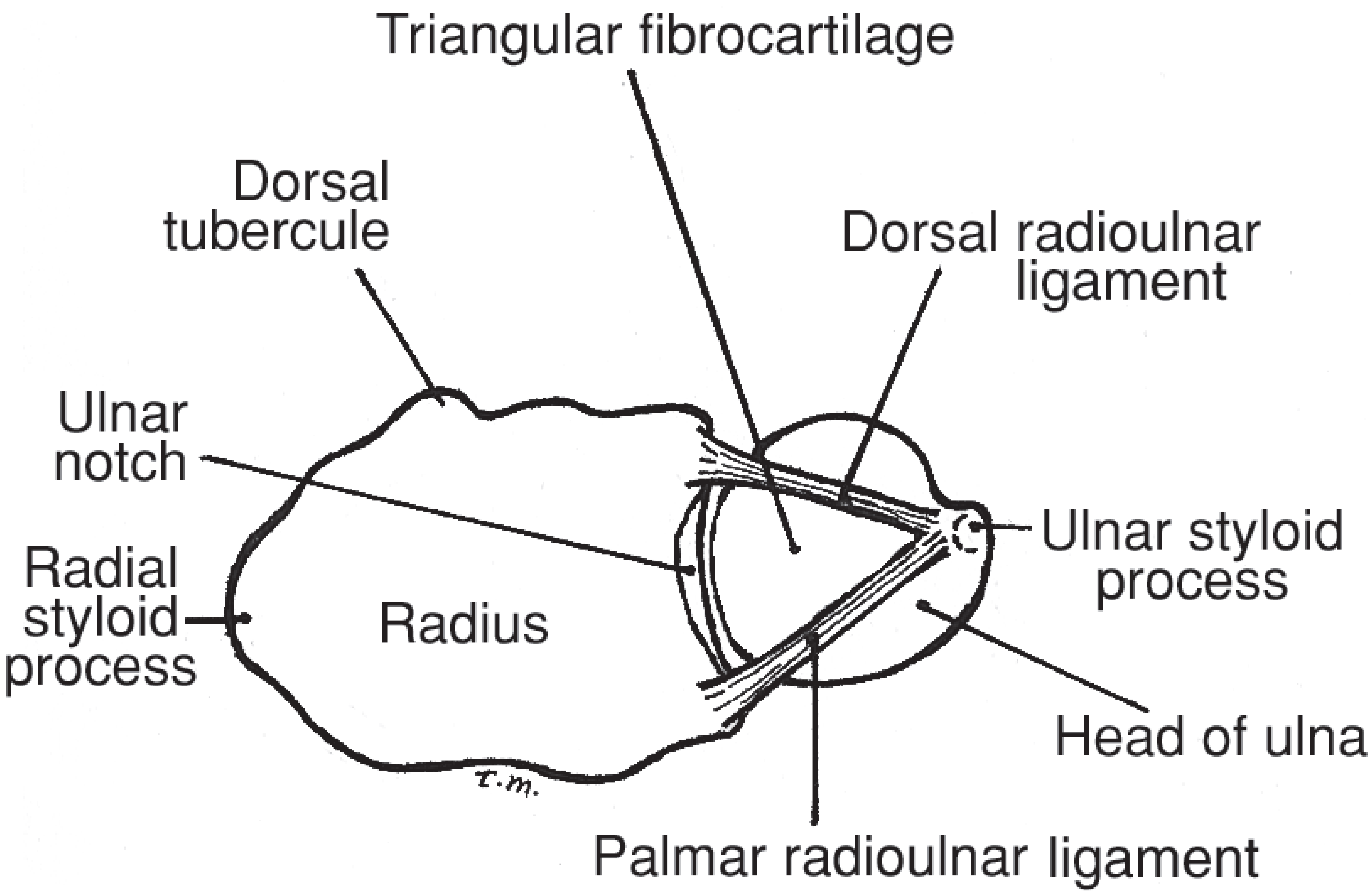
- The **quadrate ligament** extends from the inferior edge of the ulna's radial notch to insert in the neck of the radius.
- The quadrate ligament reinforces the inferior aspect of the joint capsule and helps maintain the radial head in apposition to the radial notch.
- The quadrate ligament also limits the spin of the radial head in supination and pronation.



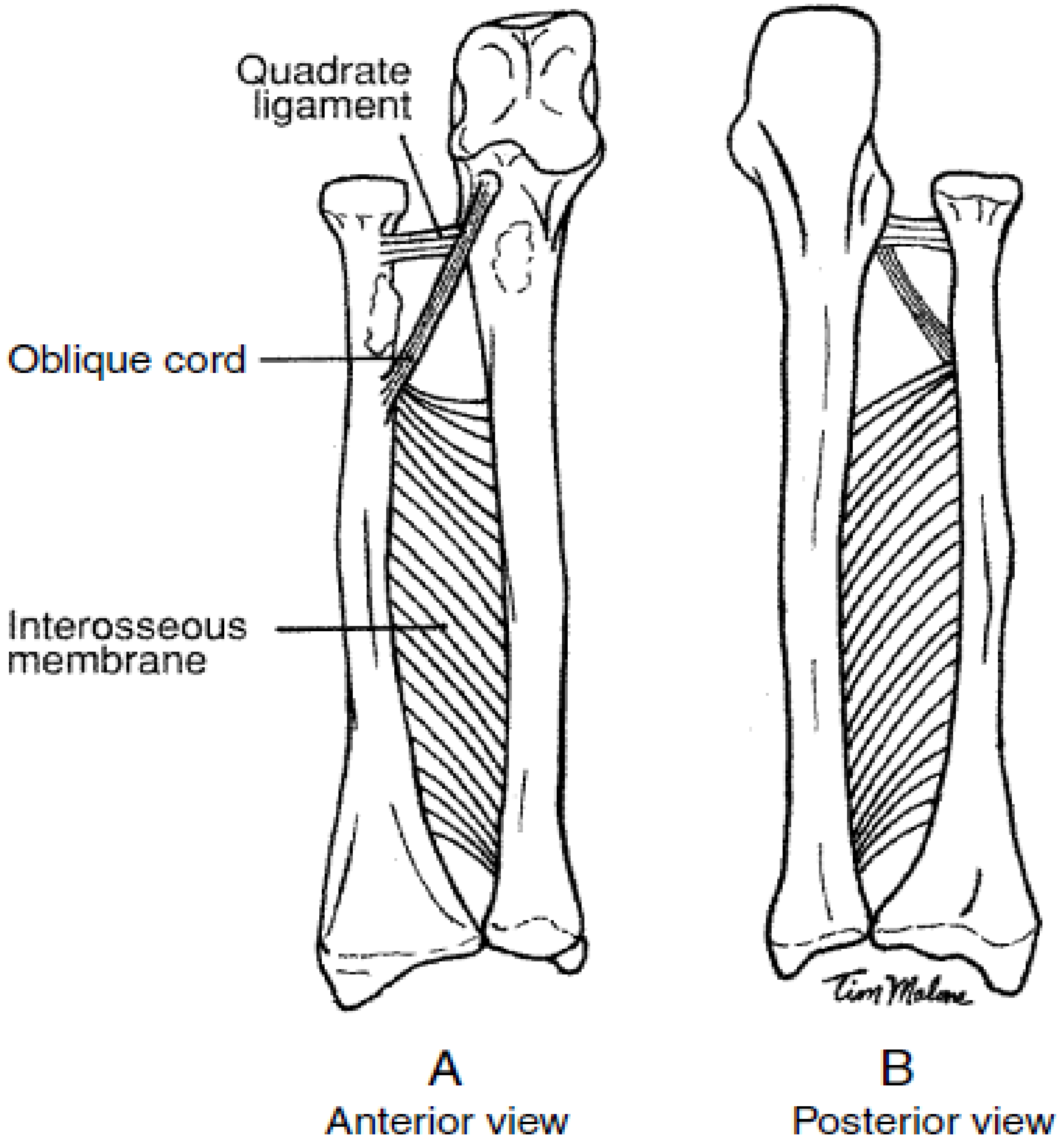


- The **oblique cord** is a flat fascial band on the ventral forearm that extends from an attachment just inferior to the radial notch on the ulna to insert just below the bicipital tuberosity on the radius.
- The fibers of the oblique cord are at right angles to the fibers of the interosseous membrane.
- It may assist in preventing separation of the radius and ulna.

- The **dorsal** and **palmar radioulnar ligaments,** as well as the interosseous membrane, reinforce the distal radioulnar joint.
- The dorsal and palmar ligaments are formed by longitudinally oriented collagen fiber bundles originating from the dorsal and palmar aspects of the ulnar notch of the radius.
- The two ligaments extend along the margins of the articular disc to insert on the ulnar fovea and base of ulnar styloid process.


Triangular fibrocartilage
Dorsal tubercule
Dorsal radioulnar ligament
Ulnar notch
Ulnar styloid process
Radial styloid process
Radius
Head of ulna
Palmar radioulnar ligament

- The **interosseous membrane**, which is located between the radius and the ulna, is a complex structure consisting of the following three components: a central band, a thin membranous portion, and a dorsal oblique cord.



- The **interosseous membrane** maintains space between the radius and ulna during forearm rotation.
- The interosseous membrane protects the proximal radioulnar joint by transferring some of the compressive loads at the distal radius to the proximal ulna.
- The interosseous membrane maintains transverse stability of the forearm during compressive load transfer from the hand to the elbow.

MUSCLES

- The primary muscles associated with the radioulnar joints are the **pronator teres, pronator quadratus, biceps brachii, and supinator.**
- The **pronator teres** has two heads: a humeral head and an ulnar head. The humeral head comes from the common flexor tendon on the medial epicondyle of the humerus.
- The smaller ulnar head arises from the medial aspect of the coronoid process of the ulna. Both heads attach distally to the surface of the lateral side of the radius at its greatest convexity.

- The **pronator quadratus**, which is located at the distal end of the forearm, also has two heads (superficial and deep).
- Both of these heads arise from the ulna and cross the interosseous membrane anteriorly to insert on the radius.
- The fibers of the superficial head pass transversely across the interosseous membrane, whereas the fibers of the deep head extend obliquely across the interosseous membrane to insert on the radius.

- The **supinator** is a short, broad muscle that arises from the lateral epicondyle of the humerus, the radial collateral ligament, the annular ligament, and the lateral aspect of the ulna.
- The muscle crosses the posterior aspect of the interosseous membrane to insert into the radius just medial and inferior to the bicipital tuberosity.
- The anconeus muscle may also play a role in supination and pronation.

FUNCTION: RADIOULNAR JOINTS

AXIS OF MOTION:

- The axis of motion for pronation and supination is a longitudinal axis extending from the center of the radial head to the center of the ulnar head.
- In supination, the radius and ulna lie parallel to one another, whereas in pronation, the radius crosses over the ulna.
- The ulnar head moves distally and dorsally in pronation and proximally and medially in supination.

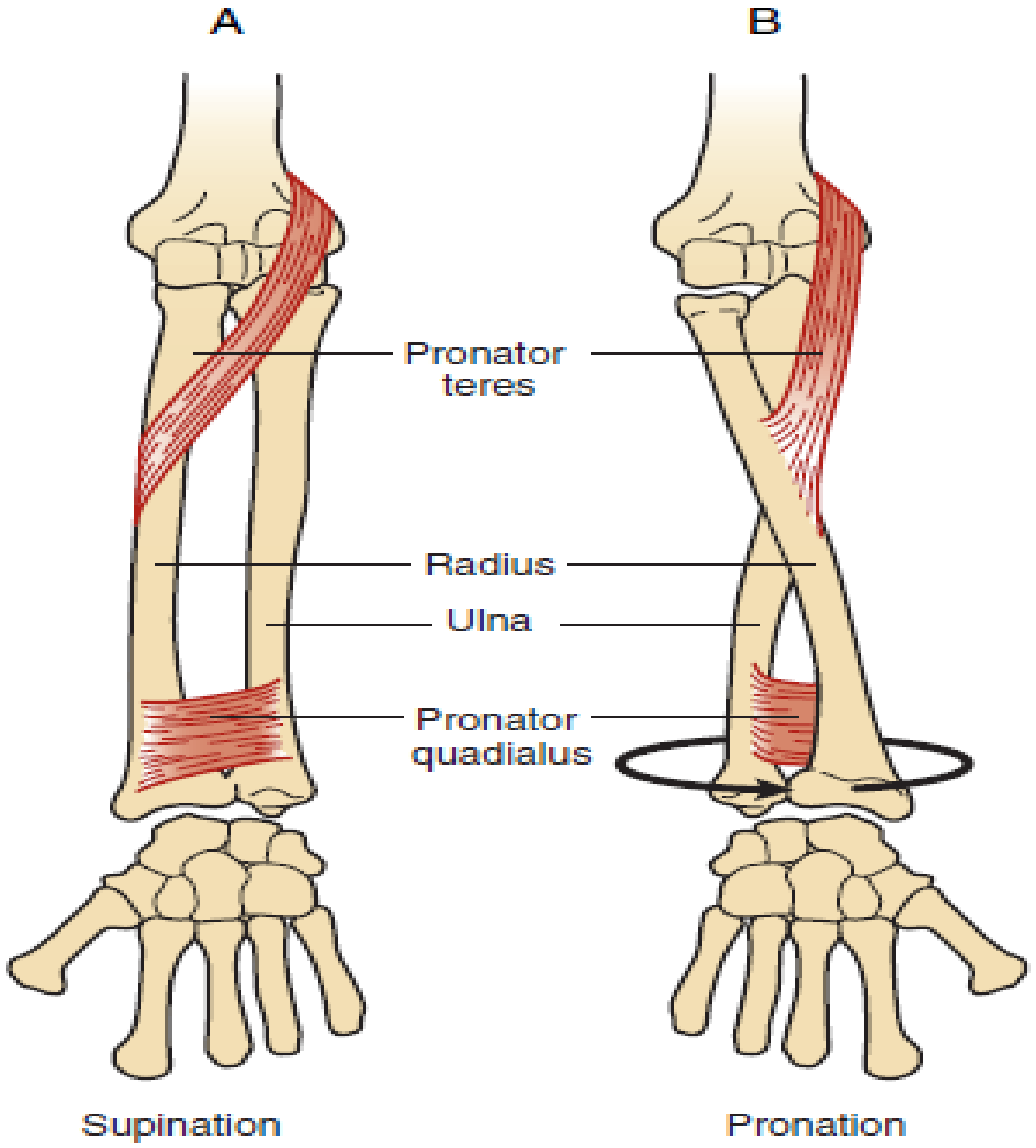
RANGE OF MOTION:

- A total range of motion of 150° has been ascribed to the radioulnar joints.
- The range of motion of pronation and supination is assessed with the elbow held against the trunk in 90° of flexion.
- This position of the elbow stabilizes the humerus so that radioulnar joint rotation may be distinguished from rotation that is occurring at the shoulder joint.

- When the elbow is fully extended, active supination and pronation occur in conjunction with shoulder rotation.
- Limitation of pronation when the elbow is extended may be caused by passive tension in the biceps brachii.
- Supination is limited by passive tension in the palmar radioulnar ligament and the oblique cord.

MUSCLE ACTION

- The pronators produce pronation by exerting a pull on the radius, which causes its shaft and distal end to turn over the ulna.
- The pronator teres has its major action at the radioulnar joints, but the long head, as a two-joint muscle, plays a slight role in elbow flexion.



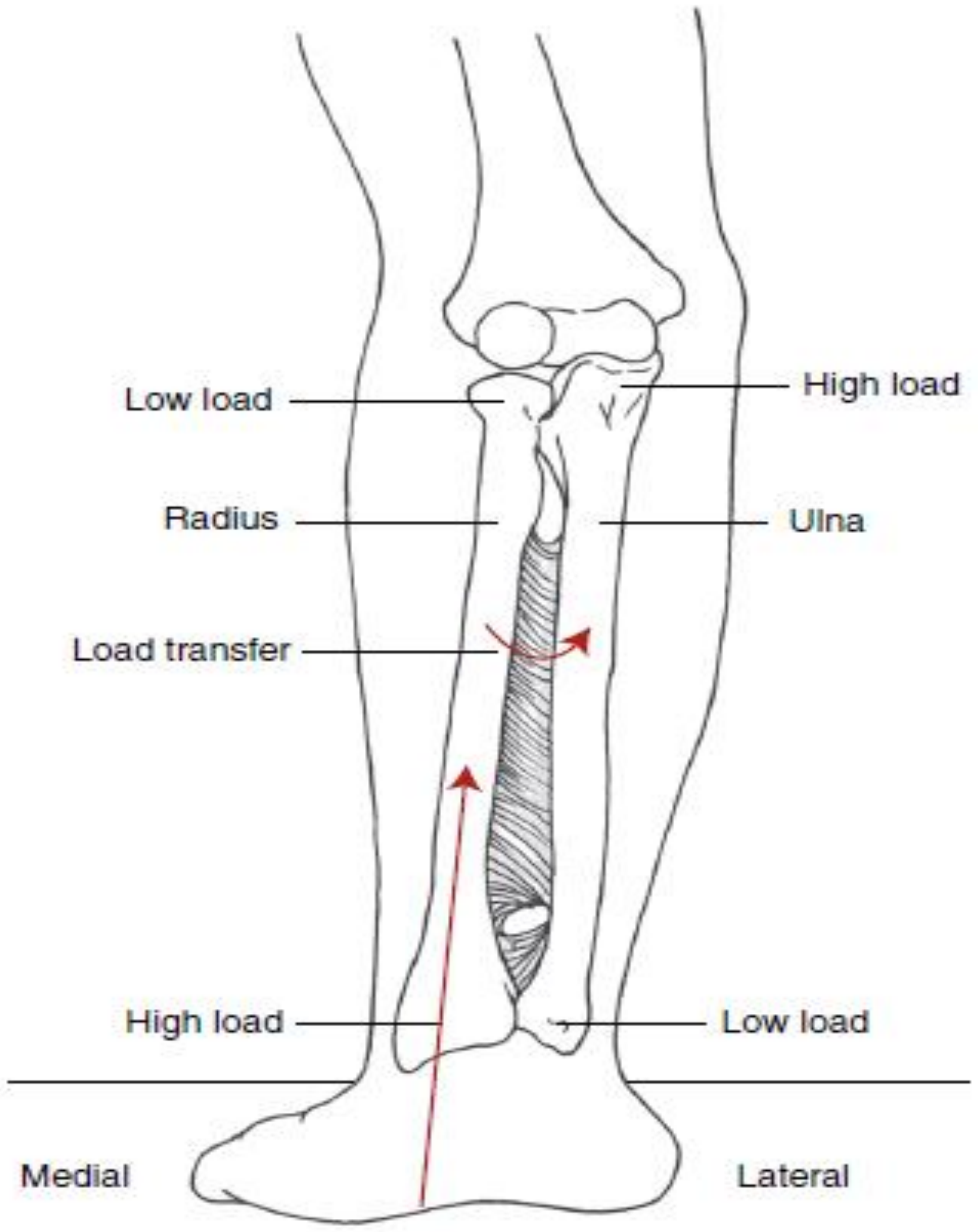
- The pronator quadratus, a one-joint muscle, is unaffected by changing positions at the elbow.
- The pronator quadratus is active in unresisted and resisted pronation and in slow and fast pronation.
- The deep head of the pronator quadratus is active during both resisted supination and resisted pronation and is thought to act as a dynamic stabilizer to maintain compression of the distal radioulnar joint.

- The supinator muscle may act alone during unresisted slow supination in all positions of the elbow or forearm.
- It can also act alone during unresisted fast supination when the elbow is extended.
- However, activity of the biceps is always evident when supination is performed against resistance and during fast supination when the elbow is flexed to 90°.

STABILITY

- Muscular support of the distal radioulnar joint is attributed to the pronator quadratus and the extensor carpi ulnaris tendon.
- The deep head of the pronator quadratus is active throughout supination and pronation and therefore is thought to provide dynamic stabilization for the distal radioulnar joint.
- Activity in the extensor carpi ulnaris muscle exerts a depressive force on the dorsal aspect of the ulnar head as the tendon is stretched over the head during supination.

- Tension in the tendon helps to maintain the position of the ulnar head during both supination and pronation.
- Non-muscular support of the distal radioulnar joint is provided by the dorsal and palmar radioulnar ligaments, the interosseous membrane and its tract, and the articular disc.
- The dorsal radioulnar ligament becomes taut in pronation, whereas the palmar radioulnar ligament becomes taut in supination.



- When the elbow was in the varus position (no contact between the radial head and capitulum), force was transmitted from the distal radius through the interosseous membrane to the proximal ulna.
- When the elbow was in the valgus position (contact between the radial head and the capitulum), the force was transmitted through the radius.

MOBILITY AND STABILITY OF ELBOW COMPLEX

FUNCTIONAL ACTIVITIES:

- The joints and muscles of the elbow complex are used in almost all activities of daily living, such as dressing, eating, carrying, and lifting.
- Most of the activities of daily living require a combination of motion at both the elbow and radioulnar joints.

- A total arc of about 100° of elbow flexion (between 30° and 130°) and about 100° of forearm rotation (50° supination and 50° pronation) is sufficient to accomplish simple tasks such as eating, drinking, brushing hair, brushing teeth, and Dressing.
- About 40° of pronation and 20° of supination are necessary to use a telephone.

EFFECTS OF AGE, GENDER, AND INJURY

❖ AGE AND GENDER:

- The decrease in muscle strength that accompanies increasing age appears to be affected by the type of muscle action involved (eccentric/concentric), the muscle group involved, and gender, along with other factors such as level of physical activity.
- Also, the elderly have been found to have smaller pennation angles and decreased fascicle lengths, which may account for as much of 50% of the loss of muscle function.

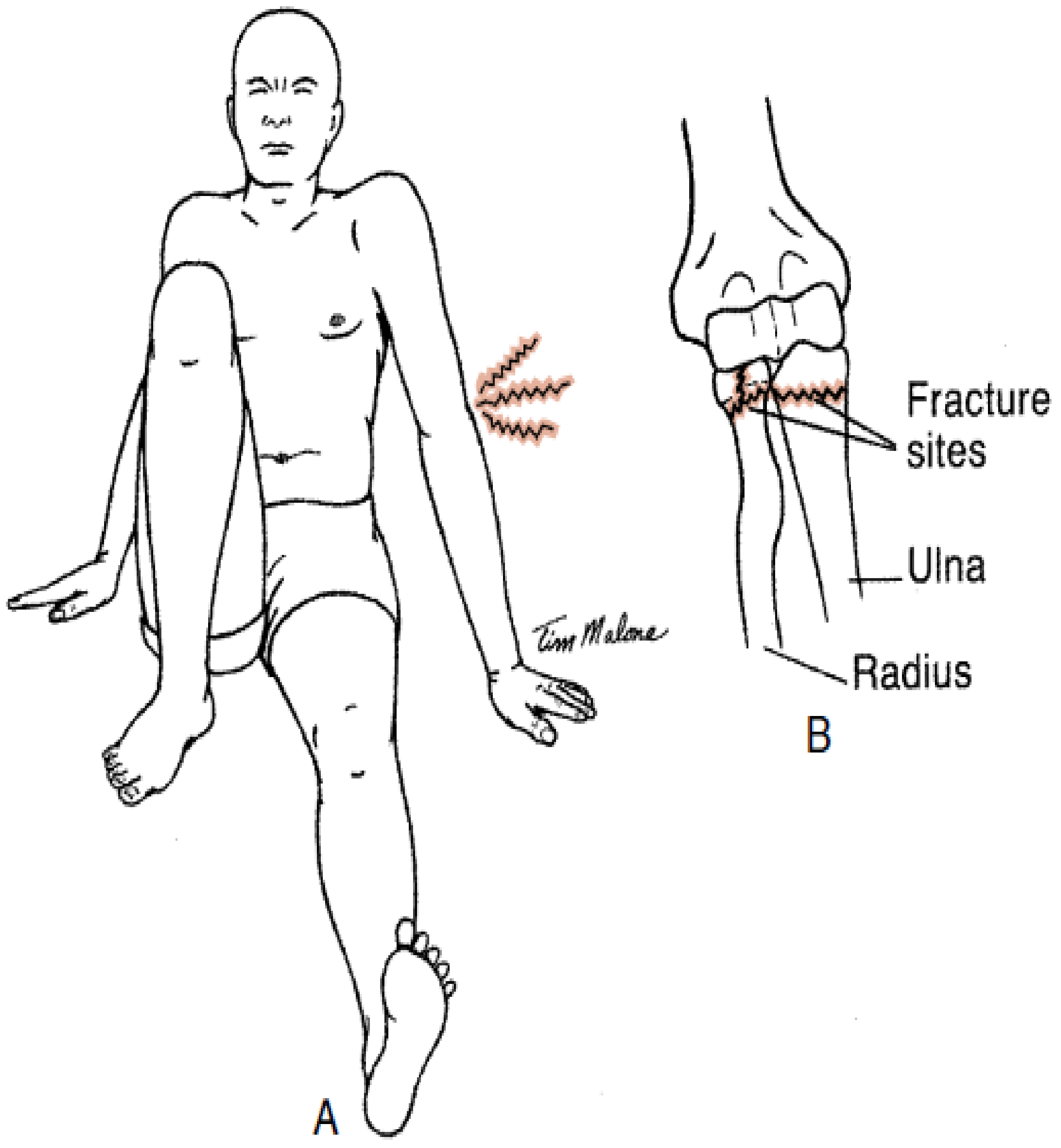
- Significant differences between young and old groups have been found in the location where peak torque is produced in a range of motion.
- Younger subjects produce significantly greater relative joint torques than older subjects across all effort levels except for the light effort level.
- Maximal isometric force and series elastic component compliance of the elbow flexors were significantly less in the elderly than in younger groups, but the antagonist Co-activation was similar for both groups.

❖ INJURY:

COMPRESSION INJURIES:

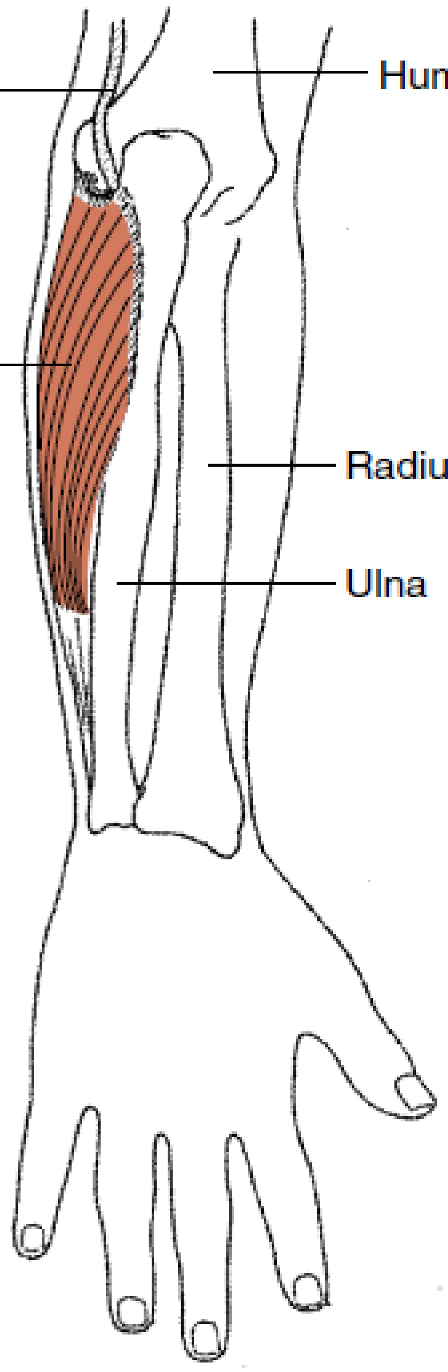
- Resistance to longitudinal compression forces at the elbow is provided mainly by the contact of bony components; therefore, excessive compression forces at the elbow often result in bony failure.
- Falling on the hand when the elbow is in a close-packed (extended) position may result in the transmission of forces through the bones of the forearm to the elbow

- If the forces are transmitted through the radius, as may happen with a concomitant valgus stress, a fracture of the radial head may result from impact of the radial head on the capitulum.
- A fracture of the radial head maybe accompanied by a tear of the central band of the interosseous membrane



- If the force from the fall is transmitted to the ulna, a fracture of either the coronoid process or olecranon process may occur from the impact of the ulna on the humerus.
- If neither the radius nor the ulna absorbs the excessive force by fracturing, then the force may be transmitted to the humerus, which may result in a fracture of the supracondylar area.
- Muscle contractions also may cause high compression forces at the elbow. Nerve compression, bony fracture, or dislocation may also result from muscle contractions.

- Repetitive forceful contractions of the flexor carpi ulnaris muscle may compress the ulnar nerve as it passes through the cubital tunnel between the medial epicondyle of the humerus and olecranon process of the ulna.
- These stresses can cause an injury called **cubital tunnel syndrome**, in which motion of the fourth and fifth fingers is impaired.

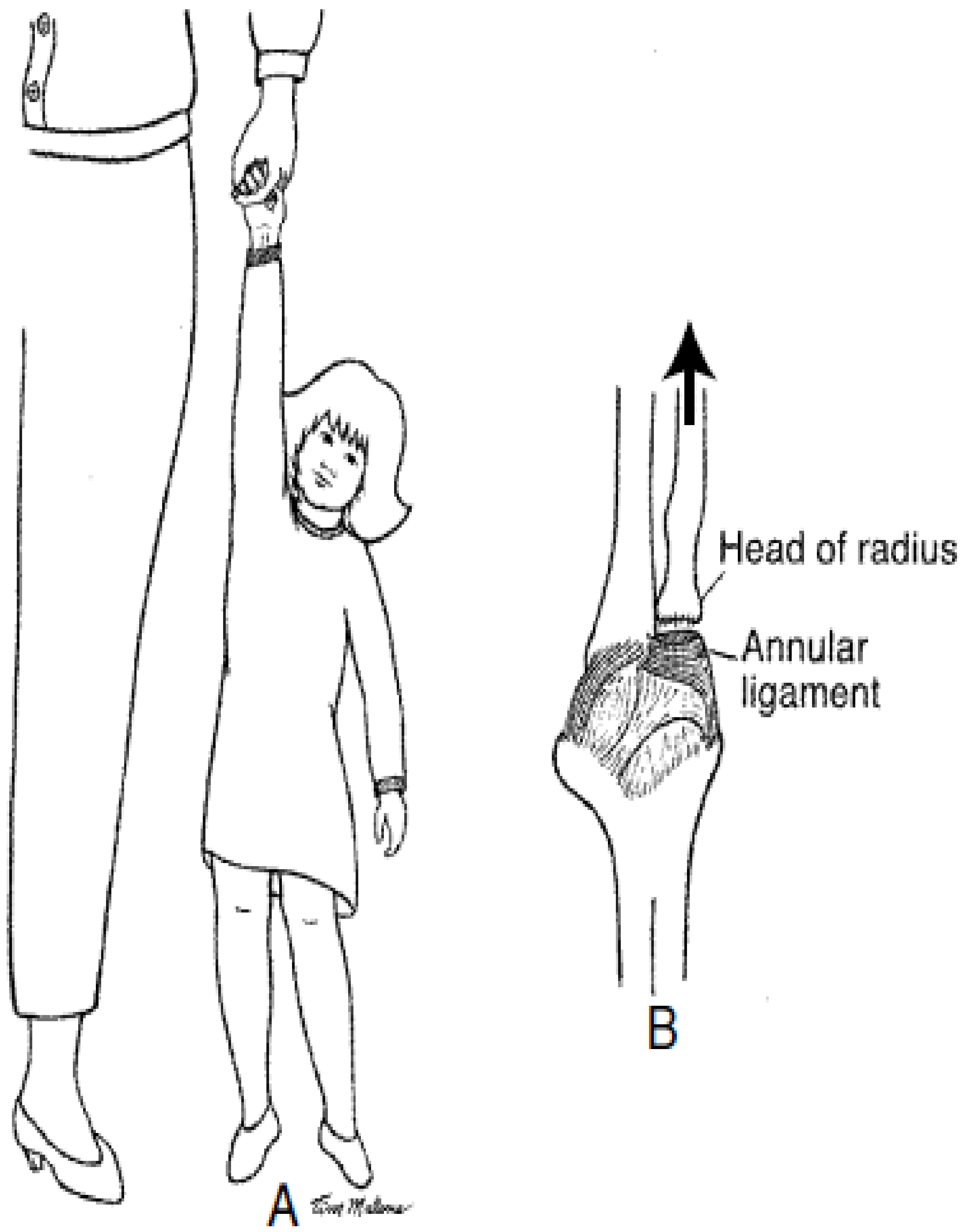


Right forearm
Posterior view

DISTRACTION INJURIES:

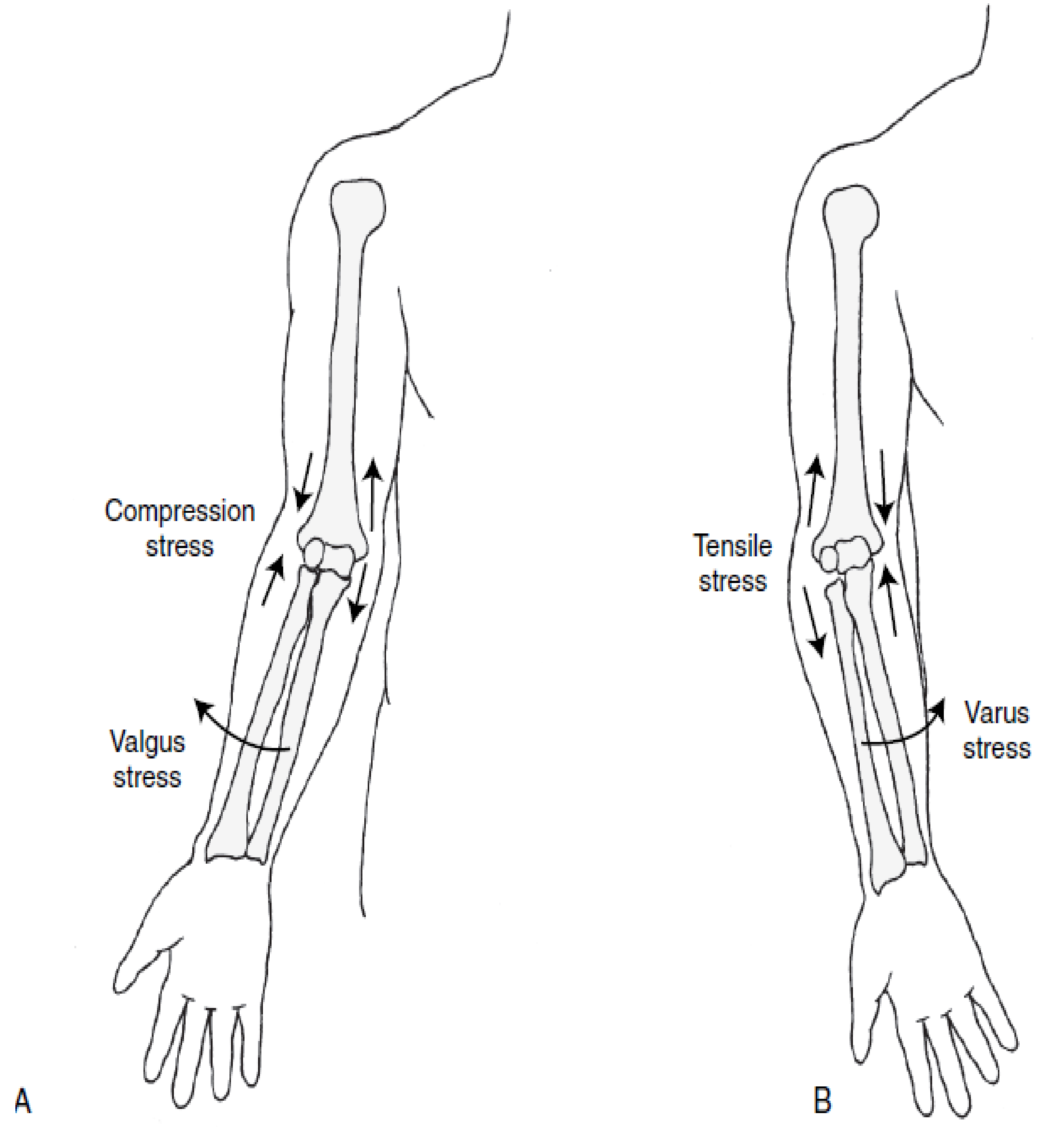
- Ligaments and muscles provide for resistance of the joints of the elbow complex to longitudinal traction.
- A tensile force of sufficient magnitude exerted on a pronated and extended forearm may cause the radius to be pulled inferiorly out of the annular ligament.

- This injury is common in children younger than 5 years and rare in adults. Lifting a small child up into the air by one or both hands or yanking a child by one hand is the usual causative mechanism, and therefore the injury is referred to as either **nursemaid's elbow or pulled elbow.**

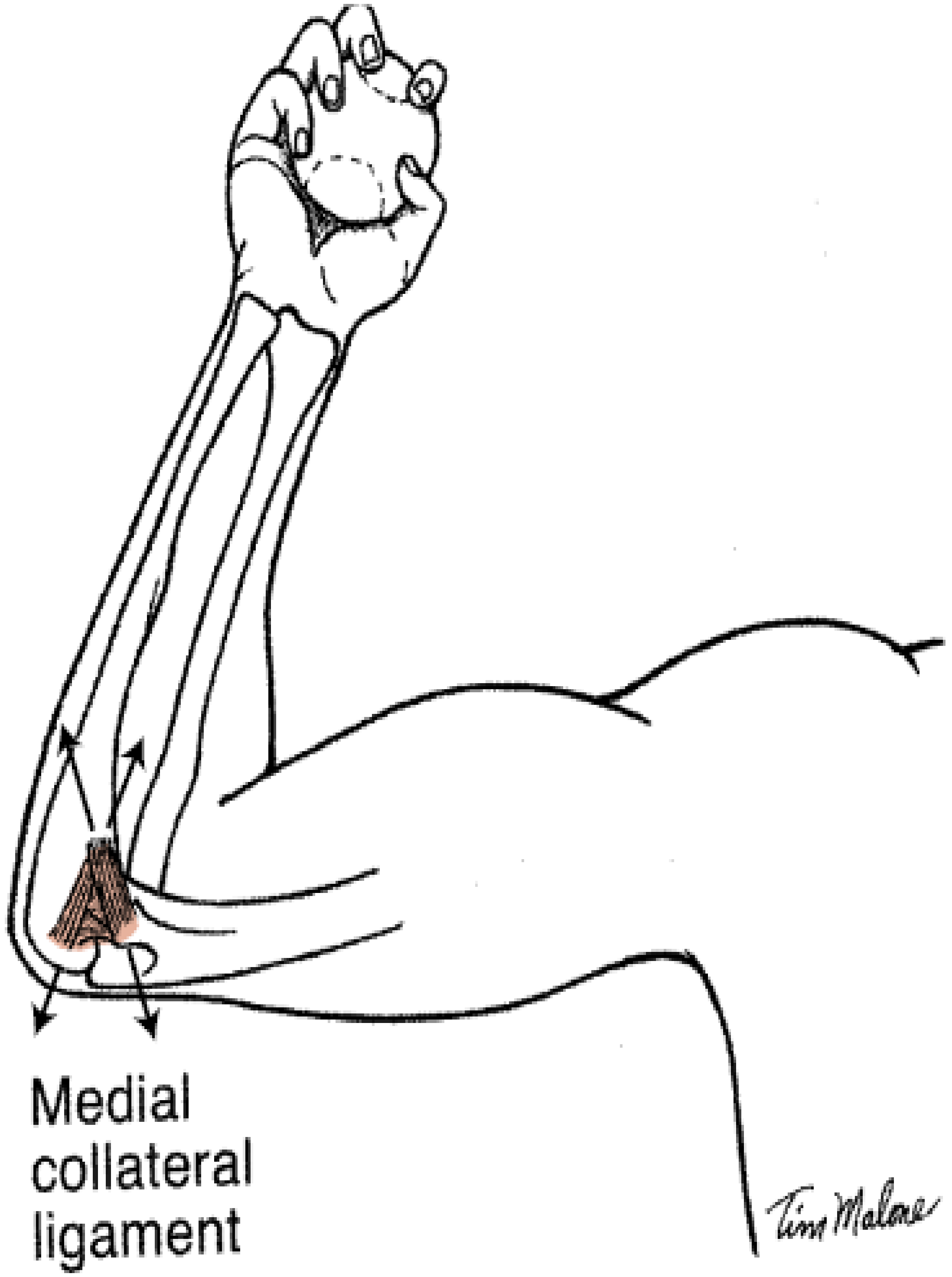


VARUS/VALGUS INJURIES:

- Distraction and compression forces are created if either one of the collateral ligaments is overstretched or torn.
- If one side of the joint is subjected to abnormal tensile stresses, the other side is subjected to abnormal compressive forces.



- The medial collateral ligament is subjected to tensile stress during the backswing or "cock-up" portion of throwing a ball.
- If the stress on the medial collateral ligament is repetitive, such as in baseball pitching, the ligament may become lax and unable to reinforce the medial aspect of the joint.



- Other conditions that may occur in the throwing elbow include ulnar neuritis, flexor-pronator muscle strain or tendinitis, and medial epicondylitis.
- Medial tendinitis and medial epicondylitis may be caused by forceful repetitive contractions of the pronator teres, the flexor carpi radialis, and, occasionally, the flexor carpi ulnaris.
- These muscles are involved in the tennis serve when the combined motion of elbow extension, pronation, and wrist flexion is used.