Chapter 16:
Adhesive Capsulitis

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I. Anatomy: see Chapter 5 (Shoulder Fractures and Instabilities), Sections I-V

II. Glenohumeral Capsular Pattern
    A. External rotation most limited followed by abduction then internal rotation

III. Definition and Characterization of Adhesive Capsulitis
    A. Consensus definition of the American Shoulder and Elbow Surgeons: "a condition of uncertain etiology characterized by significant restriction of both active and passive shoulder motion that occurs in the absence of a known intrinsic shoulder disorder"[1]
    B. Gradual loss of active and passive shoulder motion due to progressive fibrosis and contracture of the glenohumeral joint capsule
    C. Characterized by global loss of glenohumeral joint motion with external rotation typically most limited
    D. Distinct from other conditions that cause shoulder pain and stiffness
    E. Terminology varies
        1. Term "adhesive capsulitis" was introduced by Neviaser in 1945 to describe shoulder stiffness due to inflammation, fibrosis and capsular contracture[2]
        2. Term "frozen shoulder" was introduced by Codman in 1934[3] and is still a commonly used synonym; however, use of this term can create confusion as a frozen shoulder can result from other causes

IV. Epidemiology
    A. Occurs in 2% - 5% of the general population[4]
    B. Reported incidence of 10% to 35% in individuals with diabetes mellitus[5]
    C. More common in females[3]
    D. Most common in age range from 40 to 60 years[5]

V. Classification
    A. Primary adhesive capsulitis
        1. Idiopathic process of global glenohumeral capsular inflammation with progressive fibrosis and contracture
        2. Characterized by significant loss of active and passive shoulder motion with progression through identifiable stages
        3. Not associated with a systemic condition or history of injury
        4. Treatment
            a) Based on stage of presentation and irritability of shoulder[6]
    B. Secondary adhesive capsulitis
        1. Shoulder stiffness associated with systemic disease or known injury and may not involve the joint capsule
        2. Signs and symptoms may not follow a progression through stages as in primary adhesive capsulitis

3. Etiology
    a) Intrinsic, e.g. associated with shoulder disorder or trauma
        (1) Stiffness following shoulder surgery
        (2) Rotator cuff pathology
        (3) Impingement syndrome
        (4) Glenohumeral osteoarthritis
        (5) Acromioclavicular joint osteoarthritis
        (6) Posterior labral tears
        (7) Biceps pathology
    b) Extrinsic, e.g. associated with condition external to the shoulder
        (1) Proximal humeral fracture
        (2) Cervical spine disease
        (3) Cardiac disease
        (4) Neurological conditions
        (5) Non-shoulder surgery
    c) Systemic
        (1) Diabetes mellitus
        (2) Thyroid disease
4. Treatment
    a) Direct toward associated condition and findings on evaluation
5. Outcome
    a) Differs depending on associated condition[7,8]
    b) Worse prognosis when associated with diabetes mellitus

VI. Pathophysiology of Primary (idiopathic) Adhesive Capsulitis

A. Etiology is unclear

B. Hypothesis: hypervascular synovitis that provokes a progressive fibroplastic response in the adjacent capsule resulting in diffuse capsular fibroplasia and contracture[9]

C. Arthrograms demonstrate decreased joint volume and obliteration of axillary recess

D. Relationship with Dupuytren's contracture

1. Histological changes in the glenohumeral joint capsule are similar to those found in Dupuytren's contracture of the hand[9,10]

2. Reported rate of association with Dupuytren's contracture ranges from 18% - 52%[11]

VII. Stages of Primary Adhesive Capsulitis

A. Determined clinically based on examination and symptoms

B. Stages

1. 3 stages were historically described[5]
    a) Stage 1: Freezing (lasts 2-9 months)
    b) Stage 2: Frozen (lasts 3-12 months or longer)
    c) Stage 3: Thawing (lasts many months or years)

2. 4 stages are currently described with the addition of a pre-adhesive stage[12,13]
    a) Stage 1: Pre-adhesive stage
        (1) Characteristics
            (a) Pain with active and passive range of motion (ROM)
            (b) Progressive loss of forward elevation, abduction, internal and external rotation
        (2) Symptoms
            (a) Gradual onset of pain typically referred to deltoid insertion
            (b) Achy at rest, sharper pain with movement especially external rotation with arm at side
            (c) Night pain
            (d) Duration of symptoms is 0-3 months from onset
        (3) Signs
            (a) Empty end feel at extremes of motion
            (b) Full motion under anesthesia
            (c) Capsular pain on deep palpation
        (4) Pathology
            (a) Arthroscopic appearance
                (i) Fibrinous synovial inflammatory reaction
                (ii) No adhesions or capsular contracture
            (b) Biopsy of capsule
                (i) Hypervascular, hypertrophic synovitis
                (ii) Normal capsular tissue
3. Stage 2: Freezing stage
        (1) Characteristics
            (a) Combination of acute synovitis and progressive capsular contracture
        (2) Symptoms
            (a) Pain with active and passive motion
            (b) Night pain that may be severe
            (c) Stiffness
            (d) Occur between months 3-9 from onset
        (3) Signs
            (a) Motion significantly limited in forward elevation, abduction, internal and external rotation
            (b) Some loss of motion under anesthesia
        (4) Pathology
            (a) Arthroscopic appearance
                (i) Thickened, hypervascular synovitis described as having a Christmas tree appearance
                (ii) Some loss of axillary recess

(b) Biopsy of capsule
(i) Hypertrophic, hypervascular synovitis
(ii) Perivascular and subsynovial scar formation

4. Stage 3: Frozen or maturation stage
(1) Characteristics
(a) Marked stiffness
(b) Decrease in pain
(2) Symptoms
(a) Chief complaint of stiffness
(b) Pain only at end ROM and occasionally at night
(c) Occur between months 9-15 from onset
(3) Signs
(a) End feel is like mechanical block or tethering
(b) No improvement in motion under anesthesia
(4) Pathology
(a) Arthroscopic appearance
(i) Complete loss of axillary recess
(ii) Minimal synovitis
(b) Biopsy of capsule
(i) Dense, hypercellular, collagenous tissue with thin synovial layer
5. Stage 4: Thawing or chronic stage
(1) Characteristics
(a) Capsular remodeling and reestablishment of capsular volume
(b) Gradual improvement or resolution of symptoms
(2) Symptoms
(a) Minimal pain
(b) Stiffness with gradual improvement
(c) Occur between months 15 to 24 from onset and beyond
(3) Signs
(a) Progressive improvement in ROM
(4) Pathology
(a) Arthroscopic appearance
(i) Mature adhesions
(b) Biopsy of capsule
(i) Not reported in the literature

VIII. Irritability Classification[6]
A. High Irritability
1. High pain
2. Consistent night pain or resting pain
3. High disability

4. Pain prior to end ROM
5. Active ROM (AROM) less than passive ROM (PROM) due to pain

B. Moderate Irritability
1. Moderate pain
2. Intermittent night or resting pain
3. Moderate disability
4. Pain at end ROM
5. AROM similar to PROM

C. Low Irritability
1. Low pain
2. No resting or night pain
3. Low disability
4. Minimal pain at end ROM with overpressure
5. AROM equal to PROM

IX. Natural History

A. Not well understood

B. Historically described as self-limiting with spontaneous resolution within 3 years

C. Many individuals have residual mild pain and limited motion on long-term follow-up

X. Evaluation[14]

A. Comprehensive history including identification of any intrinsic, extrinsic or systemic etiology of shoulder stiffness

B. Questions to determine stage
1. Ability to sleep through the night
2. Chief complaint of pain versus stiffness
3. Improving or worsening symptoms
4. Duration of symptoms

C. Upper quarter screen to rule out cervical spine and neurological disorders

D. Shoulder AROM
1. Global limitations common in primary adhesive capsulitis but are stage-dependent
2. Scapular substitution is common
a) Shrug sign with shoulder forward elevation

E. Shoulder PROM (supine)
1. Primary adhesive capsulitis is characterized by
a) 50% loss of external rotation
b) Loss of 25% or more in at least 2 planes

F. End-feel
1. Characterized by
a) Empty end-feel in stage 1
b) Capsular end-feel in subsequent stages
2. Characteristically global glenohumeral hypomobility reflecting capsular pattern

G. Strength
    1. Weak lower trapezius muscles and overactive upper trapezius muscles[15]
H. Special tests
    1. Special tests requiring end range positioning are too painful to be useful in differentiating from other shoulder conditions

XI. Differential Diagnosis[5,16]
A. Identify and treat systemic predisposing factors
    1. Diabetes mellitus
    2. Thyroid disease
B. Differentiate from extrinsic etiologies
    1. Proximal humeral fracture
    2. Cervical disc disease
        a) C5-6 cervical radiculopathy with painful shoulder with or without loss of motion
    3. Cardiac disease
        a) Atherosclerotic coronary vascular disease
        b) Following myocardial infarction
    4. Neurological conditions
        a) Parkinson's disease
        b) Stroke
        c) Parsonage-Turner syndrome (brachial neuritis)
    5. Non-shoulder surgery
        a) Breast cancer surgery
        b) Axillary node and neck dissection
        c) Cardiac catheterization, coronary artery bypass grafting, interventional cardiology procedures, thoracotomy
C. Differentiate from intrinsic shoulder conditions
    1. Loss of external ROM with intact rotator cuff strength distinguishes adhesive capsulitis from other shoulder conditions[17]
    2. Global glenohumeral hypomobility distinguishes primary adhesive capsulitis from selective hypomobility (isolated regions of capsular tightness) associated with other shoulder conditions[5,18,19]
        a) Posterior capsule tightness
            (1) Anterior instability
            (2) Rotator cuff pathology
            (3) Impingement syndrome
            (4) Posterior labral tears (as seen in pitchers)
        b) Anterior capsule tightness
            (1) Glenohumeral osteoarthritis
            (2) Following over-tightening of anterior structures in surgery for anterior instability
D. Radiographic studies
    1. Plain radiographs (X-rays)
        a) Usually normal except osteopenia from disuse[12]

b) Useful for ruling out secondary causes of shoulder stiffness (e.g. fracture, osteoarthritis, calcific tendonitis)[16]

2. MRI not required but may be indicated to rule out secondary causes (e.g. rotator cuff tears, biceps pathology)[16]

3. CT scans not required but may be indicated after trauma or surgery to rule out secondary causes (e.g. fracture non-union and mal-union, loose bodies, hardware)[16]

XII. Treatment

A. Direct treatment of secondary adhesive capsulitis at etiology and specific findings on evaluation

B. General principles for treatment of primary adhesive capsulitis[5]

1. Some form of treatment is warranted
2. Lack of consensus on optimal treatment
   a) Assessment of multiple systematic reviews concluded insufficient evidence to draw conclusions about effectiveness of non-operative treatments commonly used[20]
   b) Lack of reviews comparing surgical interventions[20]
3. Initial approach is almost always non-operative
4. Operative approaches may be indicated for patients who don't respond to non-operative management
5. Treatment approaches are often combined
6. Treatment is based on the stage of presentation

C. Non-operative approaches

1. Rehabilitation[12-16,21,22]
   a) Evidence
      (1) Cochrane database review of physiotherapy for painful conditions of shoulder concluded no evidence that physiotherapy alone is of benefit in adhesive capsulitis[21]
      (2) Many lower level studies report benefit of physical therapy[21,22]
   b) Goals[13,16]
      (1) Stage 1
         (a) Reduce pain and inflammation
         (b) Optimize function
      (2) Stage 2
         (a) Continue to decrease pain and inflammation
         (b) Minimize capsular adhesions and limitation of motion
         (c) Restore scapulohumeral rhythm
         (d) Optimize function
      (3) Stages 3 and 4
         (a) Increase range of motion
         (b) Restore function
   c) Treatment guidelines[12-14]
      (1) Stage 1

(a) Education
    (i) Activity modification to limit provocation of pain
    (ii) Postural correction
    (iii) Positioning at rest supported in plane of scapula
(b) Modalities to control pain and inflammation
(c) Referral for a glenohumeral joint corticosteroid injection[23-25]
(d) Gentle motion in pain-free ranges
    (i) Gentle shoulder PROM exercises as tolerated
    (ii) Continuous passive motion machine for external rotation
    (iii) Hydrotherapy
(e) Low-grade joint mobilization (grades I-II) in loose pack position for pain
(f) Closed chain scapular stabilization
(g) Home exercise program (HEP)
    (i) Pendulums (Fig. 1)
    (ii) Shoulder PROM in pain-free ranges

(2) Stage 2
(a) Modalities to decrease pain and inflammation and to increase tissue extensibility
(b) PROM and AROM exercises of low intensity, short-duration in plane of the scapula
(c) Joint mobilization as tolerated to increase ROM
(d) Soft tissue techniques
(e) Scapular stabilization exercises
(f) HEP
    (i) Pendulums (Fig. 1)
    (ii) Passive forward elevation (Fig. 2)
    (iii) Cane exercises for internal and external rotation in plane of scapula (Fig. 3)
    (iv) Passive horizontal adduction (Fig. 4)
        (a) Avoid if produces anterior shoulder pain and impingement

(3) Stages 3-4
(a) Modalities to decrease discomfort and increase tissue extensibility
(b) Prolonged low-load stretching and positioning
(c) Proprioceptive neuromuscular facilitation (PNF) techniques
(d) Soft tissue techniques
(e) Joint mobilization grades III-IV performed at end-range positioning as tolerated

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Fig 1. Pendulums.

Fig 2. Passive forward elevation in supine.

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Fig 3. Passive external rotation in supine.

Fig 4. Passive horizontal adduction in supine.

(f) Strengthening of scapular muscles to reestablish muscle balance and of rotator cuff musculature if weak
(g) HEP
(i) AROM, PROM and flexibility exercises in all planes
(ii) Scapular strengthening

d) Precautions
(1) Avoid provoking pain and inflammation
(2) Avoid strengthening in early stages
(3) Avoid overly vigorous stretching
(4) Avoid impingement

e) Modalities[13,14]
(1) Commonly used in treatment of adhesive capsulitis
(a) Heat prior to exercise for pain relief, to promote relaxation and to increase tissue extensibility
(b) Ice/cold packs following exercises to reduce pain and inflammation
(c) Electric stimulation for pain relief
(2) Evidence for modalities in treatment of adhesive capsulitis
(a) Transcutaneous electric stimulation (TENS) combined with prolonged low-load stretch resulted in less pain and improved motion[26]
(b) Low-power laser therapy
(i) More effective than placebo[21,27]
(ii) Systematic review concluded that evidence supports laser therapy (weak level of evidence)[21]
(c) Ultrasound, iontophoresis and phonophoresis not shown to be effective[28-30]

f) Range of motion and stretching
(1) Progression of exercises
(a) Progress duration and intensity based on stage and pain
(b) Begin with gentle PROM exercises in pain-free ranges
(c) Progress as tolerated to include AROM exercises
(d) Further progress to stretching to tolerance
(e) Add PNF techniques (e.g. hold-relax) near end-range to reduce muscle guarding via antagonistic inhibition when tolerated
(2) Progression of total end-range time (TERT)
(a) Rationale

(i) Connective tissue remodels in response to type and amount of stress it undergoes over time
(ii) Amount of increase in PROM of a stiff joint is proportional to the total amount of time the joint is held at its end-range position (TERT)[31]
(b) In early stages of adhesive capsulitis use more frequent repetition, shorter duration and lower intensity ROM; avoid vigorous stretching
(c) Progress TERT by adding low-load prolonged stretching and positioning of the shoulder at end range of restricted motions as pain diminishes

g) Home exercise program[13,14]
(1) Select exercises to influence all restricted regions of the glenohumeral capsule
(2) Progression
(a) Initial exercises
(i) Pendulums (Fig. 1)
(ii) Passive forward elevation (Fig. 2)
(iii) Passive internal and external rotation in plane of scapula (Fig. 3)
(iv)Passive horizontal adduction (Fig. 4)
(b) Eliminate exercises that are too painful
(c) Use heat prior to exercises and cold following as needed
(d) Add pulleys as tolerated and progress to end-range holds
(e) Add AROM and scapular stabilization
(f) Progress to scapular strengthening

h) Evidence for ROM, stretching and HEP in pain-free ranges in treatment of primary adhesive capsulitis
(1) Significantly greater number of subjects recovered shoulder function in group performing HEP alone (pendulums and AROM in pain-free range) than in group treated with aggressive physical therapy (strenuous AROM and PROM beyond limits of pain)[32]
(2) 90% success rate in treatment at stage 2 with a specific stretching program limited to range of tolerable discomfort[33]
(a) Pendulums (Fig. 1)
(b) Passive forward elevation (Fig. 2)
(c) Passive external rotation (Fig. 3)
(d) Passive horizontal adduction (Fig. 4)
(e) Passive internal rotation (Fig. 5)

i) Joint mobilization[14]

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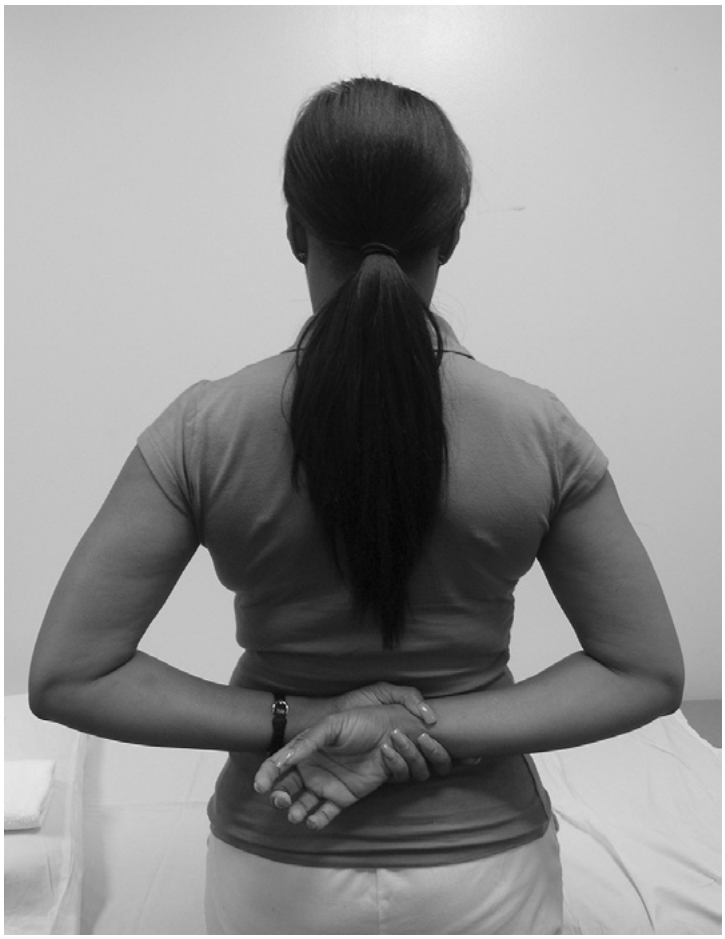

Fig 5. Passive internal rotation.

(1) Grade
    (a) Low-grade mobilizations (grade I and II) in early stages for pain
    (b) High-grade mobilizations (grade III and IV) in later stages for capsular restrictions
(2) Positioning
    (a) Perform initially in loose pack position anteriorly, inferiorly and posteriorly
    (b) Progress to mobilization at end-range of physiologic motions
(3) Direction of mobilization
    (a) Traditional approach
        (i) Promote accessory motion with glides in opposite direction of physiologic motion for convex-on-concave joints such as the glenohumeral joint
    (b) Direction of translation of the humeral head with glenohumeral motion reported in cadaveric study[18]
        (i) Anterior-superior translation during flexion
        (ii) Posterior translation during extension and external rotation
        (iii) Anterior translation during internal rotation and cross-body motion (horizontal adduction)
    (c) Posteriorly directly joint mobilization was demonstrated to be more effective than anteriorly directed joint mobilization for improving external rotation ROM in subjects with adhesive capsulitis[34]
(4) Evidence for joint mobilization in treatment of adhesive capsulitis
    (a) Subjects receiving either low-grade mobilizations (grade I and II) or high-grade mobilizations (grade III and IV) without other treatment had significant improvement in motion and function[35]
    (b) Subjects receiving mobilization and active exercise had significantly greater increase in passive abduction than group performing active exercise alone[36]
    (c) End-range mobilization and mobilization with movement was more effective than mid-range mobilization for increasing mobility and functional ability[37]

j) Strengthening

(1) Promote scapular stabilization to facilitate normal movement patterns
(2) Address muscle imbalances in later stages
(a) Individuals with adhesive capsulitis have significantly weaker lower trapezius muscles and overactive upper trapezius muscles[15]

2. Oral medications
   a) NSAIDs for inflammation and pain
      (1) Evidence for short-term benefit in pain relief and ROM[38]
   b) Analgesics for pain
3. Injection
   a) Intraarticular injection of corticosteroid to control pain and decrease synovitis[23-25]
   b) Combine with rehabilitation[14]
      (1) Begin with pendulums
      (2) Return to therapy or HEP after 4 days
   c) May or may not improve outcomes over physical therapy alone: reported results are variable[39-41]
4. Capsular distension
   a) Also called brisement or hydrodilation
   b) Ruptures the glenohumeral capsule by injection of fluid
   c) Evidence for short-term benefits in pain, ROM and function but no conclusive evidence for long-term benefit[42]

D. Operative approaches with post-operative rehabilitation
   1. Commonly used following failure of non-operative management for 6 months
   2. Manipulation under anesthesia (MUA)[5]
      a) Historical next step after failed conservative management
      b) Delayed until inflammatory phase has resolved
      c) Ruptures the glenohumeral capsule but does not address synovitis
      d) Contraindications
         (1) Inflammatory phase
         (2) Previous failed MUA
         (3) Rotator cuff tear
         (4) Osteopenia
         (5) Neurologic injury
         (6) Stiffness resulting from previous surgery or trauma
         (7) Chronic insulin-dependent diabetes mellitus
      e) Performed under regional, general anesthesia or local injection
      f) Corticosteroid injection may be used following the manipulation
      g) Results of manipulation are varied
         (1) Good results reported in most reviews[43-45]
         (2) Outcome at 1 year not better than with HEP alone[46]

h) Post-MUA rehabilitation
    (1) Initiate on day of manipulation
    (2) AROM and PROM
    (3) Joint mobilization
    (4) Edema control
    (5) Transition to HEP

3. Arthroscopic debridement and release[5]
    a) Systematic release of the glenohumeral capsule
    b) Debridement of synovitis
    c) Allows for bony or soft tissue decompression if indicated
    d) Evidence demonstrates improvements in ROM, pain and function[46-51]
    e) Postoperative rehabilitation
        (1) Initiate on day of surgery to maximum PROM
        (2) Follow with outpatient rehabilitation
4. Open surgical release[5,12]
    a) Rarely indicated for primary adhesive capsulitis
    b) May be indicated in acquired shoulder stiffness involving contracture of extra-articular soft tissues e.g. following prior shoulder surgery, fracture or stroke
    c) Adhesions and the glenohumeral capsule are released
    d) Subscapularis may be lengthened if necessary to achieve external rotation (unlike in arthroscopic release)
    e) Coracohumeral ligament may be excised
    f) Post-operative rehabilitation[5]
        (1) Early PROM
        (2) Initiate AROM when soft tissues have healed sufficiently (approximately 4 weeks post-operatively)
        (3) Protect subscapularis if lengthened
            (a) Communicate with surgeon to determine degree of external rotation ROM obtained intraoperatively
            (b) Limit external rotation stretching for 2 months
            (c) No resisted internal rotation for 3 months

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Multiple Choice Questions

1. The pathologic tissue found in the late stages of primary adhesive capsulitis is similar to that of
   A. Rheumatoid arthritis
   B. Dupuytren's disease
   C. Osteoarthritis
   D. Scleroderma

2. An individual complaining of shoulder stiffness and severe night pain of 6 months duration is most likely in which stage of adhesive capsulitis?
   A. Stage 1: Pre-adhesive stage
   B. Stage 3: Frozen or maturation stage
   C. Stage 4: Thawing or chronic stage
   D. Stage 2: Freezing stage

3. An empty end-feel at the end range of glenohumeral motion is most likely in which stage of adhesive capsulitis?
   A. Stage 2: Freezing stage
   B. Stage 3: Frozen or maturation stage
   C. Stage 1: Pre-adhesive stage
   D. Stage 4: Thawing or chronic stage

4. In adhesive capsulitis, glenohumeral joint hypomobility is characteristically
   A. Anterior
   B. Global
   C. Posterior
   D. Inferior

5. Joint mobilizations used to treat shoulder stiffness related to impingement syndrome should usually target which part of the glenohumeral capsule?
   A. Anterior
   B. Posterior
   C. Inferior
   D. Superior

6. Plain radiographs (X-rays) obtained in the evaluation of adhesive capsulitis
   A. May reveal diffuse glenohumeral synovitis
   B. Demonstrate decreased glenohumeral capsular volume
   C. Are not usually indicated
   D. Are useful for ruling out secondary causes of shoulder stiffness

7. The primary goal in treatment of stage 1 primary adhesive capsulitis is to
   A. Minimize capsular adhesions and limitation of motion
   B. Increase glenohumeral range of motion
   C. Reduce pain and inflammation
   D. Maintain scapular stability

8. The primary goal in treatment of stage 3 primary adhesive capsulitis is to

Multiple Choice Questions

A. Increase glenohumeral range of motion
B. Reduce pain and inflammation
C. Minimize capsular adhesions and limitation of motion
D. Maintain scapular stability

9. Which of the following treatments is indicated in the treatment of stage 1 primary adhesive capsulitis?
   A. Active and passive motion exercises to improve motion
   B. Gentle passive motion exercises to minimize loss of motion
   C. Vigorous stretching to improve motion
   D. Resistive scapular strengthening to prevent substitution

10. Capsular remodeling to improve range of motion in the later stages of adhesive capsulitis is best accomplished with
   A. Low-load, short-duration range of motion and stretching
   B. High-load, short-duration joint mobilization and stretching
   C. Low-load, prolonged stretching and positioning
   D. High-load, long-duration joint mobilization and stretching

11. Capsular distension or brisement used as a treatment for adhesive capsulitis
   A. Ruptures the glenohumeral capsule by injection of fluid
   B. Releases adhesions of the glenohumeral capsule by debridement
   C. Ruptures the glenohumeral capsule by manipulation
   D. Stretches the glenohumeral capsule by forced physiological motion

12. Manipulation under anesthesia for primary adhesive capsulitis is
   A. Rarely indicated in this condition
   B. Effective for the release of pathologic tissue
   C. Usually the first line of treatment
   D. Commonly performed following failed non-operative treatment

13. Arthroscopic release for the treatment of primary adhesive capsulitis is
   A. Less commonly performed than open release
   B. Most effective when performed during the first 6 months of symptoms
   C. Effective for the release of pathologic tissue
   D. The gold standard of care for most patients

Multiple Choice Question Answer Key
Chapter 16

1-B, 2-D, 3-C, 4-B, 5-B, 6-D, 7-C,
8-A, 9-B, 10-C, 11-A, 12-D, 13-C