

Shoulder Arthroplasty (non-live)

Goals and Objectives

Course Description

"Shoulder Arthroplasty" is a video recording of a previously presented webinar for athletic trainers. This program examines surgical management of shoulder pathology through joint arthroplasty. This course includes a review of current literature relating to shoulder pathophysiology, arthrokinematics, arthroplasty procedures, and rehabilitative management.

Course Rationale

The purpose of this course is to provide athletic trainers with a comparative analysis of surgical techniques and post-surgical management to understand current prosthetic advances, rehabilitation considerations and maximize outcomes based on current research.

Course Goals and Objectives

Upon completion of this course, participants will be able to:

1. List and identify all common orthopedic structures of the shoulder girdle.
2. Recognize and define common degenerative and traumatic shoulder pathologies.
3. Define normal and pathologic shoulder arthrokinematics
4. Identify current surgical and non-surgical management strategies for treating shoulder arthropathy
5. Compare and contrast the three most common shoulder arthroplasty surgical procedures.
6. Identify post-surgical complications following shoulder arthroplasty.
7. Compare anatomical and post-arthroplasty shoulder kinematics.
8. Identify the primary goals of post-surgical patient management.
9. Detail factors associated with improved outcomes following total joint replacement.
10. Outline the components of a comprehensive rehabilitation program following shoulder arthroplasty.

Course Provider – Innovative Educational Services

Provider Conflict of Interest - None

Course Instructor - Jodi Gootkin, PT, MEd, CEAS

Instructor Conflict of Interest - None

Target Audience – Athletic Trainers

Athletic Training Practice Domains - Clinical Evaluation & Diagnosis (0201, 0202, 0203, 0204, 0205); Treatment and Rehabilitation (0401, 0404, 0405)

Level of Difficulty – According to the education levels described by the PDC, the following continuing education course is considered to be Advanced Level

Course Prerequisites – None

Method of Instruction/Availability – Video recording available online on-demand

Criteria for Issuance of CE Credits – Watch video recording and then score at least 70% correct on course post-test.

Continuing Education Credits – Three (3) hours of continuing education credit.

Fees - \$34.95

Refund Policy - Unrestricted 100% refund upon request. The request for a refund by the learner shall be honored in full without penalty or other consideration of any kind. The request for a refund may be made by the learner at any time without limitations before, during, or after course participation.

Outline & Schedule

Shoulder Anatomy	0:00 – 0:10
Shoulder Arthrokinematics	0:11 – 0:20
Shoulder Pathology	0:21 – 1:00
Shoulder Replacement Surgeries	1:01 – 1:40
Acute Post-Surgical Management	1:41 – 1:45
Complications	1:46 – 2:00
Rehabilitation	2:01 – 2:40
Clinical Outcomes	2:41 – 2:45
Future of Shoulder Arthroplasty	2:46 – 3:00

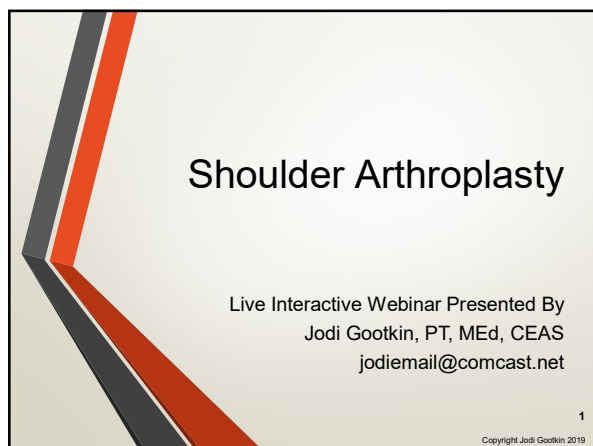
Approval -



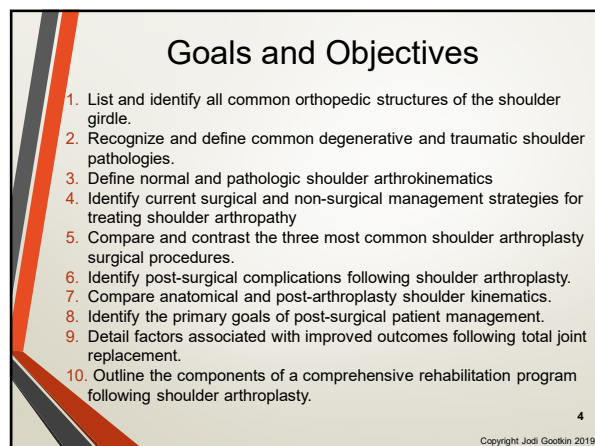
Innovative Educational Services is approved by the Board of Certification, Inc. to offer continuing education for Certified Athletic Trainers.

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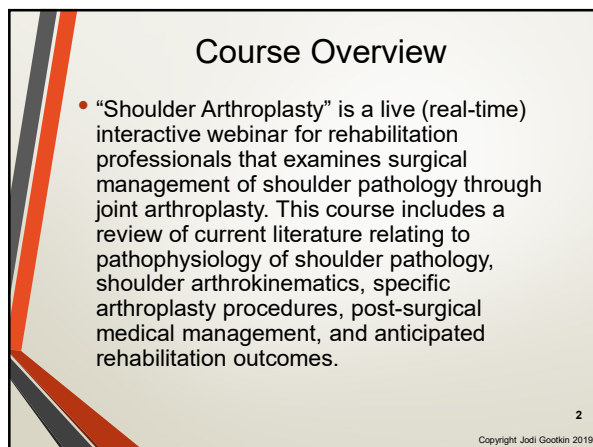
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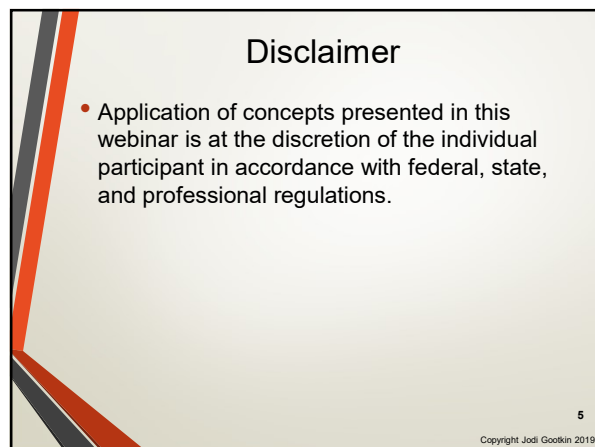
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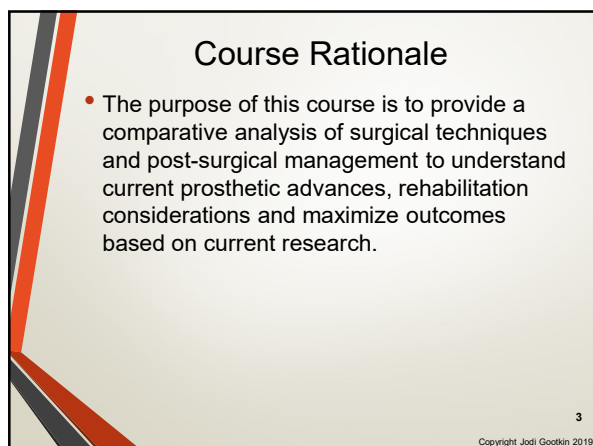
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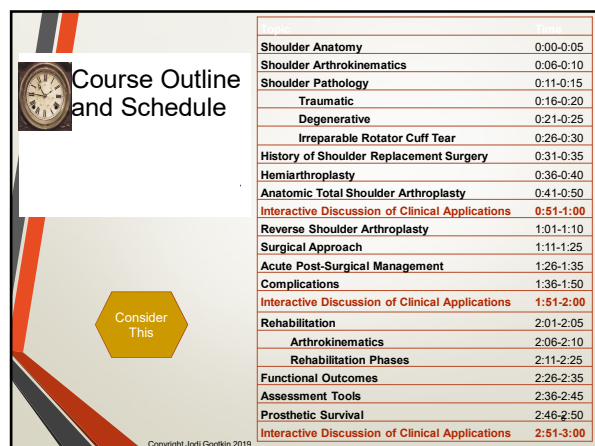
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Convex-Concave Rule

- Normal arthrokinematics of the shoulder follow the convex on concave rule.
- With open chain motions, the convex humeral head moves against the concave glenoid surface with roll and glide occurring in opposite directions.

Motion	Roll	Glide
Abduction	Superior	Inferior
Flexion (Anterior Elevation)	Anterior	Posterior
Internal Rotation	Anterior	Posterior
External Rotation	Posterior	Anterior

Consider This

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Shoulder Anatomy

- Functional use of the upper extremity occurs through coordinated movement of the triaxial ball and socket glenohumeral joint with the scapulothoracic, sternoclavicular, and acromioclavicular joints.

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Compressive and Shear Forces

The articular surface area of the humeral head is approximately three times greater than that of the glenoid fossa requiring the joint to rely on surrounding soft tissue structures for stability.

Compressive Force + Shear Force → Subluxation Risk Joint Loading

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Shoulder Musculature

Rotator Cuff

- Supraspinatus
- Infraspinatus
- Teres Minor
- Subscapularis "biphasic muscle"

Deltoids

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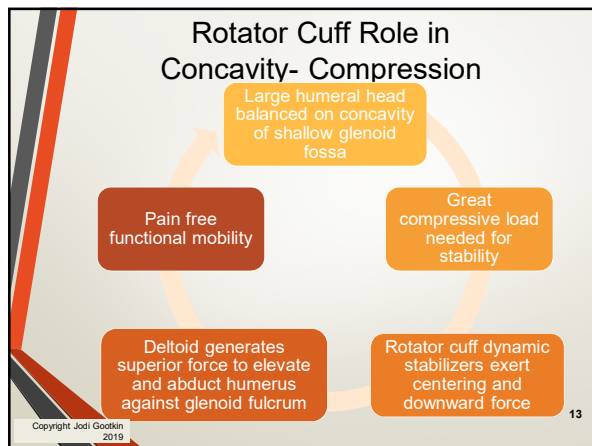
Shoulder Arthrokinematics

- The rotator cuff provides inherent joint stability through compression of the humeral head against the glenoid fossa.
- The cuff muscles function as a force couple creating dynamic stabilization so the deltoid can elevate and abduct the shoulder with the glenoid acting as a fulcrum.

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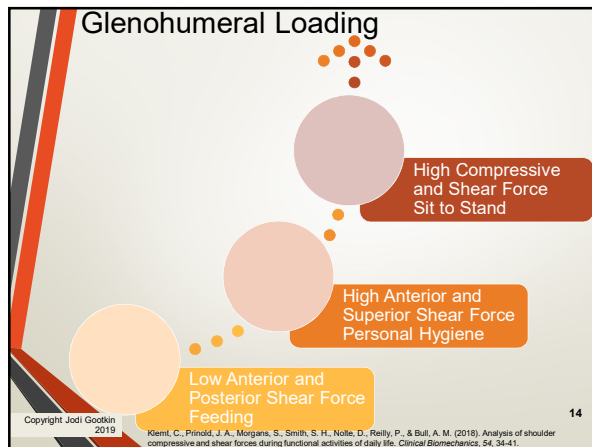
Traumatic Shoulder Pathology

- Complications from complex proximal humerus fracture include non-union or displacement of tuberosities and their tendinous insertions.
- In cases at risk for avascular necrosis or where Open Reduction Internal Fixation (ORIF) cannot achieve stable alignment, hemiarthroplasty or arthroplasty may be utilized.

Garcia, H., Gauden, E., Taylor, S. A., Dines, D. M., & Dines, J. S. (2013). Arthroplasty for Proximal Humerus Fractures: A Review of Current Management. *Techniques in Orthopaedics*, 28(4), 324-332.

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Degenerative Shoulder Pathology Osteoarthritis

- As osteoarthritis progresses significant glenoid bone loss and deterioration of the rotator cuff contribute to additional pain and disability.
- Patients undergoing Total Shoulder Arthroplasty appear to have improved functional and pain scores compared to hemiarthroplasty.
- Reverse Shoulder Arthroplasty may be selected if extensive posterior erosion of the glenoid fossa is present.

Soni, B., Boonen, M., Balthoff, M., Zellner, F., Lereu, M., Brudner, T., & Pallas, P. (2017). The medium and long-term outcome of total shoulder arthroplasty for primary glenohumeral osteoarthritis in middle-aged patients. *Bone Joint J*, 99(7), 939-943.

Singh, J. A., Sperling, J., Buchbinder, R., & McMAKEN, K. E. L. Y. (2011). Surgery for shoulder osteoarthritis: a Cochrane systematic review. *The Journal of Rheumatology*, 38(4), 588-595.

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Shoulder Pathology

- Common Diagnoses Managed with Shoulder Arthroplasty

Traumatic Shoulder Injuries	Degenerative Shoulder Conditions	Rotator Cuff Arthropathy
• Proximal Humerus Fractures • Avascular Necrosis	• Primary Osteoarthritis • Post Traumatic Arthritis	• Irreparable Rotator Cuff Tear

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Degenerative Shoulder Pathology Rheumatoid Arthritis

- Several reviews do not support shoulder arthroplasty for patients with rheumatoid arthritis at this time.
- Chronic inflammatory synovitis resulting in poor bone stock, osteopenia, and diminished soft tissue integrity restricts range of motion improvements post operatively.

Christie, A., Dagfinrud, H., Ringen, H. O., & Hagen, K. B. (2010). Beneficial and harmful effects of shoulder arthroplasty in patients with rheumatoid arthritis: results from a Cochrane review. *Rheumatology*, 49(3), 598-602.

Christie, A., Dagfinrud, H., Engen, K. M., Flaatten, H. L., Ringen, H. O., & Hagen, K. B. (2010). Surgical interventions for the rheumatoid shoulder - The Cochrane database of systematic reviews, (1), CD006188-CD006188.

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Irreparable Rotator Cuff Tear

- Massive rotator cuff tears involve multiple tendons significantly limiting function.
- Anterosuperior tear – subscapularis/supraspinatus
- Posterosuperior tear - supraspinatus/infraspinatus/teres minor

Full thickness rupture of 2 or more tendons or tear dimension > 5 cm

Fatty infiltration of muscles Goutallier stage 3-4

Shoulder pseudoparalysis

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Pseudojoint Formation

- Humeral impingement against the acromion leads to degenerative changes referred to as “acetabularization” of the under surface of the acromion and “femoralization” of the humeral head.

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Rotator Cuff Arthropathy

- The development of severe shoulder arthritis concurrent with rotator cuff tear is diagnosed in the presence of specific clinical findings:
- Insufficient rotator cuff Irreparable = Massive
- Glenohumeral osteoarthritis
- Superior migration of humeral head

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Radiologic Findings

- Seebauer Classification
 - Type 1 - humeral head and glenoid fossa remain concentric
 - Type 2 - humeral head migrates superiorly
- Hamada Classification

Grade 1	AHI greater than or equal to 6 mm
Grade 2	AHI less than or equal to 5 mm
Grade 3	Grade 2 plus acetabularization of acromion
Grade 4	Grade 3 plus glenohumeral arthritis
Grade 5	Grade 4 plus humeral head collapse

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Rotator Cuff Deficiency

- In the absence of the normal concavity compression from a functioning rotator cuff, the humeral head migrates superiorly with deltoid contraction.

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Shoulder Pseudoparalysis

Large humeral head balanced on concavity of shallow glenoid fossa

Glenohumeral osteoarthritic changes and painful ROM

Non-functioning rotator cuff

Failure to apply compressive load to humeral head

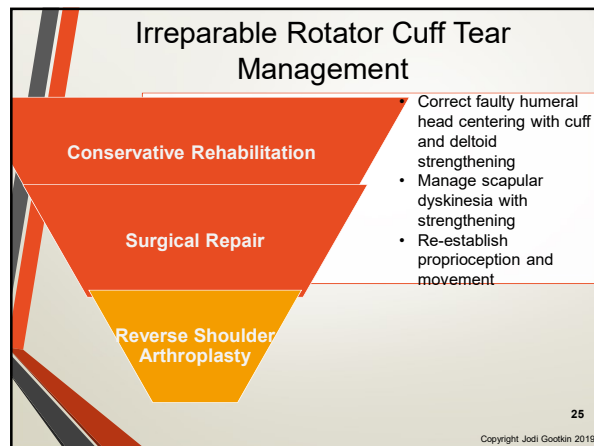
Humeral head migrates superiorly with deltoid contraction

PSEUDOPARALYSIS
Painless loss of active elevation

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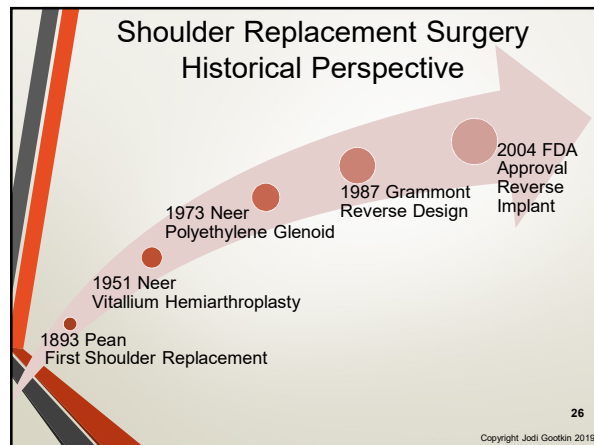
Shoulder Replacement Surgical Procedures

- Hemiarthroplasty
- Anatomic Total Shoulder Arthroplasty (TSA)
- Reverse Shoulder Arthroplasty (RSA)

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Hemiarthroplasty

- Replacement of the humeral head with a prosthetic component.
- Patient's glenoid fossa typically contains intact cartilage so no glenoid component is utilized.

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Goal of surgery

- The primary goals of surgery are to relieve pain, provide stability to the joint and restore motion for function.
- To achieve functional mobility, the surgeon must achieve joint stability, rotator cuff balance, and deltoid force restoration.

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Hemiarthroplasty Indications

- Severe humeral head and proximal humerus fractures
- Osteoarthritis when there is a healthy glenoid and intact cartilage
- Pathologic fracture secondary to neoplasm
- Rotator Cuff Arthropathy with good shoulder active ROM

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Cuff Tear Arthroplasty (CTA)

- The prosthetic humeral head has an extended surface to articulate with the deteriorated glenoid fossa and coracoacromial arch.
- The glenoid component is not replaced.

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Anatomic Total Shoulder Arthroplasty Prosthesis

- Metal alloy humeral head with titanium humeral shaft and cross-linked polyethylene glenoid components replace damaged bone surfaces.

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Total Shoulder Arthroplasty Prosthetic Types

- The goal of prosthetic components is to reproduce joint mechanics and restore joint stability and muscle motor function.
- Integrity of rotator cuff is a major factor contributing to the prosthetic selection.

Anatomic Total Shoulder Arthroplasty (TSA)

- Neer
- Unconstrained Design
- Intact rotator cuff required

Reverse Shoulder Arthroplasty (RSA)

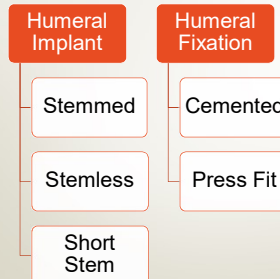
- Grammont
- Constrained design
- Deltoid strength required

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Humeral Components



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Anatomic Total Shoulder Arthroplasty

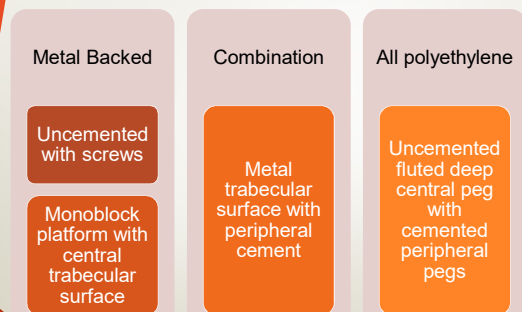
- Also known as
 - Anatomic Total Shoulder Arthroplasty ATSA
 - **Total Shoulder Arthroplasty TSA**
 - Neer prosthesis
- Indicated for patients with an intact rotator cuff and
 - Osteoarthritis
 - Rheumatoid Arthritis
 - Post Traumatic Arthritis
 - Avascular Necrosis

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Glenoid Components



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TSA Unconstrained Prosthesis

- Must have intact rotator cuff as unconstrained design requires stability from native rotator cuff musculature for functional motion of the upper extremity.
- When the rotator cuff is not strong enough to stabilize the humeral head in the glenoid fossa, the deltoid is unopposed and cannot effectively elevate the extremity.

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Humeral Component Fixation

Cemented

- Acromial fractures
- Infection
- Nerve injury
- Thromboembolism

Uncemented

- Early humeral stem migration
- Non-progressive radiolucent lines

- Functional outcomes and range of motion equivalent with both uncemented and cemented RSA stems.

Phadnis, J., Huang, T., Watts, A., Krishnan, J., & Bain, G. I. (2016). Cemented or cementless humeral fixation in reverse total shoulder arthroplasty? a systematic review. The bone & joint journal, 98(1), 65-74.

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Reverse Shoulder Arthroplasty

- Also known as
 - **Reverse Shoulder Arthroplasty RSA**
 - Reverse Total Shoulder Arthroplasty rTSA
 - Reverse Shoulder Replacement RSR
 - Grammont Prosthesis
- Indicated for patients
 - Osteoarthritis WITHOUT an intact rotator cuff
 - Complex proximal humeral fractures
 - Rheumatoid Arthritis
 - Failed Anatomic Total Shoulder Arthroplasty or Hemiarthroplasty

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Constrained Design

- The constrained mechanical design of the prosthesis provides joint stability with extremity motion in the absence of a functioning rotator cuff.
- The fixed center of humeral rotation is moved distal and medial in relation to glenoid surface.
 - Converts shear to compressive force

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Reverse Shoulder Prosthesis

- Glenohumeral articulation is inverted with the convex prosthesis attached to glenoid fossa and the concave component attached to humerus.
- The glenosphere is attached to a baseplate secured into the fossa by a large central peg and cortical screws.
- The humeral component is a cup shaped body attached to a metal stem that is press fitted or cemented into the humeral medullary canal.
- A polyethylene liner articulates the two components.

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Fixed Fulcrum

- Creates fixed fulcrum at the glenoid for the humerus to rotate against allowing the deltoid to elevate the arm without impingement.
- Lengthening of the humerus in relation to the scapula enhances the moment arm of the deltoid to perform forward elevation and abduction.
- Prosthetic design allows arm elevation in the absence of a fully functioning rotator cuff.

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RSA Contraindications

- Axillary nerve damage
- Non-functioning deltoid muscle group
- Infection
- Neuropathic joints
- Inadequate glenoid bone stock

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Male vs. Female Shoulder Anatomy

- Surgical alteration of shoulder articular surfaces by 4-5 mm compared to the native joint can significantly impact kinematics of the joint.

Men

- Greater head diameter, glenoid neck length, and greater tuberosity width

Women

- Greater radius of curvature

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Syed, U. A. M., Davis, D. E., Wei Ko, J., Lee, B. K., Huttman, C., Jazdell, A., ... & Abboud, J. A. (2017). Quantitative Anatomical Differences in the Shoulder. *Orthopedics*, 40(3), 155-160.

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Surgical Considerations

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Deltoid Tensioning

- Significant pre-operative deltoid atrophy is associated with diminished functional achievements post surgery.

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Over tensioning =
Acromion Fracture

↑

Insufficient
Tension =
Joint Instability

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Neck-Shaft Angle

- Alteration of the angle between the humeral head and neck in the prosthetic design influences stability of the joint post operatively.
- Humeral component design creates a neck-shaft angle of 135 degrees.
- Increasing the angle to 155 degrees demonstrates higher instability rates of the new joint.

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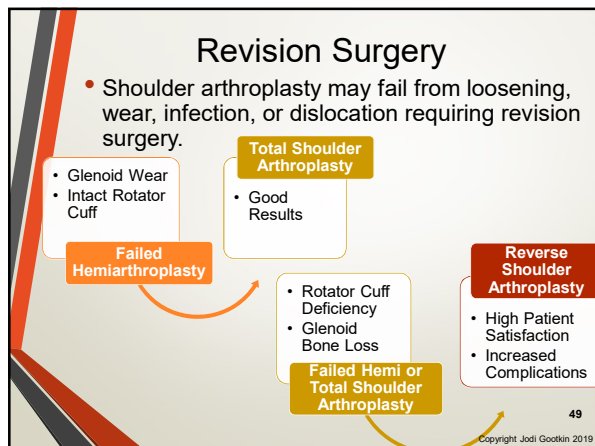
Component Fixation

- Limited bone stock may present a challenge to achieving fixation of glenoid component.
 - Locking screws with multi-axial designs and hydroxyapatite coatings aid in improving fixation.
- Some surgeons prefer impaction grafting with a humeral press fit component to reduce fracture risk.

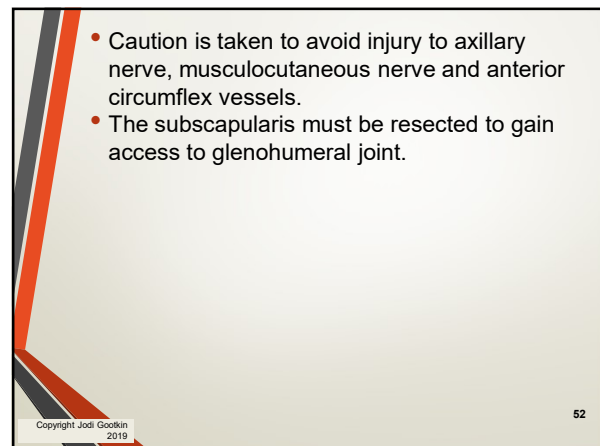
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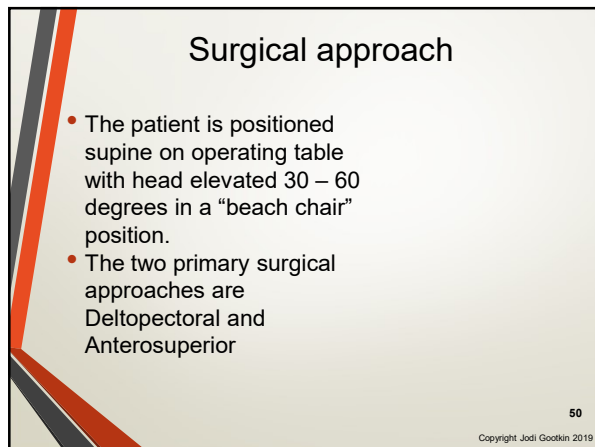
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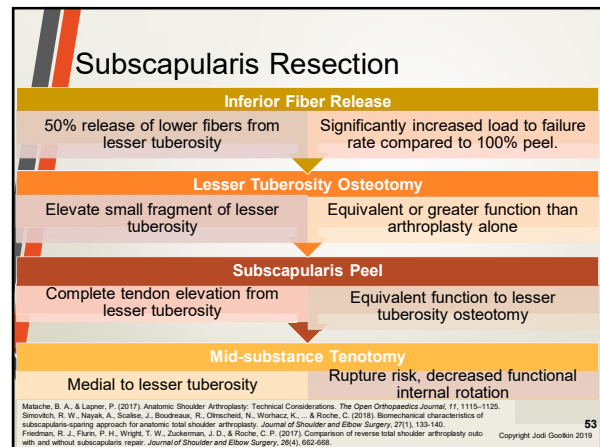
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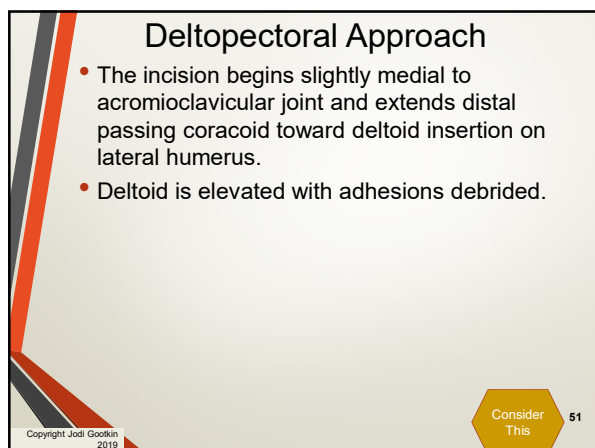
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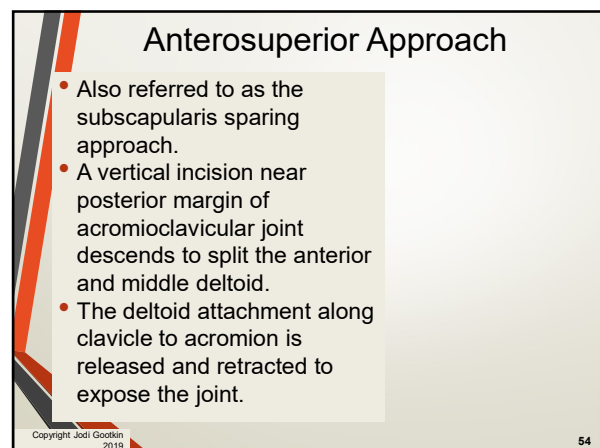
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Concurrent Procedures

- Release of adhesions under the coracoid and glenohumeral ligament allows mobilization of rotator cuff tendons to reduce the risk of injury.
- Debridement and/or partial or complete rotator cuff repair may improve outcomes in some patients.
- Bone grafting may be utilized for severe glenoid bone loss due to osteoarthritis.

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Acute Post Surgical Management

- As future demand increases, management of perioperative factors that influence hospital length of stay can increase discharge disposition to home, improve functional outcomes, and manage health care costs.

Under 55 years old, demand increase 8% per year

Over 55 years, old demand increase 12% per year

2030, younger patients account for 4% of arthroplasties

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Padegimas, E. M., Mollenfort, M., Lazarus, M. D., Ramsey, M. L., Williams, G. R., & Namdari, S. (2015). Future patient demand for shoulder arthroplasty by younger patients: national projections. *Clinical Orthopaedics and Related Research*, 473(6), 1860-1867. Copyright Jodi Gootkin 2019

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Latissimus Dorsi Tendon Transfer

Teres Minor and/or Infraspinatus Tear

Limited Active Shoulder External Rotation

Latissimus Dorsi Tendon Transfer

Substitutes for Active Shoulder External Rotation

Significantly Improved Function

External Rotation ROM, patient satisfaction, and functional outcomes

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Patient education

- Preoperative education should focus on pain self-management, activities of daily living training, donning/doffing sling, and mobility in addition to patient expectations of recovery.

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Long Head of Biceps Tendon(LHBT) Tenodesis

LHBT tenodesis is indicated in patients with chronic atrophic changes, tendon rupture, and routinely performed by some surgeons in absence of obvious tendonopathy.

Tenodesis is performed with resection of the proximal tendon and resuturing to the insertion of the pectoralis major near the intertubercular groove.

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Post Operative Management

Surgical Approach

Surgical Procedures

Anesthetic

Review Operative Report Physician Orders and Protocol

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Surgical Drain

- Some physicians opt to insert a drain prior to closure of the surgical incision to minimize the risk of hematoma formation.
- Typically removed post-operative day 1 when drainage is less than 30mL.

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Tobacco Use and Pain Management

- Current tobacco use is associated with a more challenging post-operative course.
 - Higher perceived pain scores
 - Greater narcotic pain medication consumption
 - Slightly longer hospital length of stay

Wells, D. B., Holt, A. M., Smith, R. A., Brolin, T. J., Azar, F. M., & Throckmorton, T. W. (2018). Tobacco use predicts a more difficult episode of care after anatomic total shoulder arthroplasty. *Journal of shoulder and elbow surgery*, 27(1), 23-28.

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Pain Management

- Peripheral Nerve Block (PNB)**
 - Intraoperative interscalene or supraclavicular injection
- Patient Controlled Analgesia (PCA)**
 - Patient dispensed at preset dosage
- Intraoperative Injections**
 - Periarticular injection of extended-release liposomal bupivacaine

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Breathing Exercises

- In addition to reducing the risk of atelectasis and pneumonia, breathing exercises emphasizing postural alignment can assist in reducing protective muscle spasms.

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Interscalene and Supraclavicular PNB Side Effects

- Horner's Syndrome**
 - Myosis
 - Ptosis
 - Anhidrosis
- Bezold-Jarisch Reflex**
 - Bradycardia
 - Hypotension
- Recurrent Laryngeal Nerve Block**
 - Hoarseness
- Diaphragmatic Hemiparesis**
 - Decreased Respiratory Capacity
- Hand Motor Block**
 - Decreased Grip Strength

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Complications

- Revision arthroplasty demonstrates greater complication rates compared to primary arthroplasty.

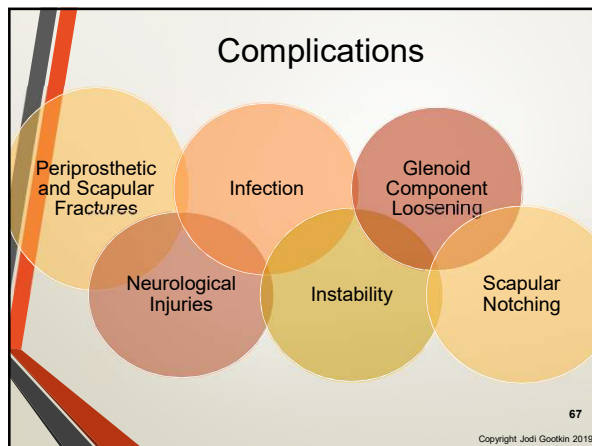
Category	Hemiarthroplasty	Total Shoulder	Reverse Shoulder
PROCEDURES	20	43	37
COMPLICATIONS	17	14	9
READMISSION	7	5	4

Floyd, S. B., Chapman, C. G., Thigpen, C. A., Brooks, J. M., Hawkins, R. J., & Tokish, J. M. (2018). Shoulder arthroplasty in the US Medicare population: a 1-year evaluation of surgical complications, hospital admissions, and revision surgery. *JSES Open Access*, 2(1), 40-47.

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Infection

- Higher infection rates occur with the RSA potentially due to greater unoccupied joint space post prosthetic implant.
- Common pathogens are *Propionobacterium acnes* and *Staphylococcus*.
- Increased incidence of infections in patients with rheumatoid arthritis, diabetes mellitus, history of oral steroid use, shoulder trauma, smoking or failed shoulder hemiarthroplasty.

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Periprosthetic Fractures

- Over reaming of a glenoid that has minimal sclerosis can result in fracture and instability of the component fixation.
- Tuberosity and shaft fractures may be accommodated by altering stem length.

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Infection Diagnosis

Patient Symptoms
• Pain • Stiffness • Fever • Night sweats • Chills
Clinical Signs
• Draining sinus • Erythema • Effusion
Diagnostic Testing
• Arthrography and culture • Radiographic changes • Serologic markers

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Scapular Fractures

- Acromion fractures may occur at the base of the spine of the scapula or through the acromion.
- May result from pre-operative deterioration of the acromion from superior humeral head translation or pseudoparalysis combined with over tensioning of the deltoids during repair.

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Neurological Injuries

- Intraoperative nerve injury may result from cement thermal reaction or over penetration of glenoid baseplate screws.
- Lengthening of the upper extremity greater than 2 cm may increase risk of nerve injury.

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Neurological Injuries Clinical Presentation

- Post-operative assessment should distinguish sensory changes originating from the healing incision and tissues from neuropraxia.

Nerve	Motor	Sensory
Musculocutaneous	Biceps Brachialis Coracobrachialis	Lateral Forearm
Axillary	Deltoids	Lateral Shoulder
Suprascapular	Supraspinatus Infraspinatus	Posterior Superior Scapula
Radial	Triceps Wrist Extensors	Posterior Distal Arm, Posterior Forearm, Dorsum of Hand Thumb Side

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Joint Protection

- No glenohumeral extension beyond neutral

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Instability

- Instability can occur with both types of arthroplasty.
- Surgical technique and prosthetic design factors contribute to dislocation risk.

Patient Risk Factors	Surgical Risk Factors
- BMI > 30 - Male Gender - Previous Surgery	- Inadequate Deltoid Tensioning - Malpositioned Implants - Mechanical Impingement - Subscapularis Deficiency - Deltopectoral Approach - Axillary Nerve Injury

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Post Operative Immobilization

- Immobilization balances optimizing healing of the tendon bone interface with avoiding stiffness.
- Subscapularis protection is critical for healing of the tendon reattachment and to avoid joint subluxation.

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Instability

- Conservative management with closed reduction is often successful, but recurrent instability may require revision surgery.

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Shoulder Sling

- Patient and family education should emphasize correct donning procedure and alignment to ensure alignment of upper extremity in neutral extension with scapular retraction avoiding excessive cervical stress.
- RSA will use abduction pillow along with sling.

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Positioning

- In supine add support behind shoulder for humerus to remain neutral aligned with trunk.
 - 10-20 degrees of forward flexion, slight ABDuction and internal rotation
 - Head of bed elevated 30-60 degrees
- In sitting arm supported in sling or on pillow in lap with elbow visible.

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Rocking Horse Phenomena

- In the TSA, with shoulder flexion and abduction the point of contact of the humeral head in the glenoid fossa shifts superiorly.
- Without accurate glenoid prosthetic orientation and sufficient rotator cuff strength the glenoid baseplate undergoes eccentric loading.

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Mobility Precautions

- Early Rehab
 - Avoid combination of active or passive shoulder internal rotation, ADDuction, extension
 - No pushing, pulling, lifting
- Later Rehab
 - Avoid combination of active shoulder ABDuction above 80 degrees and external rotation

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Aseptic Loosening

- Poor implant alignment, rotator cuff dysfunction, and humeral head instability contribute to loosening.

```

graph LR
    A[Edge loading "rocking horse"] --> B[Polyethylene wear]
    B --> C[Osteolysis]
    C --> D[Aseptic loosening]
    D --> E[Prosthetic failure]
  
```

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Glenoid Component Loosening

- Loosening of the glenoid component is the most common long term complication associated with TSA as a consequence of the unconstrained design combined with a deficient rotator cuff.
- The shallow glenoid migrates and loosens against the unopposed force of the deltoid contraction.
- Additional contributing factors:
 - Eroded or medialized glenoid
 - Component malposition that increases stress forces
 - Excessive reaming reducing bone stock
 - Underlying infection
 - Rotator cuff tear
 - Instability

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Scapular Notching

- Over time following RSA, humeral component impingement causes erosion of the inferior scapular neck.

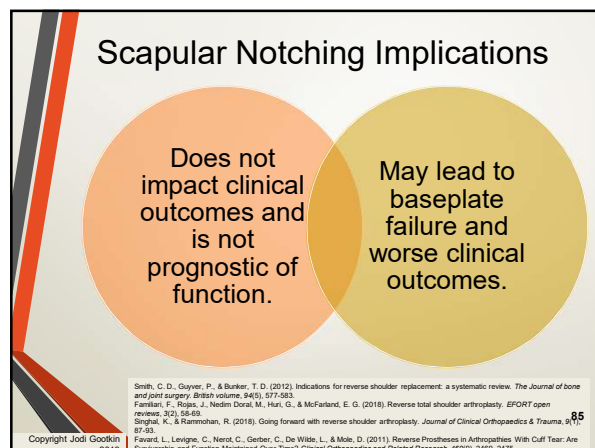
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graph TD
    A[Anterosuperior approach] --> B[Glenoid superior tilt]
    B --> C[High glenoid component]
    D[Impingement between polyethylene and scapula] --> E[Biologic response to debris from wear]
    E --> F[Mechanical Impingement with arm abduction]
    C --- F
  
```

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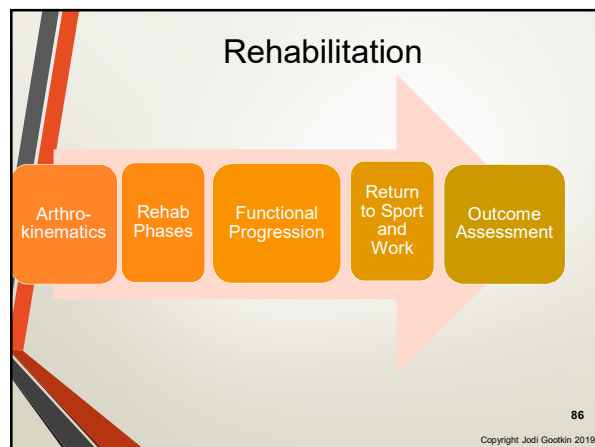
85

Kinematic Analysis of Motion

- Scapulohumeral rhythm is typically reduced with the overall scapular kinematic pattern preserved.
- The patient may substitute with increased scapular motion to compensate for decreased glenohumeral mobility for the performance of activities of daily living.

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Range of Motion Expectations

- **Full ROM is NOT expected** upon discharge from rehabilitation.
- Upon discharge from therapy most patients achieve approximately 80-120 degrees flexion and 30 degrees external rotation.

Smith, C. D., Guyver, P., & Bunker, T. D. (2012). Indications for reverse shoulder replacement: a systematic review. *The Journal of bone and joint surgery, British volume*, 94(5), 577-583.
 Favard, L., Lavigne, C., Nerot, C. et al. Reverse prostheses in arthroplasties with cuff tear: Are survivorship and function maintained over time? *Clin Orthop Relat Res* 2011;469:2469-75.
 Familari, F., Rojas, J., Nedim Dorai, M., Hurl, G., & McFarland, E. G. (2018). Reverse total shoulder arthroplasty. *EFORT Open Reviews*, 3(2), 58-69.
 Chun YM, Kim DS, Lee DH, Shin SJ. Reverse shoulder arthroplasty for four-part proximal humerus fracture in elderly patients: Can a healed tuberosity improve the functional outcomes? *J Shoulder Elbow Surg* 2017;26:1216-21.
 Sanchez-Sotelo, J., Nguyen, N. T. V., & Morrey, M. (2018). Anatomic Total Shoulder Arthroplasty Using a Self-Pressurizing Pegged Bone-Preserving Cemented Glenoid Component: A 2-to 5-Year Follow-up Study. *Journal of Shoulder and Elbow Arthroplasty*, 2, 2471549217750478.

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Post Operative Arthrokinematics

- The goal of reconstruction is to replicate normal articular anatomy restoring soft tissue length tension relationships, kinematics, and function.

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ROM Continued

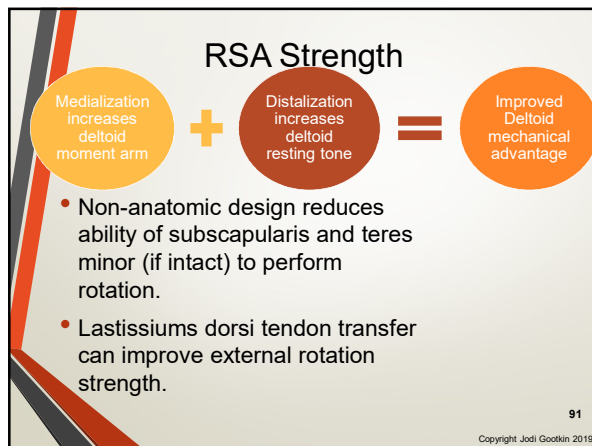
Procedure	Outcomes
Severe fracture	Abduction 90°-100°, poor internal rotation, significant variance in external rotation
Major rotator cuff tear	Elevation improved from 71° to 130°
Irreparable rotator cuff deficiency	Improved anterior elevation from 42° to 100°, abduction 43° to 90°
Acute proximal humerus fractures	Abduction limited to 90°-100° ER/IR varied
Osteoarthritis	Mean 154° elevation, 18° ER, IR to T10

Smith, C. D., Guyver, P., & Bunker, T. D. (2012). Indications for reverse shoulder replacement: a systematic review. *The Journal of bone and joint surgery, British volume*, 94(5), 577-583.
 Favard, L., Lavigne, C., Nerot, C. et al. Reverse prostheses in arthroplasties with cuff tear: Are survivorship and function maintained over time? *Clin Orthop Relat Res* 2011;469:2469-75.
 Familari, F., Rojas, J., Nedim Dorai, M., Hurl, G., & McFarland, E. G. (2018). Reverse total shoulder arthroplasty. *EFORT Open Reviews*, 3(2), 58-69.
 Chun YM, Kim DS, Lee DH, Shin SJ. Reverse shoulder arthroplasty for four-part proximal humerus fracture in elderly patients: Can a healed tuberosity improve the functional outcomes? *J Shoulder Elbow Surg* 2017;26:1216-21.
 Sanchez-Sotelo, J., Nguyen, N. T. V., & Morrey, M. (2018). Anatomic Total Shoulder Arthroplasty Using a Self-Pressurizing Pegged Bone-Preserving Cemented Glenoid Component: A 2-to 5-Year Follow-up Study. *Journal of Shoulder and Elbow Arthroplasty*, 2, 2471549217750478.

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Sample Phases

Phase I: Start Pos-op Day 1	Phase II: Start 4 Weeks	Phase III: Start 6 Weeks	Phase IV: Start 12 Weeks
• Allow tissue healing • Maintain new joint integrity • Increase shoulder PROM • Restore elbow/wrist/h and AROM • Reduce pain, inflammation • ADL Modification	• Restore arthrokinematics, muscle balance, and motor control • Restore full PROM • Restore AROM • Control pain, inflammation • Activity Retraining	• Restore shoulder strength, power, and endurance • Optimize neuromuscular control • Return to functional activities with operative extremity	• Maintain AROM • Enhance functional use of operative extremity • Improve shoulder strength, power, and endurance • Progress weight bearing exercises

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Rehabilitation Phases

- Progression must be based on clinical findings not timeframes and consider concomitant rotator cuff repair, biceps tenodesis, latissimus dorsi transfer, subscapularis reattachment, and humeral fracture healing.
- **Communication with the physician** regarding the patient's risk factors for complications can assist the clinician in progressing the patient.

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Sample Phase 1 Precautions

- Avoid shoulder AROM
- No driving
- Avoid sudden movements especially rotation
- No combined shoulder internal rotation, extension, and adduction
- No lifting, pulling, pushing objects
- No supporting of body weight by hand on the operative side
- Keep incision clean and dry

Wear Sling
Ask for help with activities
Always be able to see elbow with positioning

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Rehabilitation Protocols

Timelines & Interventions Vary Follow the Physician Protocol

RSA Progression is typically slower

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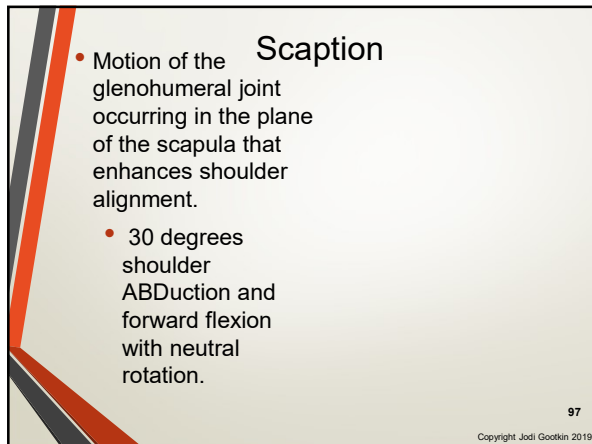
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Sample Phase I : Begins POD 1

- Patient education joint protection and positioning
- PROM
 - Forward flexion in supine to tolerance
 - ER in scaption
 - IR to chest
- AROM elbow, hand, wrist, and forearm
- Pendulum exercise
- Scapular setting
- Cryotherapy

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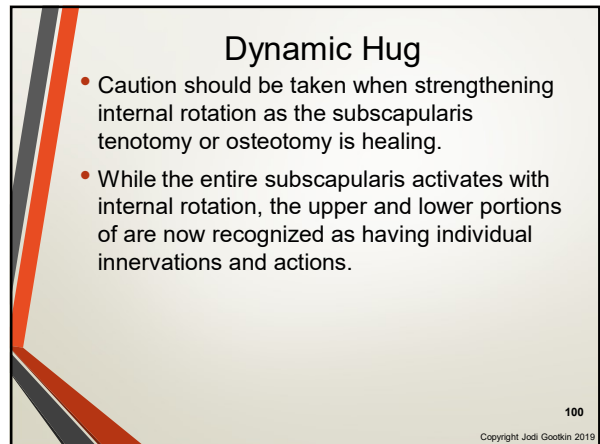
Scaption

- Motion of the glenohumeral joint occurring in the plane of the scapula that enhances shoulder alignment.
 - 30 degrees shoulder ABDuction and forward flexion with neutral rotation.

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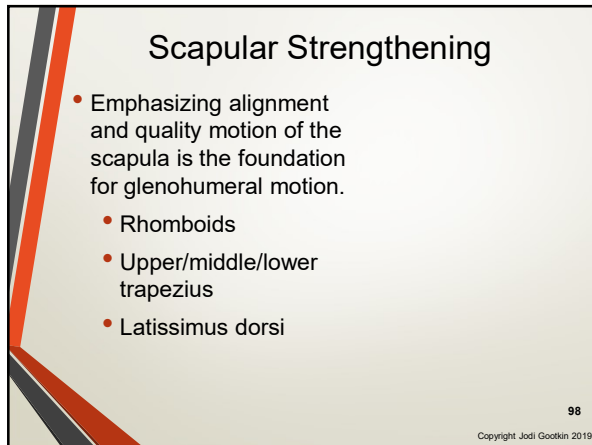
Dynamic Hug

- Caution should be taken when strengthening internal rotation as the subscapularis tenotomy or osteotomy is healing.
- While the entire subscapularis activates with internal rotation, the upper and lower portions of are now recognized as having individual innervations and actions.

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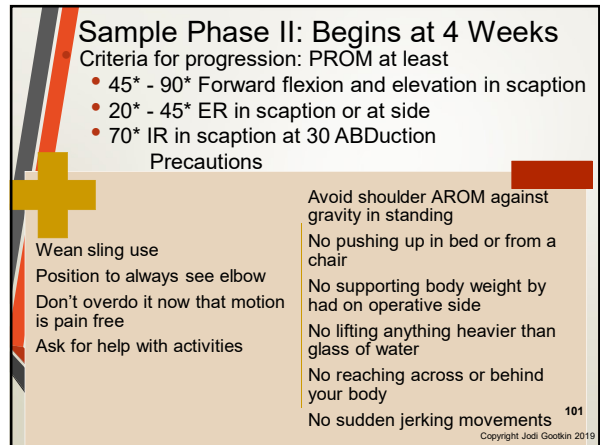
Scapular Strengthening

- Emphasizing alignment and quality motion of the scapula is the foundation for glenohumeral motion.
 - Rhomboids
 - Upper/middle/lower trapezius
 - Latissimus dorsi

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Sample Phase II: Begins at 4 Weeks

Criteria for progression: PROM at least

- 45° - 90° Forward flexion and elevation in scaption
- 20° - 45° ER in scaption or at side
- 70° IR in scaption at 30° ABDuction

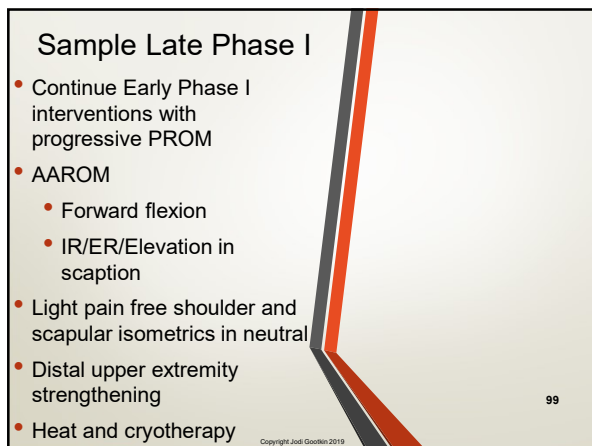
Precautions

• Wean sling use • Position to always see elbow • Don't overdo it now that motion is pain free • Ask for help with activities	• Avoid shoulder AROM against gravity in standing • No pushing up in bed or from a chair • No supporting body weight by hand on operative side • No lifting anything heavier than glass of water • No reaching across or behind your body • No sudden jerking movements
--	--

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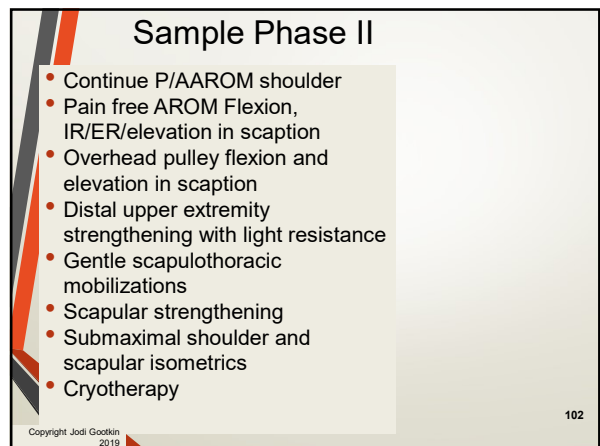
Sample Late Phase I

- Continue Early Phase I interventions with progressive PROM
- AAROM
 - Forward flexion
 - IR/ER/Elevation in scaption
- Light pain free shoulder and scapular isometrics in neutral
- Distal upper extremity strengthening
- Heat and cryotherapy

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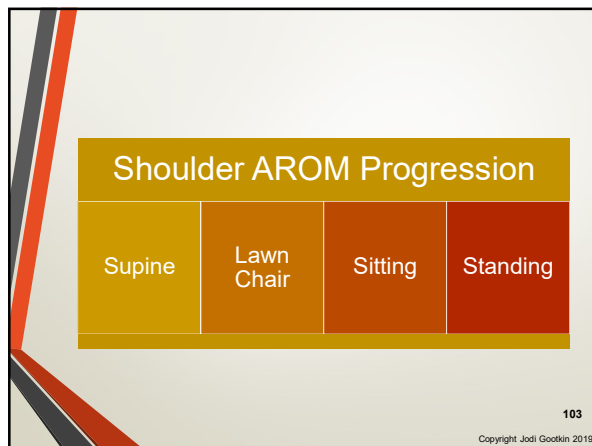
Sample Phase II

- Continue P/AAROM shoulder
- Pain free AROM Flexion, IR/ER/elevation in scaption
- Overhead pulley flexion and elevation in scaption
- Distal upper extremity strengthening with light resistance
- Gentle scapulothoracic mobilizations
- Scapular strengthening
- Submaximal shoulder and scapular isometrics
- Cryotherapy

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Sample Late Phase III

- Progressive scapular strengthening
- A/AROM shoulder internal rotation behind back and extension
- Supine shoulder flexion with light resistance
- Theraband shoulder flexion and elevation in scaption
 - Check with physician on shoulder extension and internal rotation

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Sample Phase III: Begins at 6 Weeks

Criteria for progression: PROM in scaption at least

- 120° -140° Forward flexion and elevation
- 40° -60° ER
- 70° IR at 30 ABDuction
- 100° Active against gravity elevation with good mechanics

Precautions

+ • Wean from sling completely • Utilize operative extremity for light functional tasks	• No heavy lifting objects over 6 pounds • No sudden lifting or pushing activities • No sudden jerking motions
---	--

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Sample Phase IV: Begins at 12 Weeks

Criteria for progression:

- AROM At least
 - 140° Forward flexion
 - 120° ABDduction
 - 60° ER in scaption
 - 70° IR in scaption at 30 ABD
- 100°- 120° Active against gravity shoulder elevation with good mechanics

Precautions

+ • Gradually progress strengthening	• Avoid functional activities stressing anterior capsule
---	--

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Sample Early Phase III

- Progress shoulder AROM
- Advance PROM to stretching
- Resisted shoulder ER in scapular plane
- Begin endurance training

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Sample Phase IV

- End ROM stretching
- Progressive strengthening
- Return to moderately challenging functional activities and recreation

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Exercises to Avoid

- Horizontal extension, ABDuction and external rotation combination

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Activities of Daily Living (ADLs)

- During early rehab, encourage self care by providing dressing and hygiene instruction and reassurance of performance that protects the healing tissues.
 - One handed donning and doffing of button-up shirt one to two sizes larger than usual size.
 - Seated donning of elastic waist loose bottom pants/shorts using dressing stick.
 - Pop-top toothpaste, pump soap and shampoo dispensers.

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Discharge from Therapy

- Maintain non-painful full AROM
- Restored use of upper extremity for advanced functional activities
- Maximized strength, power, and endurance

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Hygiene and Toileting

- Washing underarm and torso on surgical side can be performed using Codman's position or by placing hand of operative arm gently in closed chain position on stable counter/sink at 30*-45* degrees of forward flexion or scaption.
- Raised toilet seat, commode over toilet, or grab bar on non-operative side assists with sit to stand.

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Functional Outcomes

Follow-up time frame	Procedure	Outcome
5 years	RSA	All Constant scores improved AROM forward elevation and ER improved
3 years	TSA	Able to perform combing hair, washing opposite armpit, tying apron, taking book from shelf using less flexion and abduction compared to controls.
1 year	RSA	

Favard, L., Levigne, C., Nerot, C., Gerber, C., De Wilde, L., & Mole, D. (2011). Reverse Prostheses in Arthroplasties With Cuff Tear: Are Survivorship and Function Maintained Over Time? *Clinical Orthopaedics and Related Research*, 469(9), 2469-2475.
Maur, M. W., Niklasch, M., Dreher, T., Zellert, F., Rettig, O., Klotz, M. C., ... & Kasten, P. (2014). Motion patterns in activities of daily living: 3-year longitudinal follow-up after total shoulder arthroplasty using an optical 3D motion analysis system. *BMC musculoskeletal disorders*, 15(1), 244.
Maur, M. W., Caspers, M., Zellert, F., Dreher, T., Klotz, M. C., Wirt, S. I., & Kasten, P. (2014). How does reverse shoulder replacement change the range of motion in activities of daily living in patients with cuff tear arthropathy? A prospective optical 3D motion analysis study. *Archives of orthopaedic and trauma surgery*, 134(8), 1065-1071.

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TSA Functional Progression

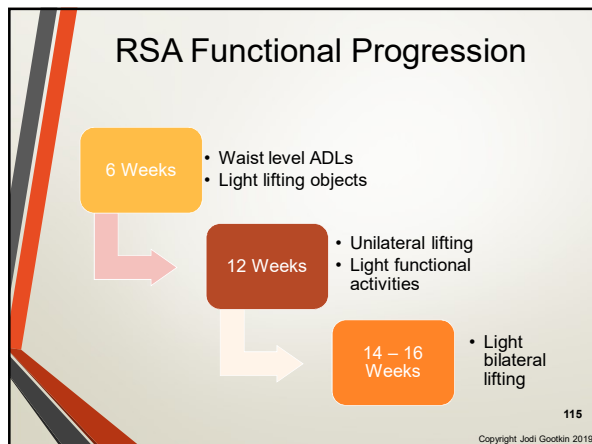
```

graph TD
    A["TSA 2 - 4 Weeks"] --> B["6 Weeks"]
    B --> C["12 Weeks"]
    C --> D["6 Months"]
  
```

- TSA 2 - 4 Weeks**
 - Waist level ADLs
 - Light lifting objects
 - Driving
- 6 Weeks**
 - Driving
 - Sedentary job
 - Unilateral lifting
 - Light meal prep
- 12 Weeks**
 - Light bilateral lifting, carrying, pushing, pulling
- 6 Months**
 - Heavy Lifting

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Shoulder Arthroplasty Clinical Outcomes

- Research is supporting similar outcomes can be expected from patients following total and reverse shoulder arthroplasty.
- The majority of the ROM and function gains occur within the first six months.

Simovitch, R., Fluris, P. H., Marczuk, Y., Friedman, R., Wright, T. W., Zuckerman, J. D., & Roche, C. P. (2015). Rate of improvement in clinical outcomes with anatomic and reverse total shoulder arthroplasty. *Journal of Bone and Joint Surgery*, 98-1907-11.

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Return to Sport and Work

- Total Shoulder Arthroplasty appears to have better outcomes with ability to return to pre-operative recreational sports.

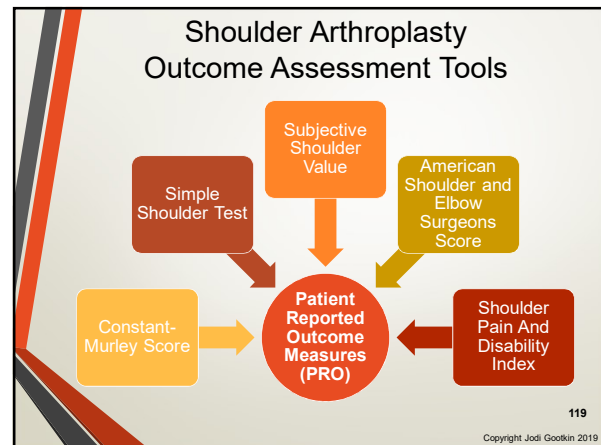
TSA	RSA
Greater ease with variety of sports and work activities requiring shoulder function.	Able to participate in work and low to mid-impact sports.
Higher sport and work specific ASES scores	Improved duration and intensity of participation.
Increased frequency of sport participation.	More restricted guidelines on return to certain sports.
Small proportion report persistent restrictions.	Longer recovery period before return permitted.

Consider This

Kurawicki, J., Rozas, S., Law, Y., Levy, J. (2018). Participation in Work and Sport Following Reverse and Total Shoulder Arthroplasty. *Am J Orthop*, May 23, 2018.
Johnson, C. C., Johnson, D. J., Liu, J. N., Dines, J. S., Dines, D. M., Galotta, L. V., & Garcia, G. H. (2018). Return to sports after shoulder arthroplasty. *World Journal of Orthopedics*, 7(9), 519.

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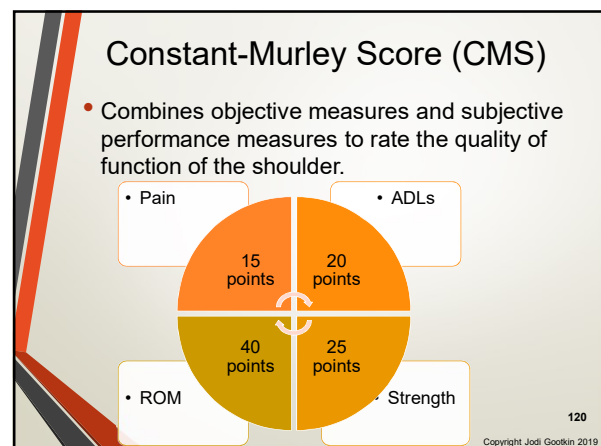
Sample Physician Sport Recommendations

Recommended and Allowed	Allowed with Experience	Not Recommended	No Consensus
Swimming Dancing Bowling Running Bicycling	Golf Ice Skating Downhill Skiing	Hockey Rock climbing Gymnastics Football	Baseball Softball Lacrosse Rowing Soccer Weight Lifting Singles Tennis

Johnson, C. C., Johnson, D. J., Liu, J. N., Dines, J. S., Dines, D. M., Galotta, L. V., & Garcia, G. H. (2018). Return to sports after shoulder arthroplasty. *World Journal of Orthopedics*, 7(9), 519.

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Simple Shoulder Test (SST)

- Reflecting on past week, patient answers yes/no questions regarding shoulder comfort and function.
- Minimal Clinically Important Difference (MCID) for shoulder arthroplasty is 3 points.

Roy, J. S., Macdermid, J. C., Faber, K. J., Drowsowech, D. S., & Athwal, G. S. (2010). The simple shoulder test is responsive in assessing change following shoulder arthroplasty. *Journal Of Orthopaedic & Sports Physical Therapy*, 40(7), 413-421.

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Subjective Shoulder Value (SSV)

- This tool is an example of a Single Assessment Numeric Evaluation (SANE).

On a scale of 0% -100% where 0% is abnormal and 100% is normal, how would you rate your shoulder?

Sabesan, V. J., Lombardo, D. J., Khan, J., & Walter, J. M. (2015). Assessment of the optimal shoulder outcome score for reverse shoulder arthroplasty. *Journal of Shoulder and Elbow Surgery*, 24(10), 1653-1659.

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American Shoulder and Elbow Surgeons Score (ASES)

Patient Reported

Pain VAS

Functional Questions

Physician Assessed

ROM

Strength

Instability

Subjective

Flexion, ER, IR, Horizontal Adduction

0-5 MMT Scale

Anterior, inferior, posterior

Tenderness, scarring, atrophy

- Patient rating of pain and function using 0-50 point scale for each.
- MCID 12 -17 point change

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Prosthetic Survival

- Implants are surviving at short and midterm follow-up with assessment of long term durability and longevity needed.
- Historical use of shoulder arthroplasty in patients of advanced age with advanced arthritis and irreparable rotator cuff tears limits the research cohort for long term studies as patients often outlive the prosthesis.

Bacle, G., Nové-Josserand, L., Garaud, P., & Walch, G. (2017). Long-term outcomes of reverse total shoulder arthroplasty: a follow-up of a previous study. *JBUS*, 99(6), 454-461.

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Shoulder Pain And Disability Index (SPADI)

- Patient ranking on 0 to 10 scale of pain level with specific activities and difficulty with ADLs.
- Pain and Disability scores total to 130 with a score of 0 indicating no disability or pain.

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Research Considerations

- Retrospective analysis of patients undergoing shoulder arthroplasty between 1990 and 2015 concludes that more specific study analyzing specific patient data is necessary to determine if outcomes are improving as prosthetic design and surgical technique advances.

Procedure	Studies	Cohort Size	Follow-up
TSA	42 studies	20- 705 patients	3-5 years
RSA	37 studies	20-174 patients	4-5 years

Somerson, J. S., Neradilek, M. B., Hsu, J. E., Gee, A. O., & Matsen, F. A. (2017). Is there evidence that the outcomes of primary anatomic and reverse shoulder arthroplasty are getting better? *International Orthopaedics*, 41(8), 1235-1244.

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RSA Long Term Outcomes

Cohort	Outcome
Initial: 186 patients followed 40 months	Midterm: Increased Constant Score and Anterior Elevation
Follow-up: 84 patients followed 150 months	Long term: Overall prosthetic survival 93% 73% scapular notching Greater degradation of function in patients who had surgery prior to age 76

Bade, G. Nové-Josserand, L., Garaud, P., & Walch, G. (2017). Long-term outcomes of reverse total shoulder arthroplasty: a follow-up of a previous study. *JBJS*, 99(6), 454-461.

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Patient Satisfaction

Procedure and Population	Satisfaction
TSA Patients under 50	95% at 5 years
Hemiarthroplasty Patients under 50	71% at 5 years
TSA for Osteoarthritis	Mean 10/10 at 3 years
RSA for Rotator Cuff Arthropaty	90% at 4 years
RSA Workers Compensations Patients	57% at 2 years
RSA Non-workers Compensation Patients	95% at 2 years

Eichinger, Josef & R. Miller, Lindsay & Hartshorn, Timothy & Li, Xinming & J.P. Warner, Jon & D Higgins, Laurence. (2015). Evaluation of satisfaction and durability after hemiarthroplasty and total shoulder arthroplasty in a cohort of patients aged 50 years or younger: An analysis of discordance of patient satisfaction and implant survival. *Journal of shoulder and elbow surgery*. American Shoulder and Elbow Surgeons. 25. 10.1016/j.jse.2015.09.028.

Patri, M., Euler, S. A., Dornan, G. J., Greenspoon, J. A., Horan, M. P., Kathagen, J. C., & Millett, P. J. (2016). Predictors for satisfaction after anatomic total shoulder arthroplasty for idiopathic glenohumeral osteoarthritis. *Archives of Orthopaedic and Trauma Surgery*, 136(6), 755-762.

Favard, L., Lavigne, C., Nerot, C., Gerber, C., De Wilde, L., & Moir, D. (2011). Reverse Prostheses in Arthroplasties With Cuff Tear: Are survivorship and function maintained over time? *Clin Orthop Relat Res* 2011;469:2469-75.

Morris, B. J., Hagler, R. E., Laughlin, M. S., Elkousy, H. A., Garisman, G. M., & Edwards, T. B. (2015). Workers' compensation claims and outcomes after reverse shoulder arthroplasty. *Journal of Shoulder and Elbow Surgery*, 24(5), 453-459.

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Rotator Cuff Tear Outcomes

- Long term high functional outcome scores associated with RSA in young patients with rotator cuff arthropathy.

Population	Outcome
Previous Rotator Cuff Repair	Lower ASES score, higher pain score, less ROM improvement
Younger patients	Excellent clinical improvement, high 12 year survivorship
506 patients	89% survivorship free of revision at 10 years with minimal functional deterioration
Under 60 years old	Significant ROM, pain and strength improvement without deterioration

Shields, E. J., Koueiter, D. M., Maerz, T., Schwark, A., & Winter, J. M. (2017). Previous Rotator Cuff Repair Is Associated With Inferior Clinical Outcomes After Reverse Total Shoulder Arthroplasty. *Orthopaedic Journal of Sports Medicine*, 5(10), 2325967117730311.

Familiari, F., Rizzo, J., Nedim Dorzi, M., Huri, G., & McFarland, E. G. (2018). Reverse total shoulder arthroplasty. *EFORT Open Reviews*, 3(2), 58-69.

Favard, L., Lavigne, C., Nerot, C., Gerber, C., De Wilde, L., & Moir, D. (2011). Reverse Prostheses in Arthroplasties With Cuff Tear: Are survivorship and function maintained over time? *Clinical Orthopaedics and Related Research*, 469(5), 2469-2475.

Ernstbrunner, L., Suter, A., Colaninno, S., Balen, S., & Gerber, C. (2017). Reverse Total Shoulder Arthroplasty for Massive, Irreparable Rotator Cuff Tears Before the Age of 60 Years: Long-Term Results. *JBJS*, 99(20), 1721-1729.

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Future of Shoulder Arthroplasty

- Enhancing design of the reverse shoulder components to restore greater external rotation is expected to improve functional outcomes.
- Monitoring long term implications of scapular notching on prosthetic survival is needed.

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Post Traumatic Outcomes

Diagnosis	Procedure	Outcome
38 patients with previous ORIF for fracture	RSA	Constant score improved from 25* to 57* Shoulder forward elevation increased from 73* to 117* degrees
23 patients with displaced proximal humeral fracture	ORIF with Plate and screws or RSA	Good clinical outcomes and fewer complications in both. Better ADL results with RSA.
Systematic review of patients with complex proximal humeral fracture	Hemiarthroplasty or RSA	Constant score, ASES score, ROM similar. Greater complications with RSA.

Raisz, P., Alami, G., Bruckner, T., Magosch, P., Habermeyer, P., Boileau, P., & Walch, G. (2018). Reverse shoulder arthroplasty for type 1 sequelae of a fracture of the proximal humerus. *Bone Joint J*, 100(3), 318-323.

Giardella, A., Alesione, F., Mocchi, M., Benicacci, M., Romano, A. M., Oliva, F., & Maradei, L. (2017). Reverse total shoulder arthroplasty versus angular stable plate treatment for proximal humeral fractures in over 65 years old patients. *Muscles, ligaments and tendons journal*, 7(2), 271.

Namdari, S., Horneff, J. G., & Baldwin, K. (2013). Comparison of hemiarthroplasty and reverse arthroplasty for treatment of proximal humeral fractures: a systematic review. *JBJS*, 95(18), 1700-1709.

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Conclusion

Shoulder arthroplasty has proven to improve joint stability, patient comfort and function. Future advances focus on expanding surgical indications and prosthetic design for enhanced clinical outcomes.

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1. Normal arthrokinematics of the glenohumeral joint follows the _____ rule.

- A. Convex on Concave
- B. Concave on Convex
- C. Superior on Inferior
- D. Inferior on Superior

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4. Which anatomical structure is replaced in a shoulder hemiarthroplasty?

- A. Humeral head
- B. Glenoid fossa
- C. Acromial-clavicular joint
- D. Coracoid process

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2. The articular surface area of the humeral head is approximately _____ times greater than that of the glenoid fossa.

- A. 2
- B. 3
- C. 4
- D. 5

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5. Which of the following is TRUE regarding a reverse shoulder arthroplasty (RSA)?

- A. The glenoid is concave
- B. The humeral head is concave
- C. The deltoid insertion is relocated to the medial humeral shaft
- D. All of the above

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3. Which of the following is NOT commonly treated surgically with a shoulder arthroplasty?

- A. Proximal humerus fracture
- B. Severe glenohumeral osteoarthritis
- C. Irreparable rotator cuff tear
- D. Chronic impingement syndrome

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6. Which of the following is commonly utilized surgical approach for shoulder arthroplasty?

- A. Latissimus sparing
- B. Posterosuperior
- C. Deltopectoral
- D. Superior Acromial

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7. Which muscle typically requires additional protection during the early stages of arthroplasty rehabilitation?

- A. Subscapularis
- B. Deltoid
- C. Supraspinatus
- D. Infraspinatus

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10. Which surgical intervention generally produces superior functional outcomes as it relates to return to sport?

- A. Hemiarthroplasty
- B. Total Shoulder Arthroplasty (TSA)
- C. Reverse Shoulder Arthroplasty (RSA)
- D. Outcomes for all are equal

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8. What is the most common long-term complication associated with anatomic total shoulder arthroplasty (TSA)?

- A. Humeral shaft fracture
- B. Supraspinatus avulsion
- C. Radial nerve neuropathy
- D. Loosening of the glenoid component

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9. Approximately, how much functional AROM should a patient have at therapeutic discharge?

- A. 30-60 degrees flexion; 15 degrees ER
- B. 60-90 degrees flexion; 30 degrees ER
- C. 80-120 degrees flexion; 30 degrees ER
- D. 120-150 degrees flexion; 60 degrees ER

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Shoulder Arthroplasty Resource Links

American Shoulder and Elbow Surgeons Score (ASES)

[https://journals.lww.com/jorthotrauma/Fulltext/2006/09001/American Shoulder and Elbow Surgeons ASES 33.aspx](https://journals.lww.com/jorthotrauma/Fulltext/2006/09001/American_Shoulder_and_Elbow_Surgeons_ASES_33.aspx)

Constant Murley Score (CMS)

<http://orthotoolkit.com/constant-shoulder/>

Shoulder Pain and Disability Index (SPADI)

<https://www.tac.vic.gov.au/files-to-move/media/upload/spi.pdf>

Simple Shoulder Test (SST)

<http://orthodoc.aaos.org/rickmatsen/SST.doc>