CQ HAND + UPPER LIMB
SPECIALIST ORTHOPAEDIC SURGEON

EVIDENCE SUMMARY

Revision rotator cuff repair

Overview

- Interposition grafting using fascia lata autograft can repair multiple rotator cuff injuries to the greatest extent [1].
- Interposition grafting using fascia lata autograft can restore the function of the shoulder joint [1].
- Interposition grafting using fascia lata autograft can effectively relieve pain [1].
- Biologic augmentation with a bioinductive collagen patch in revision rotator cuff tear repair reduces the retear rate at 12-month follow-up by 25% [2].
- Biologic augmentation with a bioinductive collagen patch in revision rotator cuff tear repair yields similar improvements in clinical outcomes [2].
- Biologic augmentation with a bioinductive collagen patch in revision rotator cuff tear repair is associated with no increased risk of complication [2].

Anatomy & Pathophysiology

BONY ANATOMY

- The proximal humerus comprises four main parts: the humeral head, greater tuberosity (GT), lesser tuberosity (LT), and humeral shaft [5].
- The articular head of the proximal humerus is spherical with a diameter of 37 to 57 mm [5].
- The most superior portion of the articular surface of the humeral head averages 8 mm above the greater tuberosity [5].
- Humeral version averages 29.8 degrees, with a range of 10 to 55 degrees [5].
- The humeral head is inclined approximately 130 degrees with respect to the humeral shaft [5].
- The anatomic neck of the proximal humerus is located at the junction of the articular surface and the tuberosities [5].
- The surgical neck represents an indistinct region, or metadiaphyseal junction, below the tuberosities but above the humeral shaft [5].

CQ HAND + UPPER LIMB
Dr Kieran Hirpara — Specialist Orthopaedic Surgeon
Suite 2, Level 1, Mater Private Hospital Rockhampton, 31 Ward Street, The Range, QLD 4700
Phone 07 4863 6556 · office@cqupperlimb.com.au · cqupperlimb.com.au

- The greater tuberosity is located in a posterior-superior location with respect to the humeral shaft and serves as the attachment site for the supraspinatus, infraspinatus, and teres minor tendons [5].
- The lesser tuberosity is located on the anterior aspect of the proximal humerus and serves as the attachment site for the subscapularis tendon [5].
- The bicipital groove lies between the greater and lesser tuberosities and serves as a pathway for the long head of the biceps [5].
- The distal aspect of the bicipital groove is internally rotated with respect to the proximal portion [5].
- The glenoid is a convex structure of shallow depth shaped like an inverted pear [5].
- The glenoid articulates with the humeral head and serves as the attachment for the labrum and joint capsule [5].
- The acromion, coracoacromial ligament, and coracoid process form the coracoacromial arch, a rigid bony-ligamentous structure that imparts stability to the shoulder girdle [5].
- The rotator cuff, subacromial bursa, and subdeltoid bursa pass underneath the coracoacromial arch [5].
- The scapula is attached to the axial skeleton by the clavicle, specifically via the acromioclavicular and sternoclavicular joints [7].
- The scapular body is triangular when viewed anteroposteriorly, with its base situated superiorly and its apex inferiorly [7].
- The glenoid is connected with the flat body of the scapula by the scapular neck [7].
- The hook-shaped coracoid process curves forwards from the superior surface of the scapular neck [7].
- The scapular spine arises from the posterior surface of the scapular body and ends in a flattened bony process, the acromion, which curves forwards [7].
- The distribution of bony mass in the scapula is highly uneven, with the highest concentration in the glenoid, scapular neck, and lateral border of the scapular body [7].
- Two bony pillars extend between the glenoid and the scapular body to transmit compressive forces from the glenoid fossa [7].
- The lateral pillar connects the inferior border of the glenoid with the inferior angle of the scapula [7].
- The spinal pillar arises from the central part of the glenoid and continues medially to become part of the base of the scapular spine [7].
- The weakest bone in the scapula is located primarily in the central part of the biomechanical body, specifically in the infraspinous fossa [7].
- The weakest area of the circumference of the biomechanical body of the scapula is the spinomedial angle, where the scapular spine connects to the medial border [7].
- The humeral head averages 19° of retroversion and 41° of inclination (neck-shaft angle) [8].
- The glenoid averages 5° of retroversion in relation to the axis of the scapular body [8].
- The subchondral bone of the glenoid is relatively flat, with the articular concavity augmented by cartilage and a circumferential labrum [8].

- The neck-shaft angle measures an average of 135 degrees, and the humeral head is retroverted an average of 30 degrees [6].

VASCULAR ANATOMY

- The proximal humerus receives its blood supply from the anterior and posterior humeral circumflex branches from the third division of the axillary artery [5].
- The posterior humeral circumflex artery travels with the axillary nerve, enters the quadrilateral space posteriorly, and anastomoses with a branch of the anterior circumflex to supply the posterior cuff [5].
- The anterior humeral circumflex artery arises from the axillary artery at the inferior border of the subscapularis and provides vascular inflow to the humeral head via its terminal anterolateral branch, known as the artery of Laing or arcuate artery [5].
- The ascending branch of the anterior humeral circumflex artery courses parallel to the lateral aspect of the long head biceps tendon and enters the humeral head at the interface of the bicipital groove and greater tuberosity [5].
- Injury to the arcuate artery may result in osteonecrosis of the humeral head [5].
- Additional extraosseous collateral branches can permit humeral head perfusion despite complete ligation of the arcuate artery [5].
- The major blood supply to the humeral head is through the ascending branch of the anterior humeral circumflex artery, which penetrates the head at the bicipital groove and becomes the arcuate artery [6].
- The anterolateral ascending branch of the anterior humeral circumflex artery provides the primary blood supply to the humeral head [8].
- The terminal intraosseous portion of the anterior humeral circumflex artery enters at the proximal aspect of the intertubercular groove as the arcuate artery [8].

SOFT TISSUE & LIGAMENTOUS ANATOMY

- The rotator cuff consists of four muscles: the subscapularis, supraspinatus, infraspinatus, and teres minor [6].
- The teres major is not a rotator cuff muscle [6].
- The rotator cuff muscles serve as depressors of the humeral head to allow the deltoid to efficiently abduct the humerus [6].
- The infraspinatus and teres minor are external rotators, while the subscapularis is an internal rotator of the humerus [6].
- The glenohumeral joint is stabilized dynamically by the rotator cuff via joint compression and by the positioning of the scapulothoracic joint [8].
- Static stabilizers of the glenohumeral joint include articular congruity, the glenoid labrum, concavity-compression, negative intra-articular pressure, and the glenohumeral capsule and ligaments [8].
- The glenoid labrum provides concavity and up to 50% of marginal glenoid socket depth [8].

- The rotator interval is defined medially by the base of the coracoid, superiorly by the supraspinatus tendon, and inferiorly by the subscapularis tendon [8].
- The rotator interval contains the coracohumeral ligament, the superior glenohumeral ligament, and the intra-articular portion of the long head of the biceps tendon [8].
- Laxity of the rotator interval results in inferior laxity, known as the sulcus sign [8].
- Contracture of the rotator interval is seen with adhesive capsulitis [8].
- The coracohumeral ligament restricts external rotation in adduction and is a static restraint to inferior and posterior translation in adduction and external rotation [8].
- The superior glenohumeral ligament is a primary static restraint against anterior translation with the arm at the side [8].
- The superior glenohumeral ligament, along with the coracohumeral ligament, forms a pulley that provides restraint against medial subluxation of the long head of the biceps tendon [8].
- The middle glenohumeral ligament is a primary static restraint against anterior translation with the arm in external rotation and 45° of abduction [8].
- The anterior band of the inferior glenohumeral ligament is a primary static restraint against anterior-inferior dislocation of the glenohumeral joint in 90° of abduction and external rotation [8].
- The posterior band of the inferior glenohumeral ligament is a primary static restraint against posterior-inferior translation in internal rotation and adduction [8].
- The superior transverse scapular ligament arises from the medial base of the coracoid overlying the suprascapular notch [8].
- The suprascapular artery runs superior to the superior transverse scapular ligament, while the nerve runs deep to it [8].
- Entrapment of the suprascapular nerve at the superior transverse scapular ligament causes denervation of both the supraspinatus and the infraspinatus [8].
- The spinoglenoid ligament overlies the suprascapular nerve at the spinoglenoid notch [8].
- Entrapment, traction, or compression of the suprascapular nerve at the spinoglenoid notch causes denervation of the infraspinatus [8].
- The subscapular bursa lies between the subscapularis tendon and the neck of the scapula and communicates with the joint cavity between the superior and middle glenohumeral ligaments [9].
- The subscapular bursa protects the tendon of the subscapularis at the point where it passes under the base of the coracoid process and over the neck of the scapula [9].
- The subscapular bursa is linked to the coracoid process by a suspensory ligament [9].
- In 28% of dissected specimens, the subscapular bursae merged with the subcoracoid bursae, forming a unique wide bursa [9].
- The subscapular bursa often houses loose bodies in the shoulder and is a region where synovitis may be most intense [9].

CQ HAND + UPPER LIMB
Dr Kieran Hirpara — Specialist Orthopaedic Surgeon
Suite 2, Level 1, Mater Private Hospital Rockhampton, 31 Ward Street, The Range, QLD 4700
Phone 07 4863 6556 · office@cqupperlimb.com.au · cqupperlimb.com.au

- A soft tissue sheath consistently covers the long head of the biceps tendon to the level of the proximal margin of the pectoralis major tendon and contributes to the roof of the bicipital tunnel [9].
- The fibro-osseous bicipital tunnel consists of three distinct anatomic zones: Zone 1 (bony groove), Zone 2 ("no man's land" between subscapularis and pectoralis major), and Zone 3 (subpectoral region) [9].

PATHOPHYSIOLOGY & BIOMECHANICS

- Stability and function of the glenohumeral joint are provided by the interaction of structures that promote a near global range of motion and purposeful function [5].
- External loads transferred to the shoulder girdle are initially offset by joint surface anatomy, joint volume, atmospheric pressure, and joint fluid cohesion and adhesion [5].
- Moderate and large loads are counterbalanced by the deltoid and rotator cuff, and by the capsulolabral and bone structures, respectively [5].
- Pathologic conditions alter complex shoulder interactions, resulting in pain, decreased range of motion and stiffness, and disability [5].
- Displacement of proximal humeral fracture fragments occurs in a predictable manner based on deforming forces created by the tendinous insertions of the pectoralis major, subscapularis, supraspinatus, and infraspinatus [5].
- The subscapularis inserts on the lesser tuberosity and causes medial displacement of the fragment [5].
- The supraspinatus and infraspinatus insert on the greater tuberosity and cause superior and posterior displacement of the fragment [5].
- The pectoralis major inserts on the humeral shaft and displaces it medially [5].
- Fractures involving the anatomic neck are prognostically worse than fractures involving other regions of the proximal humerus due to potential disruption of the vascular supply to the humeral head and subsequent development of avascular necrosis [5].
- Displaced proximal humeral fractures can impede normal movement of the rotator cuff, subacromial bursa, and subdeltoid bursa, causing impingement and disruption of normal glenohumeral motion [5].
- In proximal humeral fractures, the subdeltoid and subacromial bursae can become thickened and fibrotic, forming adhesions that limit normal glenohumeral motion [5].
- The glenoid cavity is a shallow socket, approximately one third the size of the humeral head [6].
- Stability of the glenohumeral joint depends on the capsule, ligament, and muscle [6].
- A redundant capsule allows for motion in the glenohumeral joint [6].
- The scapula is separated from the chest wall by thin gliding fibro-fatty tissue, allowing its smooth excursion over the chest wall [7].
- The scapula provides efficient support to the humeral head, allowing compressive forces to be optimally transmitted from the upper limb to the shoulder girdle without compromising stability or mobility of the glenohumeral joint [7].
- The superior shoulder suspensory complex provides a stable connection between the scapula and the axial skeleton [8].

Dr Kieran Hirpara — Specialist Orthopaedic Surgeon
Suite 2, Level 1, Mater Private Hospital Rockhampton, 31 Ward Street, The Range, QLD 4700
Phone 07 4863 6556 · office@cqupperlimb.com.au · cqupperlimb.com.au

- The superior shoulder suspensory complex is composed of the glenoid, coracoid process, coracoclavicular ligaments, distal clavicle, acromioclavicular joint, and acromion [8].
- The superior strut of the superior shoulder suspensory complex comprises the middle clavicle [8].
- The inferior strut of the superior shoulder suspensory complex comprises the lateral scapular border and spine of the scapula [8].
- Normal shoulder motion is approximately two-thirds glenohumeral and one-third scapulothoracic [8].
- The sternoclavicular joint is the only true diarthrodial articulation between the upper appendicular and axial skeletons [8].
- The posterior sternoclavicular joint capsule and ligaments are the primary stabilizers to anterior and posterior translation of the medial clavicle [8].
- The acromioclavicular joint is a small diarthrodial joint with an interposed fibrocartilaginous disk [8].
- The superior and posterior acromioclavicular ligaments are the primary stabilizers to anterior and posterior horizontal translation of the clavicle [8].
- The coracoclavicular ligaments, consisting of the conoid (medial) and trapezoid (lateral) ligaments, are the primary stabilizers to superior vertical translation of the distal clavicle [8].
- The acromion has three ossification centers: the metacromion (base), mesoacromion (middle), and preacromion (tip) [8].
- Failure of fusion of the acromial ossification centers results in os acromiale [8].
- The relationship between acromial anatomy and rotator cuff disease remains controversial, with classification of acromial morphology challenged by poor interobserver reliability [8].
- The relationship between coracoid morphology and subscapularis tears is controversial [8].
- The coracobrachialis muscle and the short head of the biceps tendon originate from the coracoid process [8].
- The pectoralis minor muscle inserts onto the medial coracoid process [8].
- The proximal humerus has three centers of ossification: the humeral head (4 to 6 months), greater tuberosity (1 to 3 years), and lesser tuberosity (3 to 5 years) [8].
- The ossification centers of the proximal humerus fuse to the shaft at age 17 to 20 years [8].
- The clavicle is the first bone to ossify, occurring in the fifth week of gestation, and is the only long bone to ossify by intramembranous ossification [8].
- The medial (sternal) epiphysis of the clavicle is the last ossification center to fuse, occurring at age 20 to 25 years [8].
- The primary blood supply to the clavicle is periosteal, with no nutrient artery present [8].
- Ossification of the scapular body begins at the eighth week of gestation [8].
- The scapular spine is an osseous ridge that separates the supraspinatus and infraspinatus fossae [8].
- The scapula has only one true diarthrodial articulation, the acromioclavicular joint [8].

Classification

- Biologic augmentation with a bioinductive collagen patch in revision rotator cuff tear repair yields similar improvements in clinical outcomes compared to controls [2].
- Biologic augmentation with a bioinductive collagen patch in revision rotator cuff tear repair does not increase the risk of complication [2].

Clinical Presentation

- Biologic augmentation with a bioinductive collagen patch in revision rotator cuff tear repair reduces the retear rate by 25% at 12-month follow-up [2].

Investigations

PLAIN RADIOGRAPHY

- The purpose of shoulder imaging is to help establish the diagnosis, determine the severity of the pathoanatomy, assist in surgical planning, and enable the surgeon to illustrate the condition of the shoulder to the patient [4].
- Standardized plain films are almost always sufficient to garner the information needed for shoulder care [4].
- The first key radiographic view is the anteroposterior (AP) view taken in the plane of the scapula such that the x-ray beam passes through the glenohumeral joint [4].
- The AP view in the plane of the scapula shows the superoinferior position of the humeral head relative to the glenoid, the presence of osteophytes on the humeral head and glenoid, narrowing of the joint space, and the degree of medial displacement of the humerus in relation to the lateral acromial line [4].
- The AP view in the plane of the scapula also shows the quality of the humeral and glenoid bone, the presence of loose bodies, and whether there is humeral head collapse or deformity [4].
- The second key radiographic view is the axillary view taken with the arm in the functional position of elevation in the plane of the scapula [4].
- The axillary view is oriented so that both the spinoglenoid notch and the scapular neck are visible [4].
- The axillary view shows a different perspective of the humeral anatomy, the amount of glenoid bone, the shape of the glenoid, its version in relation to the plane of the scapula, and the relationship of the humeral head to the glenoid fossa [4].
- The standardized axillary view is referred to as the “truth view” because it demonstrates the glenohumeral relationships in the functional position of elevation [4].
- CT scans have the disadvantage of being taken with the arm in the adducted position, unlike the axillary truth view which is taken in elevation [4].

CQ HAND + UPPER LIMB
Dr Kieran Hirpara — Specialist Orthopaedic Surgeon
Suite 2, Level 1, Mater Private Hospital Rockhampton, 31 Ward Street, The Range, QLD 4700
Phone 07 4863 6556 · office@cqupperlimb.com.au · cqupperlimb.com.au

- When taken properly, standardized anteroposterior and axillary views indicate the thickness of the cartilage space between the humerus and the glenoid, relative positions of the humeral head and the glenoid, presence of osteophytes, degree of osteopenia, and extent of bony deformity and erosion [4].
- Joint space narrowing is most evident on the axillary truth view as opposed to images made with the arm at the side [4].
- The axillary truth view can show posterior subluxation or "functional decentering" that is not evident in images taken with the arm at the side [4].
- The degree of posterior subluxation can be measured by the position of the center of the humeral head in relation to the plane of the scapula, the position of the center of the humeral head in relation to the glenoid face, or the point of contact of the humeral articular surface on the glenoid articular surface [4].
- The point of contact of the humeral articular surface on the glenoid articular surface reflects the degree of centering of the net humeral joint reaction force on the glenoid [4].
- Malcentering of the joint reaction force leads to posterior instability, posterior glenoid wear, and "rocking horse" loosening of prosthetic glenoid components [4].
- At least two X-ray views should be obtained: an anteroposterior in the plane of the glenoid and an axillary projection with the arm in abduction to show the relationship of the humeral head to the glenoid [13].

MAGNETIC RESONANCE IMAGING

- Magnetic resonance imaging (MRI) is useful to identify osteonecrosis of the humeral head, or a bone tumour [13].
- MRI can identify labral tears and rotator cuff tears, although the accuracy for these is enhanced by combining the scan with arthrography [13].

COMPUTED TOMOGRAPHY

- Computed tomography (CT) is helpful for planning fracture surgery and shoulder joint replacement [13].
- CT scans may offer a few degrees of increased precision in the measurement of glenoid version, but this precision does not necessarily improve the quality of the surgery or the clinical outcome [4].

ULTRASONOGRAPHY

- Ultrasonography is a simple and accurate test for identifying rotator cuff tears and calcific tendinitis [13].
- Ultrasonography can be useful in guiding injections or barbotage (aspirating calcific deposits in the rotator cuff) [13].
- The most commonly performed joint examination using ultrasonography is the shoulder examination [11].
- The accuracy of rotator cuff ultrasonography depends on the skill of the scanner operator and an awareness of pitfalls that are encountered [11].

GENERAL IMAGING PRINCIPLES

- The shoulder is a three-dimensional structure that cannot be represented by a single planar view [15].

- Critical relationships, such as the degree of centering of the humeral head, change with the position of the arm [15].
- Shoulder pathology may be found in a large number of different bones and soft tissues [15].
- Overlying and superimposed structures as well as metallic implants may complicate imaging the structures of interest [15].
- Surgeons need to develop a judicious approach to imaging that yields the information necessary to treat the patient while avoiding the tendency to "over-image" [15].
- The temptation to "overimage" should be resisted, obtaining only the scans or reconstructions that are necessary for the care of the patient [4].
- Proper radiographic technique is as important as proper surgical technique to achieve the desired outcome [4].

Key Evidence

- [L5] This technique can repair multiple rotator cuff injuries to the greatest extent, restore the function of the shoulder joint, and effectively relieve pain. [1] (10.1016/j.eats.2023.08.027)
- [L1] Biologic augmentation with a bioinductive collagen patch in revision rotator cuff tear repair reduces the rate at 12-month follow-up by 25%, yielding similar improvements in clinical outcomes and without any increased risk of complication. [2] (10.1016/j.jseint.2025.101507)

References

[1] Interposition Grafting Using Fascia Lata Autograft for Failed Rotator Cuff Repairs. *Arthroscopy Techniques*. 2023. DOI: 10.1016/j.eats.2023.08.027

[2] Biological augmentation in revision surgery: a matched-pair study of the effect of a nuns bioinductive collagen patch in patients with rotator cuff retear and a previous arthroscopic rotator cuff repair. *JSES International*. 2026. DOI: 10.1016/j.jseint.2025.101507

[4] Rockwood And Matsen S The Shoulder. Arthroscopic Management of Prearthritic and Arthritic Conditions of the Shoulder and the Postarthroplasty Shoulder > Radiographic Evaluation.

[5] Rockwood And Matsen S The Shoulder. Shoulder and Elbow Specialty Clinic Workers' Survey > ANATOMY.

[6] A Lange Medical Book Current Diagnosis Treatment In Orthopedics Fifth Edition. **2Musculoskeletal Trauma Surgery** > **SHOULDER AND ARM INJURIES**.

[7] Rockwood And Green S Fractures In Adults. 29: Principles of Nonunion and Bone Defect Treatment > Applied Anatomy Related to Scapular Fractures.

[8] Aaos Comprehensive Orthopaedic Review 3. Anatomy of the Shoulder, Arm, and Elbow > I. Shoulder.

[9] Rockwood And Matsen S The Shoulder. Developmental Anatomy of the Shoulder and Anatomy of the Glenohumeral Joint > Bursae.

[11] Orthopaedic Knowledge Update Sports Medicine 6. Diagnostic Ultrasonography and Ultrasonography-Guided Procedures > Annotated References.

[13] Apley And Solomon S Concise System Of Orthopaedics And Trauma. INVESTIGATION.

[15] Rockwood And Matsen S The Shoulder. Developmental Anatomy of the Shoulder and Anatomy of the Glenohumeral Joint > SENIOR EDITOR COMMENTARY.

CQ HAND + UPPER LIMB
Dr Kieran Hirpara — Specialist Orthopaedic Surgeon
Suite 2, Level 1, Mater Private Hospital Rockhampton, 31 Ward Street, The Range, QLD 4700
Phone 07 4863 6556 · office@cqupperlimb.com.au · cqupperlimb.com.au