The reductionist will fail, because in the final analysis the extremity is a single functional unit. In managing the upper extremity, the entirety of the functional system must be included, not only in diagnostic thinking, but within each treatment protocol, each treatment session; and there is great advantage in including as much of the whole system as possible in each procedure. Otherwise the problem will simply reinstate rather than resolve.

This concept of the integration of function and the dominance of muscular control largely determines clinical approaches to managing upper extremity problems. The dominance of muscular action and the importance of proprioceptive control for the upper extremity also means that this chapter should be read in conjunction with those within Book 2 on Muscles, Trigger Points, and Muscle Resistance Techniques, all of which have sections dedicated to proprioceptive coordination and treatment of the shoulder. The previous section on upper body patterning within Chapter 3 is also informative.

THE GLENOHUMERAL ARTICULATION REMODELED

The other major component in our updated model of understanding is that the shoulder is not a ball-and-socket joint. It is a cup-and-saucer joint. I use that analogy with patients, and they instantly appreciate the difference. Osteopaths must also appreciate this in order to alter the way they approach their clinical management. Jerosh went so far as to describe it as looking like a golf ball on a tee, but I think my version is a little more restrained!

The Humeral Head in Detail

The 3-D coordinate system for a right humeral head shown (left) diagrammatically. The origin is defined as the centre point of the whole articular surface. The Z-axis is the anatomic neck plane of the humerus, with the two other planes perpendicular to that. The whole articular surface, shown in grey (right), which was divided into 9 regions for contour analysis, is flattened asymmetrically.


The glenohumeral joint is only loosely constrained within a thin capsule, which is bounded by surrounding muscles and ligaments. It has lateral freedom and can dislocate relatively easily. This is

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largely due to the shallow depth of the glenoid and the fact that only about 25 percent of the humeral head surface makes contact with the glenoid. The fibrocartilaginous labrum, a ring attached to the outer rim of the glenoid, provides some additional depth and lateral stability. The glenoid therefore resembles the ‘saucer’ of the relationship, with the labrum creating the recess that normally locates the cup. Actually it is slightly more complex than a simple saucer, with the cavity ‘twisted’ from front to back, and with the inferior part somewhat deeper than the superior part, which is quite flat. But the saucer model serves to illustrate the overall function of the joint quite well.

If the glenoid does not function as a socket, then the humeral head also does not function as a ball, although the overall structure appears somewhat spherical. When the articular surface is considered alone, it is a complex ellipsoid, with the ratios of the superior and antero-superior portions greater than that of the central portion. This indicates that the mid-superior and antero-superior portions of the articular surface are slightly flatter than the central portion, and match the flatter part of the glenoid when in anatomically neutral positioning. In other words, there is a slight ridge along the centre of the articular surface, running roughly anterior-posterior, with flattened slopes.

The shallowness and small surface area of the glenohumeral joint make it susceptible to instability and injury, and require that stability be provided primarily by extrinsic support. The surrounding muscles and ligaments provide this, with the glenohumeral ligament serving as the primary static stabiliser, aided by the labrum and the capsule (with the capsule providing support only in selected vectors); together with some rotator cuff tendons and the rotator cuff muscles providing dynamic congruency.

The rotator cuff is composed of four muscles (subscapularis, supraspinatus, infraspinatus, and teres minor) attached to and forming a cuff around the head of the humerus. Subscapularis primarily acts to internally rotate, and acts both statically and dynamically to restrain gross anterior movement (dislocation). Supraspinatus is ascribed the function of initiating abduction dynamically, while restraining superior movement of the humeral head statically. Infraspinatus and teres minor resist posterior movement of the humeral head, more dynamically in this case, while adding to external rotation. From the lateral vantage point shown next page, it can be seen that their attachments serve as static limiters of translational movement of the humeral head. The biceps tendon also plays a role in stabilisation.


Stabilising Structures around the GlenoHumeral Capsule

A: acromion  
C: corocoid process  
SS: supraspinatis muscle  
IS: infraspinatus muscle  
T: tricep muscle  
BT: biceps muscle tendon  
G: labrum pad and rim  
MGHL: middle glenohumeral ligament  
SGHL: superior glenohumeral ligament  
IGHLC: inferior glenohumeral ligament complex, with axillary pouch between.

From: Modaressi et al. (2011)

When Professor Frank Willard travelled the Atlantic to lecture us at the ESO, he had a particular slide sequence that was most illuminating. It showed the careful resection of the medial and superior borders of a scapula, followed by enough freeing off that it could be swung right around to the sternal point. This revealed several fascinating relationships. The first was how small the upper thorax looked, and how it really was shaped like an old-fashioned skep beehive. (see below) This shape meant that the positioning of the scapula would always follow the skep profile, allowing considerable anterior translation around the side of the slope.

The second was that the upper extremity is attached to every point on the spine, from sub-occiput to lumbosacral region, and those myofascial attachments are quite secure. They ensure that wider movements of the arms are intrinsically matched to torso motion.

The third relationship was that the only point of skeletal attachment between the upper extremity complex and the axial skeleton was the sternoclavicular joint. The final slide looked quite surreal, with the whole arm and scapula positioned straight ahead of the bodyline. To me this indicated how important it would be to ensure good unions of clavicular fractures, in order that the correct orientation of the extremity to the axial skeleton was maintained, but I have seen some grossly-overlapped unions that were neglected during medical care, for whatever reason. Current protocol in New Zealand

is to not set fractures of the clavicle whatever the circumstances, which defies logic, as the whole orientation of the shoulder girdle can be grossly affected from then on.

The slide sequence also crystallised for me how posture, height, and orientation of the shoulder are utterly dependent on relative muscular tonus. This includes both anterior–posterior stance, and the degree of elevation or depression. This means that shoulder horizon is completely independent of any skeletal biomechanics. Obviously any kyphosis of the thoracic cage will promote anteriorisation of both scapulae, but the difference between the dominant and subordinate shoulder profiles is controlled totally by muscular imbalance. Relating this back to the Common Compensation Pattern; there is no need to incorporate distortion of the shoulder horizon into the greater pelvic and skeletal patterning of the CCP, as was illustrated in the biomechanical models of Pope and Defeo.

The dropping of the dominant side relative to the other is one of the most dominant and common features of the handedness posture. Many people believe this is due to the fact that for many years they carried their heavy schoolbag on that shoulder. But when we carry anything looped over the shoulder promontory, the immediate response is to raise the shoulder upwards somewhat in order to stop the strap slipping off with movement. So that theory is just urban myth. The real reason for this distortion is that the upper shoulder muscles into the neck usually have fairly matched tonus and length, unless the person indulges in very strong dominant-side activities. But there is a greater laterality bias between the lower muscle sets, including lattisimus dorsi, inferior trapezius, and quadratus lumborum. So the balance of superior and inferior tension on the dominant side results in a shoulder girdle complex that sits lower than the other side.

Whenever a patient presents with the subordinate shoulder girdle lower, there is certainty that postural distortion is present. This clinical sign was covered in depth within the chapter on Retropattern mechanics.

1. The model of the glenohumeral joint is not a ball-and-socket, but a cup-and-saucer, allowing an appreciation of the importance of the rotator cuff muscles and peri-articular structures in maintaining congruency. This model also encompasses the lack of lateral control offered by the capsule and labrum.

2. Nevertheless, both these last elements do provide some competent location of the humeral head, especially in unloaded motion.

3. The upper extremity performs far more complex movements than the lower extremity, which involve unique muscular and skeletal dynamics.

4. All relays within the sequence of structural elements – fingers, hand, wrist, forearm, upper arm, glenohumeral complex, scapula, clavicle and neck – combine to produce motion, load-control, positioning and stabilisation, and recruitment simultaneously.

5. Due to this complexity of function, and integration, Sherrington’s Law breaks down when considering the upper extremity.

6. In understanding the biomechanics of the upper extremity, one must appreciate that both distal and proximal directionality of relationships will operate simultaneously, and both must be considered in clinical management.

7. The upper extremity therefore demands global thinking in diagnosis and treatment.
PROBLEMS WITH GLENOHUMERAL STANCE

Apart from the differential in dominant/subordinate shoulder girdle height, the ‘skep’ shape of the upper thoracic cage allows that any anterior tensioning from the flexors of the arm, or any shortening of the pectoral muscles will draw the scapula forwards. This creates something resembling a ‘knob’ profile at the front of the glenohumeral capsule. The phenomenon can also result from thoracic kyphosis. Anteriorisation will alter geometries and tensions of structures close to or penetrating the capsule. They include the coracoid attachments, the main biceps tendon, the acromial promontory, and the clavicular attachment.

But most importantly this alteration probably places pressure at the two ‘pinch points’ of the axillary tunnel; at the sub-coracoid point, where subscapularis muscle becomes involved, and at the apex of the axilla, which is the point of intersection of the first rib, clavicle, and scapula (the apex of the armpit is actually the base of the conoid axilla, sometimes called the conoid pouch).

It is interesting that the professionals most concerned with spatial geometry of the axillary tunnel are the anaesthetists, who commonly insert nerve blocks. There is one study in particular by Cornish, an anaesthetist (and fellow-countryman), of the geometry of the axillary tunnel, which used CT scanning to follow the spread of dye. The resulting axial views showed that the scapula/subscapularis complex lies across one side of the plexus within the tunnel, encroaching from where the tunnel passes the level of the coracoid process until further down in the axilla, where it then recedes postero-medially.

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The study concluded that the head of the humerus was not a restrictor of the tunnel. But in my opinion it would be interesting to study what changes in spatial geometry might occur with pronounced anteriorisation of the glenoid.

As the ulnar branches of the brachial plexus head off more posteriorly, it does not surprise me that ulnar nerve impingement tends to be associated with an anteriorised glenoid. Parasthaesia of the small digits is almost pathognomonic of a glenoid impingement syndrome unless there is clear history pointing towards the ulnar tunnel of the elbow. In contrast, the median nerve seems to favour either perivertebral or wrist impingement points.

There is another ergonomic problem that affects function of the glenohumeral complex and concerns stance. Once the arm is elevated past a certain point, there will be impingement between the humerus and the acromial promontory. Elevation, or protraction/elevation of the arm therefore has two stages, and the second is when the scapula and shoulder girdle rises.

There are two problems associated with the transfer from Stage 1 to Stage 2 elevation. The first is that if the scapula is restricted then deltoid muscle overstrains in its shortened position, and typically presents with chronically tight fibres along the scapular border. This problem is associated with shortening or tension in the adductor muscles; the muscles that form the anterior and posterior walls of the axilla. It will happen even if the scapula is tardy in responding. If the scapula is anteriorised then Stage 2 needs to come in earlier to prevent deltoid muscle struggling to reach elevation and therefore becoming overused.

Secondly, a number of occupations and activities require the arm to be held in protraction and elevation at an angle of around 75° to 85° unsupported, while controlled movement are carried out. These include hairdressing and styling, linguistic signing, dentistry, teaching (writing on whiteboards), as well as musicians playing the flute, clarinet, violin, or harp. Some osteopaths have been known to spend quite a portion of their day in the same position! A number of household tasks also require this positioning, such as cleaning high areas and reaching to clotheslines. The ergonomics of these activities are quite challenging for the shoulder primarily because deltoid muscle is working at the limit of its range and therefore recruitment of peri-scapular muscles will be maximal, including trapezius, which brings considerable tension into the neck. Fortunately, many other protraction/elevation activities that are very common such as driving and keyboarding allow some degree of support.

**CONTROL OF THE UPPER EXTREMITY**

In keeping with the complexity of movement and positioning, the upper extremity has intricate proprioceptive and coordinative controlling. The lower extremities have a few well-defined movements to perform such as in gait, running, and climbing. Other common actions include pushing up from either chair sitting, or cross-legged sitting, or squatting.

But the upper extremity operates as a sophisticated cantilever system, moving the hand to wherever it needs to be, in order to pick up loads or transfer them, or off-load them. The hands also work in conjunction with each other; one hand holding an object while the other performs an operation on it – just as our hunter-gatherer forbearers did when they chipped flakes off flints to create cutting edges.

In this modern world, the hands also perform complex operations together, such as in playing musical instruments, keyboarding, driving; and using sporting equipment as in golf. They also perform gestural movements in synchronicity with speech. There is no end to the complexity and confident dexterity we expect of our arms (and that is without considering texting or game-consoling!).