**Essentials of Sports Injury Prevention & Rehabilitation**

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## Lecture – 3

## Joints of the Upper Limb

Good morning ladies and gentlemen. Welcome to lecture 3 of week 1 of the course on Sports Injury Prevention and Rehabilitation. We will be talking about the joints of the upper limb in this lecture. However, we will not be covering the joints of the upper limb in a precise anatomical detail, because as we all know, each joint is a PhD topic by itself. We will be covering it in special relation to sports injuries, and to the rehabilitation process. How we can prevent it, how we can improve upon the rehabilitation process, etc.

So, I will be covering this topic under the following heads: shoulder joint, elbow joint and wrist joint. If we talk about the shoulder joint, we know that it is a structurally and functionally very very complex joint. It is a freely movable area due to the articulation of the glenohumeral joint. The red circle marked is the glenohumeral joint and if we talk about the shoulder joint per say, this is the shoulder joint.

However, it cannot function in isolation and it needs something called the shoulder girdle which is comprised of 4 joints, that is the sternoclavicular that is between the medial end of the clavicle and the lateral upper end of the sternum that is somewhere here. The acromioclavicular joint which is between the acromion process of the scapula and the lateral end of the clavicle. The scapulothoracic joints, these are not joints per say, they are more muscular and tendinous attachments between the scapula and the thoracic wall, and last the glenohumeral joint which is the shoulder joint per say. Now, if we come to the biomechanics or rather the applied biomechanics, we do understand that the glenohumeral joint is inherently unstable because the glenoid fossa is shallow, and the head of the humerus is large. The glenoid fossa is able to contain approximately one third of the head of the humerus only.

So, what do we do about the rest of the head? So, there is something called a capsule, which extends from the borders of the glenoid fossa and covers more of the humeral head. This capsule, the muscles surrounding the shoulder joint and the ligaments, more precisely something called the rotator cuff tendons, and the ligaments around the shoulder joint, contribute a lot to the stability of the shoulder joint. There are three ligaments around the shoulder joint superior, middle and inferior glenohumeral ligaments. The shoulder capsule, because of the position and because there is a jelly-

like synovial fluid inside the shoulder capsule, it causes a negative intra-articular force, and the capsule and this negative intra-articular force plays an integral part in maintaining shoulder stability. Elevation of the arm involves motion at both the glenohumeral as well as the scapulothoracic articulation.

That means, if you are going to move the arm you are going to involve the glenohumeral joint as well as the scapula. Movements of the spine also assist the shoulder in positioning the upper extremity in space. So, basically you cannot have upper extremity movements without involving the scapula, the shoulder joint and the spine. If we talk about the forces; the glenohumeral joint bears half the body weight at least when you are holding the arm in the outstretched position like this or like this. At least half the body weight force is on the glenohumeral joint at this time.

During this movement, the muscles around the shoulder joint produce a compressive force on the glenohumeral joint, and the rotator cuff helps to stabilize the head of the humerus. However, if you are fatigued, if you have trauma or if there is any hyper laxity of the ligaments, the tendons and the capsule around the shoulder joint, you will definitely get shoulder injury because the rhythms will get abnormal. The scapulohumeral and the glenohumeral ligaments, and the scapulohumeral and the glenohumeral rhythms will get abnormal, and you will have trauma to the shoulder joint. If we talk about the applied anatomy of the shoulder, we will realize that it is the most common joint to be dislocated. The rotator cuff which helps to stabilize the shoulder, is also very prone to injuries in the form of partial tears or complete tears.

If there are injuries to the shoulder joint, the capsule or to the rotator cuff, you can do something called arthroscopic surgeries to repair these. Reduction of the shoulder joint is much easier, and there are several techniques which have been developed to reduce the shoulder joint dislocations. There are several fractures, which if they occur around the shoulder joint, they will impact the neurovascular structures which are present around the shoulder joints. The brachial plexus, the axillary artery, the axillary nerves, these are all present in very close proximity to the shoulder joint, and they may get damaged if there are fractures around the shoulder joint. Diabetics get a very common condition which are called frozen shoulder or periarthritis, in which fibrous bands form around the shoulder joint and prevent the shoulder joint from moving. It is as similar to wearing a tight shirt, which will prevent you from moving your arm.
Let us talk about the elbow. We have realized that the shoulder is an important joint in mobility and it is a very mobile joint. However, the elbow is another joint which is important if you want to do any actions of the upper limb. It is a synovial joint between the arm and the forearm.

It is an articulation of three bones that is the humerus, the radius and the ulna. To put it simply, the elbow joint has got three components. One: the lower end of the humerus, two: the upper end of the radius, and three the upper end of the ulna along with the olecranon process. So, it is

classified structurally as a compound joint, because there are two articulations in the joint. It consists of three articulations: the humero-ulnar, the humero-radial and the proximal radio-ulnar.

So, the humero-ulnar is this, the humero-radial is this and the proximal radio ulnar is between the radius and the ulna. Wherein the head of the humerus which is this round structure here articulates with the upper end of the ulna. It allows for two types of movements: flexion, extension, pronation and supination. The functional range of elbow motion is 30 degrees to 130 degrees in flexion and extension, and 50 degrees to 50 degrees of pronation and supination. If we talk about the elbow, we should always talk about something called the carrying angle, which is the angle produced by the humerus and the ulna.

Now, this carrying angle is usually between 10 to 15 degrees of valgus, valgus is this wherein the arm is thrown away from the body. Now, this angle is the carrying angle. 10 to 15 degrees is normal in males, and 15 to 20, 25 degrees is normal in females. As we know females have a wider and shallower pelvis and the carrying angle is more in females so that they have the arm has to clear the pelvis. If we talk about the muscles which act around the elbow joint, the primary flexor of the elbow is not the biceps as is commonly believed, but the brachialis and the primary extender is the triceps muscle.

The main supinator is the biceps brachii, and the main pronator is the pronator quadratus. The forces generated in the elbow have to be shown to be up to 3 times the body weight when you are doing your activities of daily living. If ADL causes 3 times the body weight, imagine the forces which are there upon a sporting elbow. We talk about the applied anatomy of the elbow. We will find the dislocations are rare in adults.

However, there is a very common entity called subluxation of the radial head, which occurs in children. What happens is, if you lift up children by pulling on their forearms, the head of the radius will dislocate out from the, there is a ligament which attaches the head of the radius to the ulna and it will come out from that ligament. This is called a pulled elbow, and it is very common in children who are lifted up by their forearms or their hands. Arthritis of the elbow is relatively common. More common in the elbow is a condition called epicondylitis which is commonly seen in structures surrounding the elbow that is the medial and the lateral epicondyle of the elbow.

Fractures around the elbow are common, and they do affect the alignment of the elbow joint, and which may cause either faulty movement patterns in future or arthritis of the elbow joint. If arthritis of the elbow joint is severe, you can go in for something called elbow replacement; wherein, the whole joint is replaced by a prosthesis. Commonly seen around the elbow is a procedure called a venipuncture, wherein blood is drawn from the veins around the elbow. Let us talk about something called the wrist joint. The wrist joint is also called a radiocarpal joint and

it is an articulation between the lower end of the radius, the lower end of the ulna and the carpal bones of the hand.

It is a synovial joint of the condyloid type and it is formed by the articulation of the distal end of the radius, and the proximal rows of the carpal bones. The lower end of the ulna does not directly articulate with the carpal bones. However, there is a structure here called TFCC, which articulates with the lower end of the radiocarpal and the proximal carpal bones. So, what are the carpal bones? There are 8 carpal bones. Simple to remember with the use of a mnemonic called: "she looks too pretty try to catch her".

So, scaphoid, lunate, triquetrum, pisiform, trapezium, trapezoid, capitate and hamate. So, these are the 8 carpal bones, and this is the mnemonic by which you can remember them easily. The wrist joint is a complicated joint, because it has to be it allows a lot of movements in a lot of planes, and it comprises of multiple articulations of the 8 carpal bones along amongst themselves with the distal radius, with the TFCC, with the metacarpals and amongst each other. They are conventionally divided into a proximal row, and a distal row of carpal bones. Movements at the wrist include flexion, extension, radial deviation and ulnar deviation.

You can also have a rotatory movement which is a combination of all these movements. Stability of the wrist is provided by the carpal bones itself, because they are very closely fitting to each other and there are a lot of intrinsic and extrinsic ligaments, which provide stability to the wrist joint. The wrist joint is an important joint, because the position of the wrist joint affects the abilities of the fingers to flex, extend maximally and to grasp. Any activity which the fingers have to do, has to be supported by the wrist joint. So, if anything affects the wrist or if the wrist is fused, the fingers will not be able to move and perform fine motor activities in a precise manner.

The applied anatomy of the wrist: Dislocations of the wrist are rare because the wrist fractures more than it dislocates. The ligament and the TFCCs of the wrist joint will tear or will rupture more likely than it will dislocate. A peculiar entity which is seen in the wrist joint is called scaphoid fractures, which is I would say as a physician it is one of the most painful fractures to treat, because first of all the vascularity of the scaphoid is different as compared to the rest of the body. So, if there is a problem in the scaphoid fracture or in the fracture healing, Avascular necrosis of the scaphoid is very very common and; so, you have to keep the wrist immobilized for at least 12 weeks if there is a fracture.

You may have to operate on the scaphoid much earlier than any other wrist fracture. So, scaphoid fractures have to be treated separately, more methodically and with more care than the rest of the wrist fractures. Arthritis of the wrist is unfortunately more common than we see.
You may have nerves which pass close to the wrist joint, and they may get compressed around the wrist joint and you may get something called nerve compressions, the most common of which is

carpal tunnel syndrome. You may get tendinopathies, because there is a small area around the wrist joint where a lot of tendons pass through; and these tendons may cause ruptures, they may cause tendinitis, tendinopathies which are very common around the wrist joint.

So, let us have the take home message of this lecture. There are three major joints of the upper limb which are the shoulder, the elbow and the wrist and they help the upper limb to perform all its functions including fine motor activities. The shoulder joint is highly mobile, but unstable. Arm movements involve the shoulder, the scapula, the spine and they are all multi axial movements. The elbow joint is stable, but has limited mobility.

The elbow joint allows flexion, extension, supination and pronation. The wrist joint is a complex joint involving 15 bones. The movements at the wrist are multi axial and affect finger functioning. I would recommend that you go through these references from which we have prepared this lecture. I thank you for your time and patience in listening to the lecture.

Do let us know if you have any comments and any queries regarding this lecture. Thank you for listening ladies and gentlemen and Jai Hind. Thank you.

References:

Basic Biomechanics of the Musculoskeletal System by Margareta Nordin, Victor H. Frankel; Dawn Leger - 4th ed.

Sports Injury Prevention and Rehabilitation: Integrating Medicine and Science for Performance Solutions by David Opar, Kevin Cross, and Julie Hides, 2016.