

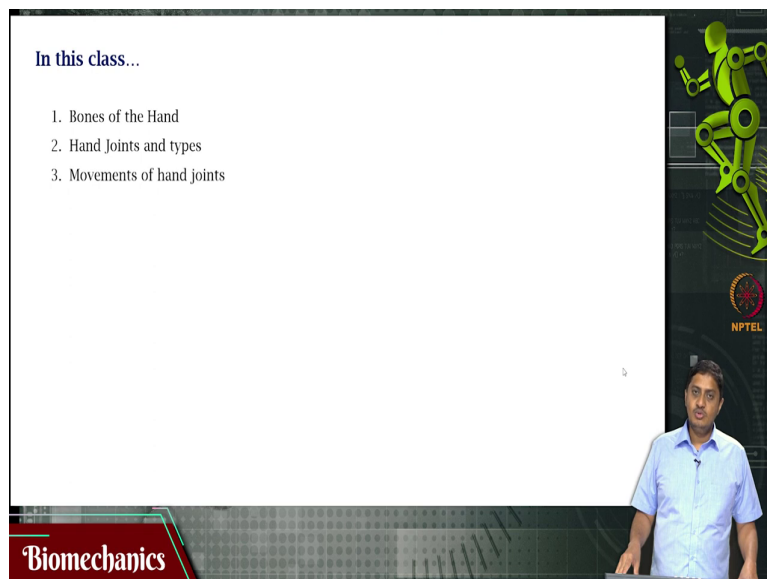
**Biomechanics**  
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**Lecture – 29**  
**Finger Theory**

Welcome to this video on biomechanics we have been looking at the biomechanics of the joints of the Upper Limb specifically we looked at shoulder joint and elbow joint. So, we will be looking at the wrist joint and the joints within the fingers. Surprisingly are rather unsurprisingly the human hand has a very large number of bones and a lot of bony articulations. These bony articulations are rather the anatomy the morphology the structure gives rise to perhaps give rise to the enormous dexterity found in humans.

So, it would make sense for us to spend some time to study the hand in some detail. So, let us get started with our analysis of the bones of the hand.

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So, in this video we will be looking at the bones of the hand the joints within the hand and the types of joints and the movements that are made by these joints.

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### Bones of the Hand

Three major bones of the hand are,

1. Carpal bones - Proximal Bones - 8  
irregular shape bones
2. Metacarpal bones - 5 metacarpal bones
3. Phalanges - Each finger has 3 phalanges except thumb

Anterior view      Posterior view

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There are three major types of Bones within the hand the first is the carpal bones. These are the most proximal of the bones within the hand and there are eight of these bones and they are not having any particular shape they are irregularly shaped bones irregular shaped bones proximal bones. So, that is bones that are closest to the wrist joint and these bones called as carpal bones each one of them has a name.

These are trapezium, trapezoid, scaphoid bones that are near the thumb then more medially in the anatomical reference position when you are looking at more medially you have Hammett well actually cap it helmet. Then more proximally we see from lunate of course you have the ulna and the radius but these form the bones of the forearm these are the forearm bones. So, here there will be the distal radio enlargent.

Remember while we discuss the elbow we discussed the proximal radial nerve joint right. Now there is one more joint of the radiation ulna which is called as the again the radio or not giant but this is more distant this is the distal radial radio ulnar joint. So, the carpal bonds are the most proximal of the bones within the hand. So, those are located closest to the wrist. Then you have the metacarpal bones those that have articulations with the carpal bones and there are five of these five metacarpal bones.

These bones do not have a name unlike the carpal bones which are trapezium trapezoid scaphoid hamide capite pcform trichotomy lunate there are eight carpal bones. The metacarpal bonds are five in number and they do not have a name they are simply called as the first metacarpal second metacarpal third metacarpal forth metacarpal fifth metacarpal.

The metacarpal bone of the thumb is called as a first metacarpal that for the index finger is called as a second third fourth and fifth so on right.

So, 1 2 3 4 5 is assigned from the thumb to the little finger. So, if someone says the fourth metacarpal they are referring to the metacarpal bone of the ring finger something to keep in mind. Then you have the bones within the fingers themselves those that form the segments of the fingers each segment is called as a phalanx the plural is phalanges phalanges. Each finger except the thumb has three such segments or phalanges.

So, let us take the index finger you have this segment and then this segment and then the distal most segment. So, the segment that is closest to the Palm or the most proximal of this segment is called as a proximal phalanx and the one in the middle is called as a intermediate Phalanx and the most distal of this is called as a distal phalanx ok. The thumb has only two phalanges one is called as a proximal Phalanx the other one is called as the distal phalanx.

There is no intermediate phalanx in the thumb. So, if I were to count I will have essentially how many phalanges I will have 3 times 4 there are four fingers and three segments in each of them. So, I will have 12 total phalanges for the four fingers and I have two more phalanges for the thumb. So, I have a set of 14 phalanges so that is that. But that is not counting the special nature of the thumb which we will discuss in the future slides.

Because the nature of the copper metacarpal joint for the digits 2 3 4 5 when I say digit 2 3 4 5 I am talking about index middle ring little the first digit is the thumb. So, the nature of the copper metacarpal joint for the digits 2 3 4 5 or the index middle ring and little finger is very different from the nature of the copper metacarpal joint for the thumb. So, we will have to discuss these details this kind of work in this kind of field the delight is always in the details.

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**Hand Joints and types**

Main joints of the hand,

1. **CMC** - Carpometacarpal Joint - Carpals bones and metacarpal bones (Thumb and other Metacarpals) - Saddle Joint and Ellipsoidal Joint *Metacarpophalangeal joint*
2. **MCP** - Metacarpal Joints - Phalanges and the metacarpals - Ellipsoidal Joint
3. **IP** - Interphalangeal Joints
  - **PIP** - Proximal IP - Proximal and Middle Phalange - Hinge Joint
  - **DIP** - Distal IP - Middle and Distal Phalange - Hinge Joint

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So, let us take the carpo metacarpal joint this is where the articulation of the carpal bones and the metacarpal bones happen right. So, this joint is called as a CMC joint CMC means carpal metacarpal joint right carpo meta carpal CMC chart the articulation is happening between the carpal bones and the metacarpal bones. So, for the thumb for the thumb let us remember this is what we are discussing right this is the carpo metacarpal joint for the thumb.

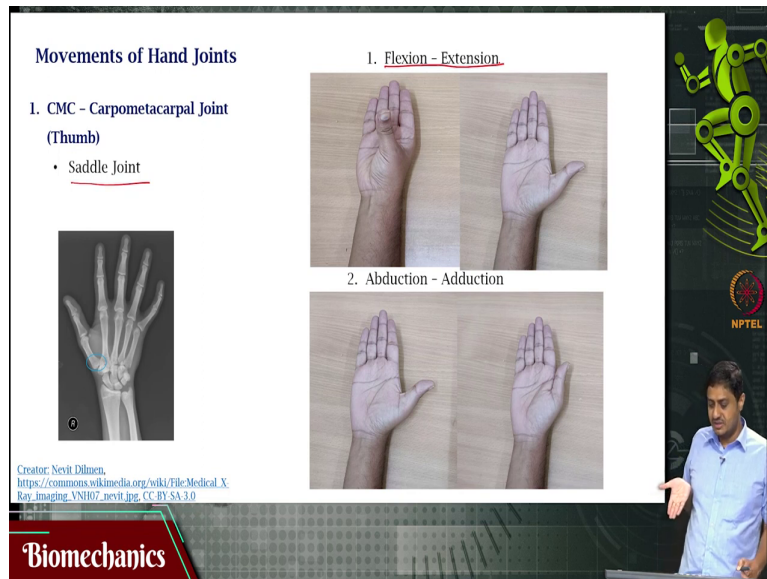
It turns out that for the fingers there is very little to no movement that happens at the CMC joint of the four digits or digits 2 3 4 and 5. However it turns out for the thumb a lot of articulation a lot of movement originates at the CMC joint and a unique feature of the thumb something that we will have to discuss in future. So, the nature of this joint it is a saddle joint and ellipsoidal joint.

What about the metacarpophalangeal joint MCP means the joint or the articulation between the metacarpal bones and the finger segments right this is the metacarpophalangeal joints or the MCP joints. Metacarpal MC here there is a P but it is rather metacarpo phalangeal joint meta carpo phalangeal joint MCP joints this is where the metacarpal bones meet the finger phalanges or the finger segments these are ellipsoidal joints.

Then you have the joints between the finger segments itself or the articulation between the phalanges themselves. These are the so, called interphalangeal joints or the IP joints interphalangeal joints. For the thumb there are only two phalanges and there is exactly one interphalangeal joint IP joint is one in number for the thumb. For the other fingers there are two interphalangeal joints one here and one there.

That is the proximal interphalangeal joint and the distal interphalangeal joint PIP joint and the DIP joint. The joint that is closest to the palm or the more proximal of these joints is called as the PIP joint or the proximal interphalangeal joint the one that is more distal is called as a DIP joint distal interphalangeal joint. Both of these are hinge joints meaning that they are going to have one degree of freedom.

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Now let us look at the moments of the joints of the hand. We start with the carpo metacarpal joint or the CMC joint of the thumb that is that joint remember that is not on the this joint this is the metacarpophalangeal joint I am talking about that joint right the joint that is closest to the wrist. It turns out that only for the thumb in humans in particular in humans only for the thumb. The CMC joint is a unique very well articulated and highly movable joint it is a saddle joint.

And many of the moments made by the thumb because of the nature of this saddle joint and the amount of movements that are possible within this saddle joint the moments that are made by the thumb are many tanks out of the plane of the palm. And it turns out that the moments are the plane perpendicular to which this movement is happening keeps on changing because of the nature of the saddle joint and the amount of articulation that is present in this inter joint.

It is an extremely difficult geometry to describe. So, this is the nature of this saddle joint which is highly movable highly articulated moment within the thumb. So, one moment that

we find is the flexion and extension of the thumb that is flexion extension right that is true. Then I have remember we always consider the anatomical position when we discuss. When the thumb moves away from the midline of the body like that as I am showing now away from the midline it is called abduction.

It is like kidnapping or abduct to move away from the midline abduction when you move toward the midline it is called adduction.

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Then you have this movement that you are seeing now which is a combination of the flexion extension and abduction and adduction that actually my thumb movements are somewhat restricted because of a fracture that I had in my scaphoid bone but you can you can try it on yourself you will find that that is that. Then because of the special nature of the thumb and the special muzzle available to perform a position in particular in humans this is a very well developed feature.


It turns out that the thumb can perform a position to the individual fingers like I am now showing this is called opposition moments. So, that is that moment there is also a combination of flexion extension and abduction adduction depending on in which direction you are moving toward the digit are you moving away from the digit. It is a combination of the two this perhaps all of this come from the nature of the saddle joint of the CMC or the carbon metacarpal joint such a very well movable joint.

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**Movements of Hand Joints**

1. CMC - Carpometacarpal Joint  
(Other metacarpals)


- Ellipsoidal Joint



1. Flexion



Extension



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For the other fingers what happens at the CMC joint right. Technically you know these are not very well movable joints. So, you can do that this is the moment that happens at the CNC joint you know as a whole but individually it is very difficult to move individual fingers like that a reason is because there is this lack of finger individuation something that we will discuss in future. So, that flexion extension is possible this is an again an ellipsoidal joint this CMC joint.

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**Movements of Hand Joints**

1. MCP - Metacarpal Joints -  
Phalanges and the metacarpals

Ellipsoidal Joint



1. Flexion



Extension



2. Abduction



Adduction



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Then you have the metacarpophalangeal joint in which there is a lot more of this articulation plus a lot more of this movement that can be visibly seen right that is that moment versus that moment flexion and extension and also I can do that. So, even I am keeping like this when I am moving the index finger away from the midline like that when I am doing that it is abducted away I can also do that right.

I can do that abduction of the fingers and adduction of the fingers. This is possible because of some special muscles that are responsible for abducting this for performing that movement right that happens at the metacarpophalangeal joint which is a two degree of freedom. So, I can do that I can do that that is I can do this sort of movement I can also do that sort of sideways movement which is abduction reduction and flexion extension I can do that. So, it is a two degree of freedom.

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The slide is titled "Movements of Hand Joints". It contains two main sections:

- 1. MCP - Metacarpal Joints - Phalanges and the metacarpals Ellipsoidal Joint**: This section includes an X-ray image of a hand with a blue circle highlighting the MCP joint. Below the image is a URL: [https://commons.wikimedia.org/wiki/File:Medical\\_X-Ray\\_imaging\\_VN107\\_nest1.jpg](https://commons.wikimedia.org/wiki/File:Medical_X-Ray_imaging_VN107_nest1.jpg), CC BY-SA 3.0.
- 3. Circumduction**: This section includes a photograph of a hand with the index finger pointing upwards, demonstrating the movement of circumduction.

The slide also features a green robot graphic on the right side, an NPTEL logo, and a "Biomechanics" logo at the bottom left. A small inset image of a man in a blue shirt is visible in the bottom right corner of the slide.

Of course I can do this the circumduction which is which can be classified as a combination of flexion extension and abduction reduction I can do this. Remember you can only do this at the MCP joint at the metacarpal phalangeal joint. You cannot for example do it at the interphalangeal joint that is not possible because the interphalangeal joints are hinge joints with one degree of freedom remember that. You cannot rotate like this or just try to do that you will realize that it is impossible.


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**Movements of Hand Joints**

3. PIP - Proximal IP - Proximal and Middle Phalange

- Hinge Joint
- Movement - Flexion (lots) - Extension (minimal)



Flexion - Extension



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Then you have the proximal interphalangeal joint this is where the proximal Phalanx and the intermediate Phalanx are the middle Phalanx mid this is a hinge joint in which there is flexion you can extend up to a limit but extending beyond that limit anatomical range is not possible. So, or rather what one would call as hyper extension is not possible at least not in the PIP joint proximal interphalangeal change.

So, a lot of flexion is possible a lot of flexion is possible but a limited amount of extension is possible. So, flexion; next like this I can do that.

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**Movements of Hand Joints**

3. DIP - Distal IP - Middle and Distal Phalange

- Hinge Joint
- Movement - Flexion (lots) - Extension (minimal)



Flexion - Extension



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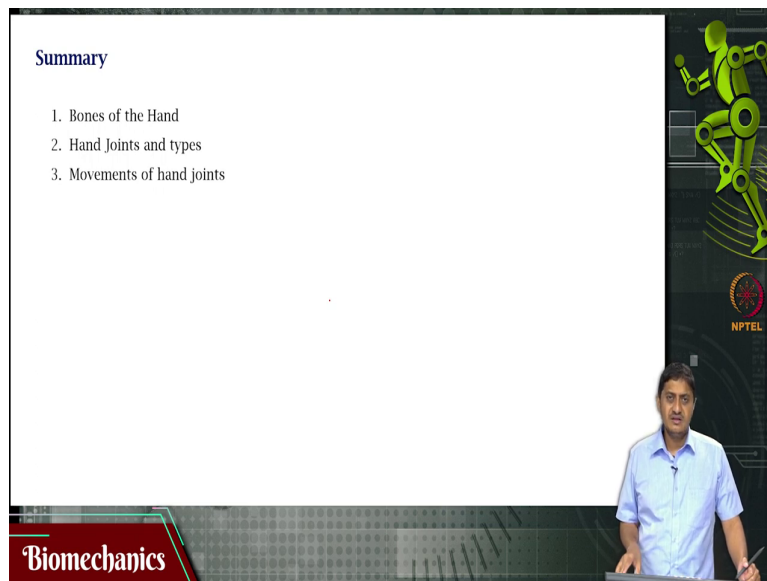
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Then you have the distal interphalangeal joint these are these joints right. In these joints again this is a hinge agent I can perform the quite difficult to demonstrate this flexion but you can observe I can perform minimal flexions like that and extension flexion extension like that.

One thing that is possible in the DIP joint but not in the PIP joint is this set of hyper extension I can actually push with an external Force with the left finger I am pushing on the right finger like that.

This is possible this is some hyper extension that is happening at the DIP joint but that is not possible at the PIP joint so, something to keep in mind. So, extension or voluntary extension is rather limited in both the interphalangeal joint hyper extension through an external load is possible at the DIP joint but not in the PIP joint.

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So, with this we come to the end of this video in this video we have seen the set of all bones of the hand what are these bones the carpal bones that are 8 in number that are closest to the wrist here and the metacarpal bones that are five in number that that attach or that articulate with the carpal bones. Each one of these metacarpal bones is called the first metacarpal second metacarpal third metacarpal fourth metacarpal and fifth metacarpal.

But the carpal bones have names trapezium trapezoid scaphoid etcetera. Then you have the after the metacarpal bones you have the finger segments themselves these are called as the phalanges segments are singularized Phalanx plural is phalanges right. The phalanges these are three in number for the four digits, digits 2 3 4 5 and two in number for the thumb and the corresponding metacarpal phalangeal joints.

Earlier when we discuss carpal metacarpal joints then metacarpal phalangeal joint and then the interphalangeal joint there are two such joints for digits 2 3 4 5 and only one such joint

further thumb. So, these are the various bones that are present in the hand how many let us try to do this math one more time carpals eight metacarpals five then phalanges three per finger for the four fingers twelve.

Then thumb phalanges 2,  $14 + 13$ . the mat correct there are 27 bones in each hand and many of these bones are highly movable and possible to articulate extraordinary level some of them are not very movable yes but some of them are highly mobile which is why you have this dexterous highly dexterous machine that is the wonder that is the human hand. So, we saw the bones of the hand the joints of the hand and the types of these joints and the movements that happen within these joints of the hand. So, with this we come to the end of this video thank you very much for your attention.