

# HUMAN FUNCTIONAL ANATOMY 213

## Biarticular muscles

### Objectives

1. To understand the mechanism of biarticular muscles
2. Their disadvantages and advantages
3. Their need for synergists

This weeks lab:  
Knee leg and foot

### In this lecture:

- Lombards paradox
- Biarticular muscles in the thigh
- Disadvantages of biarticular muscle
- Advantages of biarticular muscle

Biarticular muscles need synergists as stabilisers and joint positioners

### Stabilisers

- Biceps acting as a supinator
- Extensor pollicis

### Joint positioners

- Digital flexion and extension

### Readings

Rasch and Burke – Kinesiology and applied anatomy  
Grants method joints of the upper limb

## LOMBARDS PARADOX In the human thigh

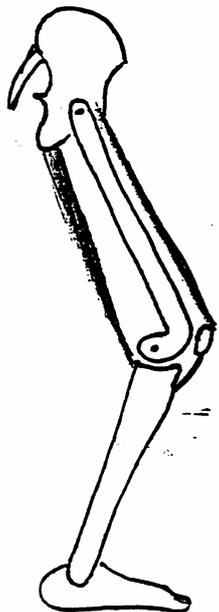
In a small research project we examined lombard's paradox in the human thigh

At the hip – the hamstrings have a greater lever arm than rectus femoris

1. Rectus femoris attaches close to the hip joint
2. Hamstrings attach to the ischial tuberosity
3. As the thigh extends further this advantage becomes less

At the knee – the rectus femoris has a greater lever arm than the hamstrings.

1. The axis of the knee joint lies near the back of the femoral condyles
2. The patella holds the rectus femoris muscle away from the axis of the knee
3. The hamstrings attach close to the back of the knee
4. The advantage of rectus femoris becomes greater as the knee extends.



This is artificial because we ignored the action of uniaxial muscles in the human thigh.

## LOMBARDS PARADOX

Uniaxial muscles are simple and relatively predictable actions.

1. We know what the action will be
2. We can work out how much of the joints range of motion the the muscle can perform.

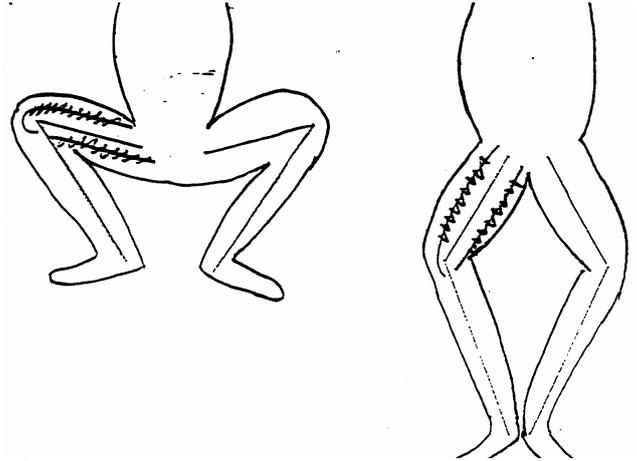
**Biarticular muscles** cross more than one joint and have several actions on different joints

### LOMBARDS PARADOX

Frogs thighs have two biarticular muscles that cross both the hip and the knee.

1. Hamstrings extend the hip and flex the knee
2. Rectus femoris flexes the hip and extends the knee

When both muscles act together – the frog hops – both joints extend



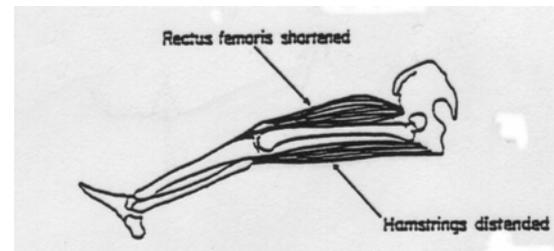
## PROPERTIES OF BIARTICULAR MUSCLES Disadvantages

### Passive insufficiency.

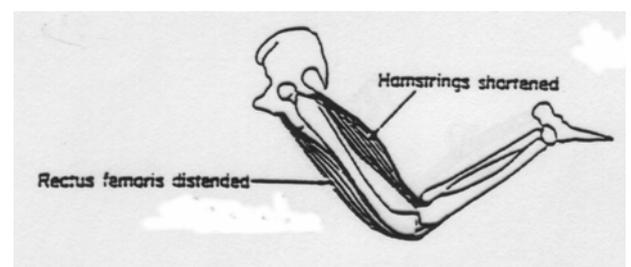
Where the muscle cannot stretch out enough for both of the joints to move through their full range. This occurs in the movement where the movement of both joints is stretching the muscle

Eg Hamstrings where you can't extend the knee on a flexed hip.

Rect femoris wont stretch out enough to allow you to flex the knee on and extended hip



Many other examples...



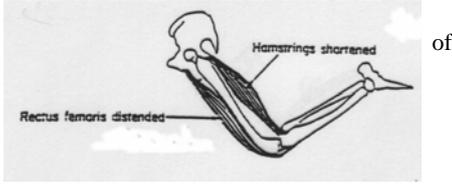
## PROPERTIES OF BIARTICULAR MUSCLES

### Disadvantages

#### Active insufficiency.

Where the biarticular muscle cannot shorten enough to do all the move of the joints that it crosses.

Remember that a muscle can only shorten by 40% its resting length.



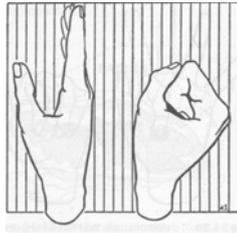
Eg. Hamstrings can't shorten enough to flex the knee on an extended hip

Bad example, because this more likely due to passive insufficiency of the rectus femoris

#### A better example:

Flexor digitorum superficialis crosses the elbow, wrist, metacarpophalangeal joints and interphalangeal joints and acts to flex all those joints (a **multiarticular muscle**).

If the wrist is flexed it is difficult to make a strong fist because flexor digitorum superficialis cant shorten enough to strongly flex all those joints.



Consequently to make a strong fist the wrist is placed in extension so that FDS can work strongly at the finger joints.

This requires the action of synergists that hold the wrist extended...

This fact is used by self-defence teachers because if someone is gripping your wrist, it is easier to pull free from their grip if you twist their wrist into flexion.

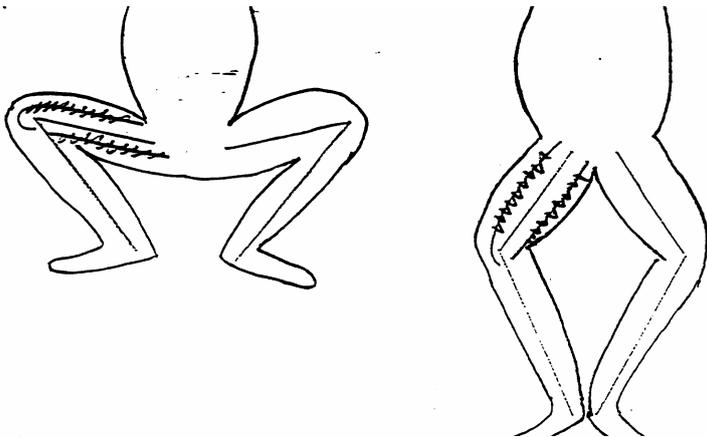
5

## PROPERTIES OF BIARTICULAR MUSCLES

### Advantages

#### “Isometric action”

Remember muscles can shorten by about 40% of their resting length Returning to the frog – but it's the same in our thighs as well.



As the limb extends:

1. Rectus femoris is lengthened by hip extension and shortened by knee extension.
2. Hamstrings are lengthened by knee extension and shortened by hip extension.

So those muscles tend to stay at approximately the same length. (“Isometric”). This is really useful because remember a muscle can only shorten by 40% of their length.

So in this situation these muscles can act effectively throughout the full range of movement of both joints

7

## PROPERTIES OF BIARTICULAR MUSCLES

### Advantages

#### Tenodesis – the cord action of biarticular muscles

This is where the biarticular muscles and their tendons act like cords and move distal joints without any muscle action at those joints.

#### Eg. The legs of your cat or dog.

If the animal is curled up with its limbs flexed and you take the proximal segment of the limb and extend it, then all the distal joints extend as well. The same thing occurs in our limbs

#### Eg. As an adaptation to paralysis of flexor digitorum superficialis and profundus.

If you hold your hand limp and let the wrist fall into flexion the fingers extend slightly. If you then extend your wrist the fingers flex and the pads of the thumb and index finger come into contact. This is because the flexor tendons are acting like cords and when the wrist is extended, the cords pull the fingers into flexion.

This can be used by people with nerve lesions where they have no digital flexors (C7&C8), but they do have wrist extensors (C5&C6)



6

## BIARTICULAR MUSCLES NEED SYNERGISTS

#### Synergists as stabilisers

Where the synergist hold one joint still so that the biarticular muscles action can be forced to happen at the desired joint.

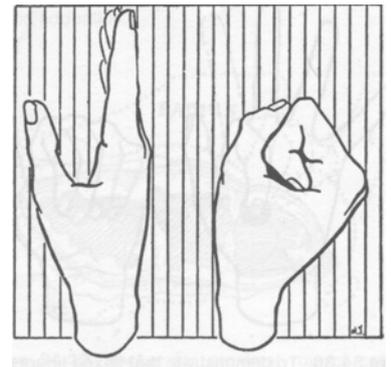
Eg. Biceps can flex the shoulder and elbow and it can also supinate the forearm. If we want to use biceps to supinate the forearm, then we find that triceps is also active – it is stabilising the elbow and shoulder against the flexion caused by biceps.

Eg. If we want to extend our thumb we will use extensor pollicis longus and brevis. Those muscles cross the wrist as well and also produce (abduction) radial deviation of the wrist. So if you feel the ulna side of your wrist while you extend the thumb – you'll feel that flexor carpi ulnaris and extensor carpi ulnaris (wrist adductors) are both active, preventing wrist abduction.

#### Synergists as joint positioners

We've already seen how extensor carpi radialis (longus and brevis) and extensor carpi ulnaris act to position the wrist in extension so that the digital flexors can make a tight fist.

The same thing applies if you want to do strong extension of the fingers



8