Anatomy shows more than seen only from an Ergonomic Aspect

Why should Fingers, Hands and Arms be supported

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A Step by Step Journey

1. Trapezius and Deltoid muscle activity
2. Ulnar sided wrist pain
3. Palmar support
4. Position of forearm and wrist
5. Ulnar sided dermatological effects
6. Proprioceptive reflexes & Sharpey’s fibers
1. Trapezius and Deltoid Muscles Activity

**Hand activities**
- influence the descending part of the Trapezius muscle
- but only partially influence the Deltoid muscle
- Deltoid muscle shows fatigue when holding the upper limb in position

Even activities of fingers only can influence muscles of arm and shoulder.
Trapezius and Deltoid Muscles Activity

Points of attention

- Trapezius muscle supports the upper extremity posture
- Deltoid muscle is one of the main shoulder joint drivers
- Higher precision of tasks results in higher muscle tension
- Stress factor, difficulty and complexity of tasks

Studies show precision influences tension of

- Trapezius muscle
- But not of Deltoid muscle
Trapezius and Deltoid Muscles Activity

Prevent unnecessary muscle loads
- support forearm, hand and fingers
- use desktop and or armrest
- height adjustable desks facilitate arm support

Result, minimal exertion of Trapezius muscles (lower EMG values)

Wrist supports do not reduce muscle activation (sideways).
Trapezius and Deltoid Muscles Activity

Desktop contact with Ulna is prevented
- slight supination (≈ 25° ulnar side) palm facing downwards
- coapting by fine muscle tonus of Flexor and Extensor muscles
- coapting due to positioning activity while handling an object
Trapezius and Deltoid Muscles Activity
Relaxed and supported arm hand and fingers

Do not reach

Supported forearm
2. Ulnar sided wrist pain

Muscle action
- Extensor Carpi Ulnaris muscle
- Flexor Carpi Ulnaris muscle
- these muscles acting together can cause “wrist snap”
- reaching

Reaching

Wrist snap
Ulnar sided wrist pain

**Muscle loads**
- moving the wrist sidewards, random case history:
  - Extensor Digitorum muscle (A)
  - Extensor Carpi Ulnaris muscle (B)
  - Extensor Carpi Radialis muscles (ECR longus and brevis)

Extensor Carpi Ulnaris
Ulnar sided wrist pain

Muscle action
- muscles acting together can cause “wrist snap”
- affecting wrist flexor muscles at the elbow
- frequent contractions lead to “pumping up”

Repetitive motions of our hand moving the wrist sidewards, may lead to some detrimental effects due to “compression neuropathy”.

Ulnar sided wrist pain

Articular Disc

- normally, load transfer from wrist to Ulna and Radius
- effect on Articular Disc
Ulnar sided wrist pain

Position and status of Articular Disc

- presumed effect of wrist snap on Articular Disc *
- load transfer from wrist to Ulna
- the effect of aging

Ulnar sided wrist pain

Pisiform bone and Guyon’s Canal
- excessive contact pressure around the pisiform area
Ulnar sided wrist pain

Possible solutions

- change forearm position to reduce contact pressure
- increase portion of forearm resting on desktop or armrest
- pivot forearm around Flexor muscle belly
- prevent wrist snap
3. Palmar Support

An anatomically derived solution

Ball shape, a spherical grip most commonly used
Palmar Support
An anatomically derived solution

Palmar Aponeurosis (Fascia)
- a supporting triangle of great strength and density
- central portion occupies the middle of the hand palm
- fatty tissue of Hypothenar, Thenar and Upper Palm surrounds triangle

After Landsmeer, 1976
Palmar Support
An anatomically derived solution

Fundamental and field research results show

A hand supporting spherical (ball shape) body realizes minimal EMG values and thus lower MVC* values.

* Minimal Voluntary Contraction (MVC)
No Palmar Support
Resulting Grip Forces

Conventional mouse
- no palmar support
- grip and pinch forces in fingers and thumb
- resulting reaction force and moments of force in joints
No Palmar Support
Effect of Grip Forces

PIP joint is not a simple hinge and thus critical
Grip Forces
What are we looking at

Reaction forces in PIP joint
- reaction force $F_r$ due to grip force
- moments $F_r \times L_1$ and $F_r \times L_2$
Grip Forces
What are we looking at

**Vertical mouse**
- grip and pinch forces in fingers and thumb
- critical moment and force in Carpometacarpal (CMC) joint of thumb
4. Position of forearm and wrist

Behaviour of Ulna and Radius

Motion of forearm and wrist

Behaviour of Ulna and Radius

**Vertical mouse**

- increased flexion and extension of wrist
- forearm in an unnatural position, supination more than just 25°
- Interosseous Membrane (IOM) taut*
Forces on Interosseous Membrane

**Vertical mouse**
- thumb and finger muscles connect to IOM
- possible muscular damage (microlesions) due to longstanding repetitive movements of thumb and fingers.

Diagram forearm deep extensors, Frick-Leonhardt-Starck, Human Anatomy 1, Thieme, 1991
5. Ulnar sided dermatological effects

Sources of complaints
- friction, sweating and pressure
- wrist pivots on desktop edge

Hard plastics used in PC mice (ABS), rarely cause contact allergy.
Unavoidable skin contact
Evidence based conclusion

A lightly slanted palm and finger supporting computer mouse requires least muscle activity and avoids unequal skin contacts (C).
6. Proprioceptive Reflexes & Sharpey’s fibers

**Proprioception**
- connective tissue is stretched or loaded
- Sharpey’s fibers ensure adhesion to tendons and ligaments
- ligaments with which they integrate may function as proprioceptors
**Proprioceptive Reflexes & Sharpey’s fibers**

**Sharpey’s fibers**
- provide tissue anchorage
- traverse the periosteum (see grey circumference)
- avoid detachment of the periosteum
- integrate directly with the muscles, ligaments, and tendons
- permeate the extracellular matrix
Proprioceptive Reflexes & Sharpey’s fibers

**Sharpey’s fibers**
- reduce excessive stress perception
- buffer potentially damaging loads
- sourcing, in depth of bone marrow

Acts contrary to for example sellotape when peel forces are exerted.
Proprioceptive Reflexes & Sharpey’s fibers

What happens when we move from position A via B to?

- a conventional mouse (A)
  - excessive gripping and pinching
  - too much skin contact

- a vertical mouse (B)
  - initial relief is experienced, proprioceptive reflexes
  - pinch force instigates excessive loads e.g. CMC
  - too much skin contact

- a lightly slanted palm and finger supporting mouse (?)
  - IOM relaxed, reduced stress perception (Sharpey’s fibers)
  - no pinch force
  - no skin contact
Evidence based results using a lightly slanted palm and finger supporting computer mouse show reduced neural excitation (proprioceptive reflexes).

Proprioceptive Reflexes & Sharpey’s fibers

Summary
Reactions and Questions

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