Study and Design of Different Types of Hand Tools

1. Study ergonomic principles in designing of hand tools.

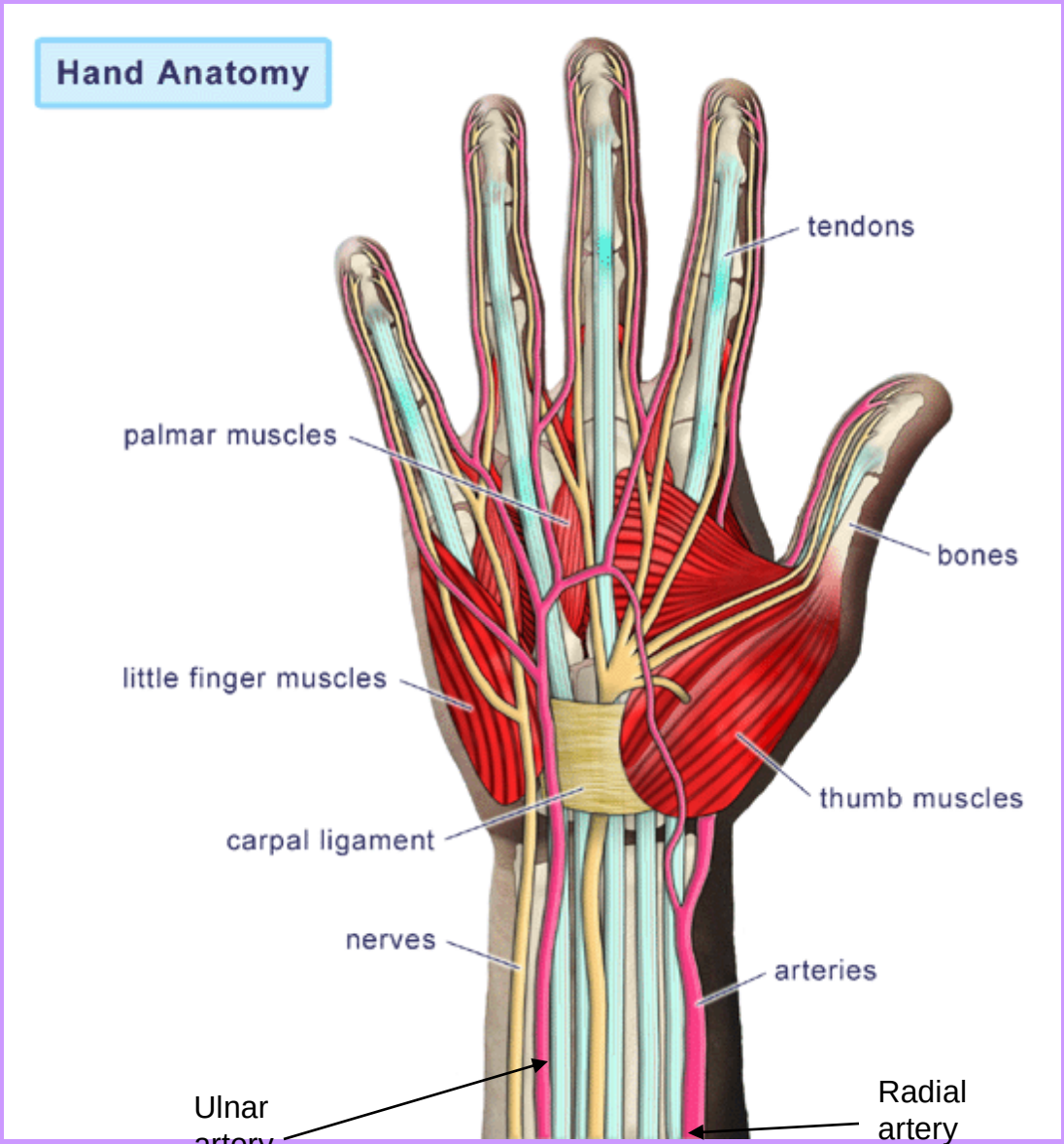
2. Observe some existing hand tools and machines.

3. Designing hand tools and machines using ergonomic principles to eliminate the existing shortcoming

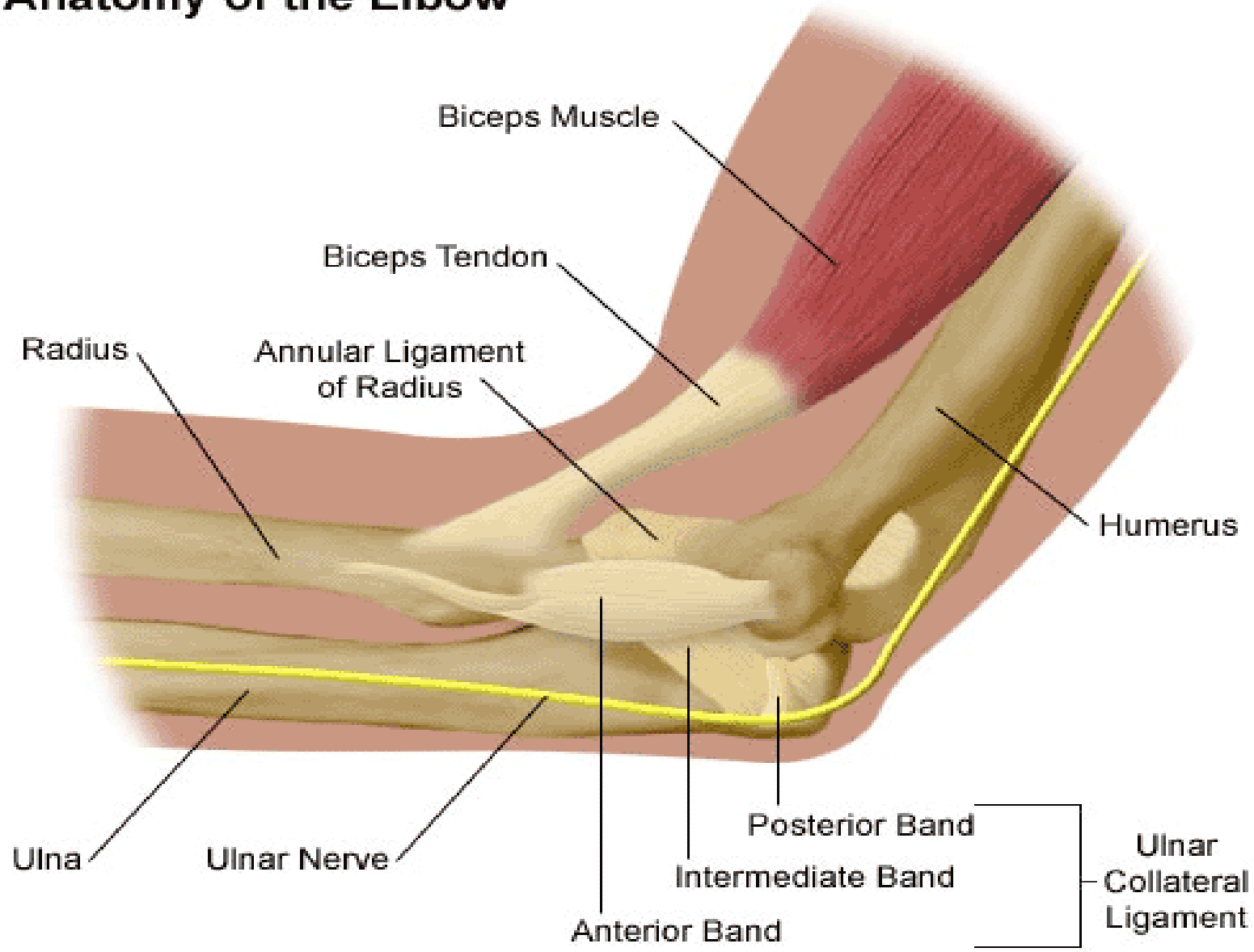
Hand Tools

1. Drill machine
2. Arc-welding Gun
3. Hack saw
4. Pliers
5. Hammer
6. Wrench

Structure of Hand



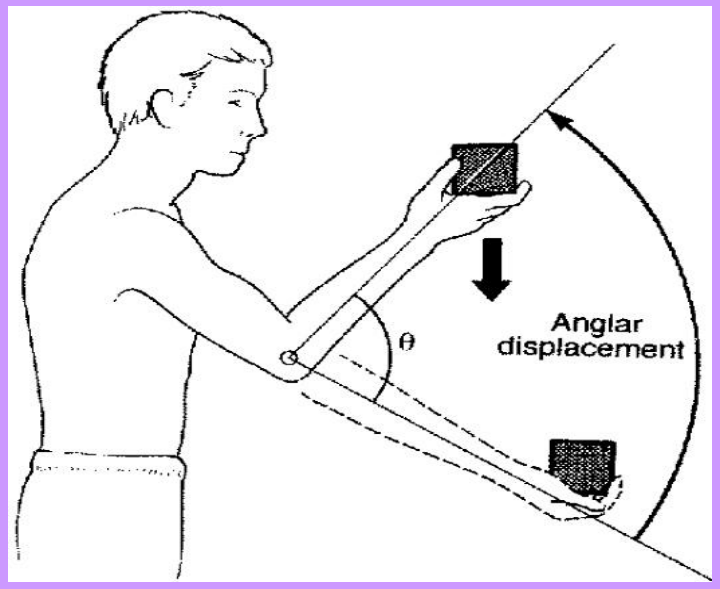
Anatomy of the Elbow

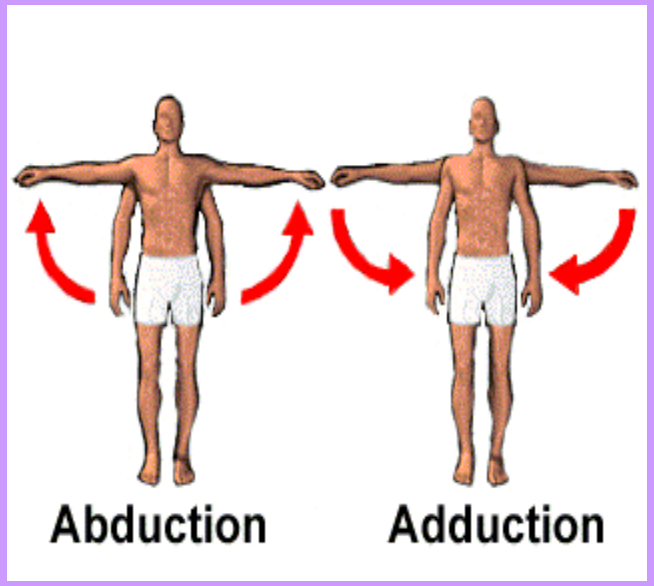


Motion of Hand

There 4 different motions of hands

1. Flexion
2. Extension
3. Abduction
4. Adduction



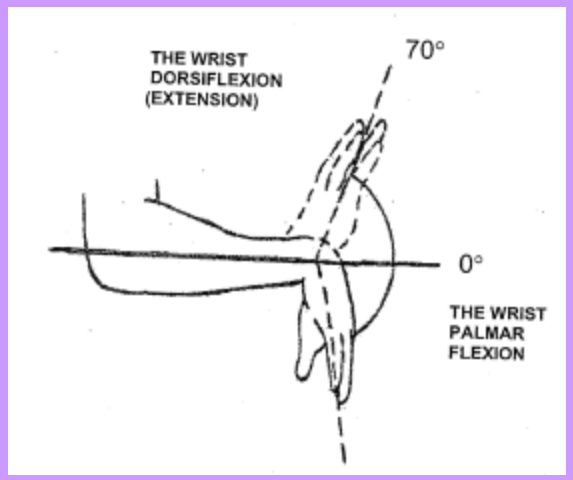


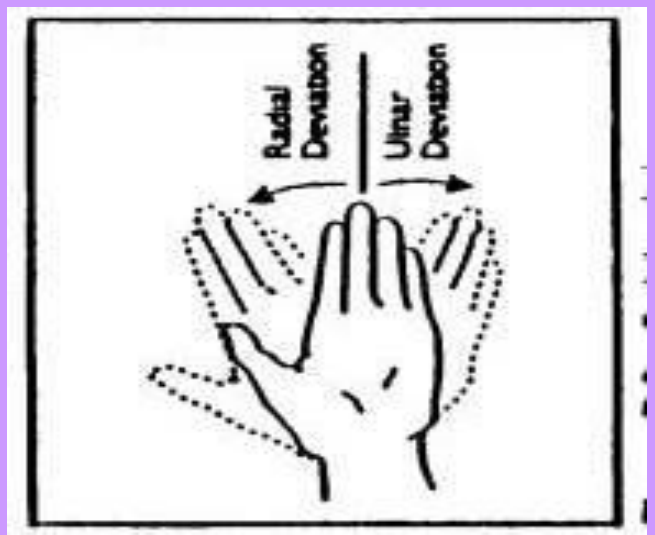
Motion of forearm

1. Supination and
2. Pronation

Motion of Wrist joint

1. Dorsiflexion and 2. Palmar Flexion
3. Ulnar Derivation and 4.Radial Deviation





Principles of hand tool and devices design

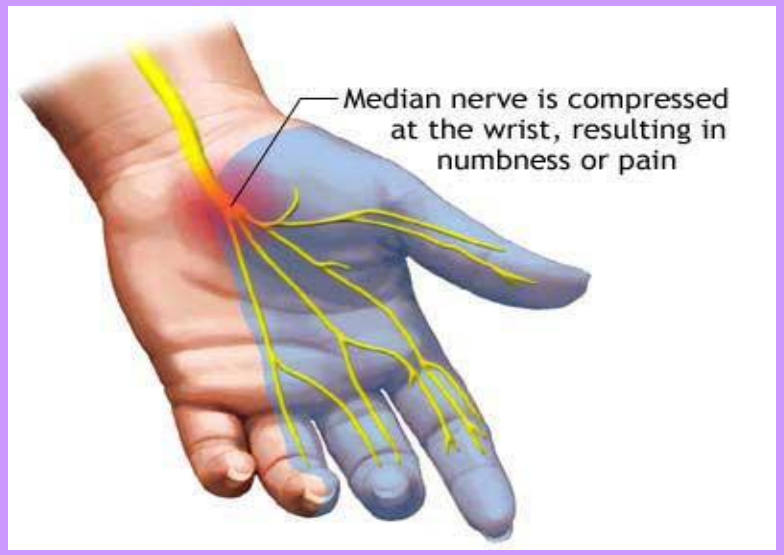
1.Maintain a straight wrist

Avoid ulnar deviation and palmar flexion (or both)

Results in **i. Tenosynovitis:**

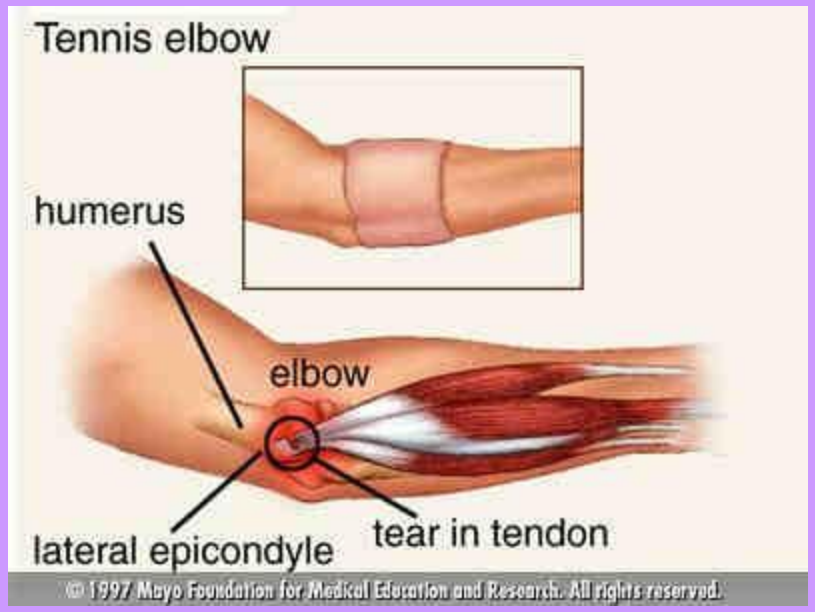
Example: Clothes wringing
Inserting screws
Starting handle of Motorcycle

ii. Carpal Tunnel Syndrome



iii. Tennis Elbow

Redial Deviation when combined with pronation and dorsiflexion

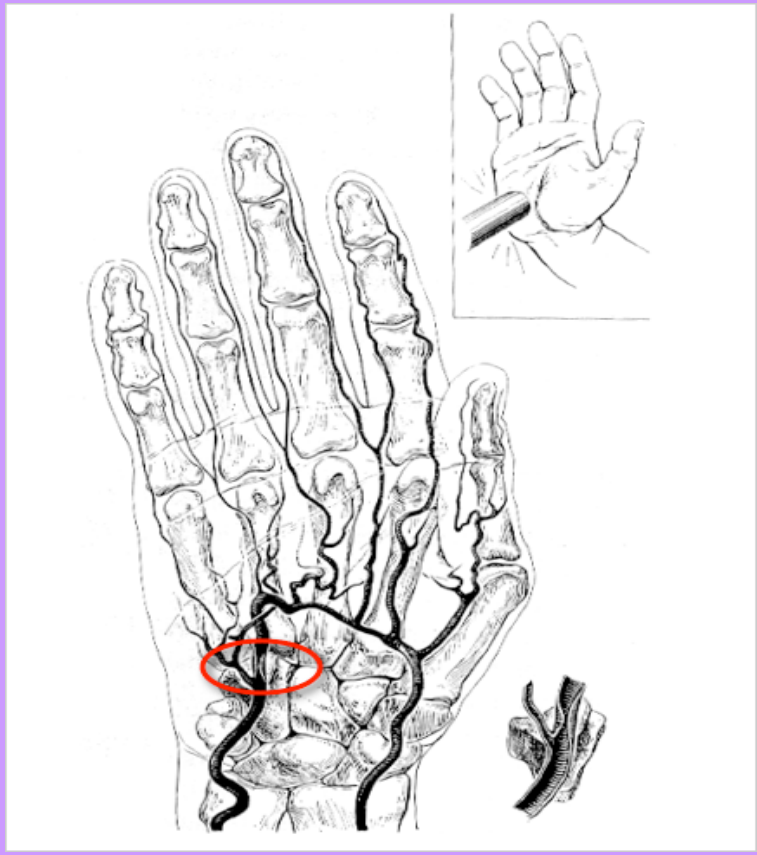


iv. Grip strength is reduced if the wrist is bent.

2. Avoid Tissue Compression Stresses

-Pressure sensitive areas are Ulnar and Radial arteries.

- Handle of the tool obstruct the blood flow of the sensitive areas and results in *ISCHEMIA* (numbness and tingling of the fingers).



HANDLES SHOULD BE DESIGNED TO HAVE LARGE CONTACT SURFACES TO DISTRIBUTE THE FORCE TO DIRECT IT TO LESS-SENSETITIVE AREAS

3. Avoid Repetitive Finger Action

If index finger is used excessively for operating triggers ***TIGER FINGER*** occurs.

Affected person can flex but can not extend finger.

When the finger is passively straighten an audible click may be heard.

INDEX FINGER USE FREQUENTLY SHOULD BE AVOIDED and THUMB OPERATED CONTROL SHOULD BE USED

Why Thumb?

Thumb is easily flexed , abducted and opposed by strong short muscles located entirely within the palm of the hand

THUMB SHOULD NOT BE HYPEREXTEND (otherwise inflammation and pain would result)

Preferable is ***Finger-strip control***

INDEX FINGER---THUMB--- FINGER STRIP CONTROL

4. Design for Safe operation

i. Eliminate pinching hazards and sharp corners and edges.

- Guard over pinch points

ii. Eliminate sharp corners and edges (can be rounded).

iii. Power tool can be designed with brake devices.

5. Grip Principles

2 types of Grip

i. Power Grip
ii. Precision Grip

Power Grip

- When Large forces are exerted.
- 4 fingers are in one side making a fist and the thumb is in other side.

3 types of power grips

i. force parallel to the forearm (saw).
ii. force at an angle to the forearm (hammer).
iii. torque about the forearm (corkscrew).

Precision Grip

Tool is pinched between the thumb and fingers.

For small forces

2 types of precision grip

i. Internal Grip: Shaft of the tool is internal to the hand.

ii. External Grip: Shaft of the tool is external to the hand.

GRIP THICKNESS:

i. Diameter – 40 mm for power grip// 50-60 mm in some cases

>6 mm for precision grip

ii. People with small hand should not perform repetitively grip with larger than 60 mm.

iii. Cross tools like scissors should have max span 100 mm and min 60 mm.

iv. Muscles of the hand closing is stronger than the muscles of the opening. A spring can be used to open the handles.

Grip Length:

i. 125 mm length is comfortable, where it should not limit tool head opening and should avoid excess compressive force of the palm.

ii. For external precision grip the length should be at least 100 mm and should be long enough to support the first finger and thumb.

iii. For internal precision grip the length should past the palm.

Grip Force:

For Swedish male :525 N and female:300 N, for 1 min without fatigue.

Grip Surface characteristics:

Slightly compressive, non-conductive and smooth.

REPORT

1. Write the characteristics of the existing tool
   - Drawing and Real picture
   - Description
2. Reasons for changing
3. Proposed Model
   - Drawing
   - Changes
4. Comparison with the existing system (WHY your design should be chosen)
5. Conclusion
6. References

Thank You