Grasping Hands

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Primate Hands

Human Hands

- Unique capability for opposition of large thumb and fingers.

Opposition Grips

Human Grasping

- Larger thumb and opposition grip gives greater dexterity and this allows more effective tool use.

Gripping Behavior

- For many activities (e.g. lifting, lowering, carrying, pushing, pulling), the type of GRIP is the interface between the person's hand and the object being handled.
- The type of grip affects the force that is generated on an object.
- The type of grip affects the risk of injury.

Types of Grip

- Power
- Pinch (precision)
- Oblique
- Hook
- Palm up, palm down

Power Grip

- Power grip (cylindrical grip) is the maximum gripping force that can be generated by the hand.
- Two factors affect the ability to generate force with a power grip:
  - Wrist orientation - deviations from a normal posture reduce the maximum grip force.
  - Grip span - spans that are too small or large will reduce grip strength. Optimal grip span is ~ 2".

Power Grip

Power Grips

Pinch (Precision) Grip

- Characterized by opposition of the thumb and the distal joints of the fingers.
- Pinch grip has ~ 25% maximum power grip strength.
- Pinch grip strength decreases rapidly at spans <1" or >3".

- Two types of grip:
  - Internal - tool handle is internal to the hand e.g. knife
  - External - tool handle external to hand e.g. pen.

External Pinch Grip

- Tool handle is external to hand e.g. pen.

Internal Pinch Grip

Pinch (Precision) Grip

Precision grip

- External and internal precision grips.

Pinch Grip

- Lateral pinch grip - usually submaximal in strength because of inappropriate grip span.

Oblique Grip

- Variant of power grip.
- Grip across a rectangular surface.
- ~65% power grip strength
- Strongly affected by grip span.

Oblique Grip: Shape

Oblique Grip: Size

Hook Grip

- Flat hand, curled fingers, thumb as stabilizer, fingers support load.
- ~strength of power grip for 2" span.
- Narrow or wide handles, or poor contours decrease grip strength. Load may exceed 22 lbs/inch maximum skin pressure.

Palm-up and Palm-down Grips

- Palm-up - used for carrying objects.
- Palm-down - weaker grip,

Palm-up Grip

- Grip strength depends on arm strength.
- Difficult to perform when the height of the object being lifted exceeds elbow height (~35" above floor level).
- Grip strength depends on grip span.

Lid Opening/Closing

- Ability to open or close a lid partly depends on the design of the lid.

- A smaller lid that allows the fingers to curl around it transmits more of the muscle force directly to the lid.
- A large lid reduces the ability of the hand to grasp and open/close it.
- Hand tools (jar openers) can be used.

Pushing and Pulling

Approx. 20% of overexertion injuries are associated with pushing/pulling work (NIOSH)

Horizontal Pushing/Pulling

- Horizontal pushing/pulling is affected by:
  - Body weight
  - Height of force application
  - Distance of force application from body
  - Amount of trunk flexion/extension
  - Frictional coefficient of the floor
  - Frictional coefficient of shoes
  - Distance moved/duration of force application
  - Availability of support structures (e.g. start blocks)
  - Posture (standing, sitting, kneeling, crawling)
- Pushing is better than pulling.

Vertical Pushing/Pulling

- Vertical pushing/pulling is affected by:
  - Body weight (for pulling)
  - Grip strength
  - Height of force application
    - Upward pulls above 10" (~25 cm) are the strongest because leg and trunk muscles can be used.
    - Downward pulls above head level are strongest because body weight can be used.
  - Posture - downward pulls from seated position are ~85% standing position.

Other Pushing/Pulling Actions

- Transverse Pushing/Pulling - across the front of the body uses the weaker shoulder muscles. At full arm extension maximum force is ~ 50% of that with horizontal pushing/pulling.
- Asymmetric Pushing/Pulling – one arm used to push/pull object or move this across the midline of the body.

Optimal Pushing/Pulling Dimensions

- Push/pull height = 91 - 114 cm
- High traction floor = 30% more push/pull force than low traction floor.
- Leg distances from load:

- Pushing = 165 cm min.
- Pulling = 40 cm max.

Palm-down Grips

- Primarily used in precision activities.
- With palm down the arms are suboptimally positioned.
- Poor grip once the load weight exceeds 1 lb. (0.5 Kg).
- Grip strength affected by grip span.