



Ergonomics in Endoscopy

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Disclosures

Pentax Research Gift

Objectives

- Ergonomics: definitions
- Risk factors associated with repetitive strain injury
 - Prevalence of reported injury in endoscopists
 - Biomechanical risk factors in colonoscopy
- Ergonomic interventions
 - Hierarchy of controls
 - Application to GI endoscopy
- Injury

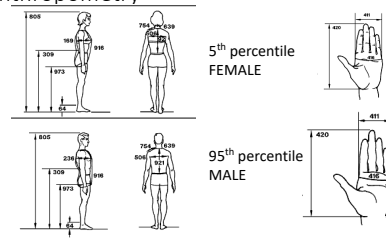
What is ergonomics?

- Ergonomics is the study of how work effects people, physically and cognitively
 - Quantify human capabilities and limitations
 - Apply to work
- Evaluates how a job can best be fit to an individual
 - Anthropometry
 - Biomechanics



<https://www.cdc.gov/niosh/publications/94-103/>

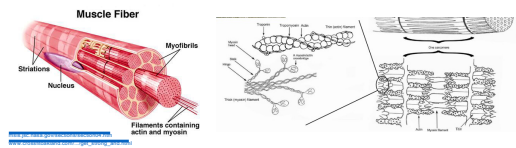
Anthropometry



<https://www.osha-slc.gov.gov/section/section03.htm>

Biomechanics

- How the body produces force and generates movement.
- Muscle force is influenced by
 - the length-tension relationship of a muscle
 - sheer muscle mass



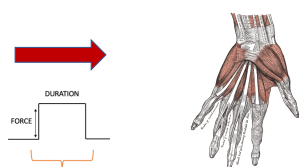
<https://commons.wikimedia.org/w/index.php?curid=73744>

Biomechanics: force, movement

External Loads



Internal Loads/ Tissue Tolerances



Gender is the most important predictor of strength

- Men are stronger than women in all age groups
- Women at their **strongest** (20s) are equally as strong as men between 70 - 80 years

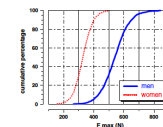


Fig. 4 Distribution of maximum hand grip force (F_{max}) of male (solid curve) and female (dotted curve) subjects. (mean $n = 100$, women $n = 100$)

Nilsen Scan J Occ Ther 2011

Leyk Eur J Appl Phys 2007

WMSDs: symptoms

- **Early stage:** Aching and tiredness of the affected limb occur during the work shift but disappear at night and during days off work.
 - No reduction of work performance.
- **Intermediate stage:** Aching and tiredness occur early in the work shift and persist at night.
 - Reduced capacity for repetitive work.
- **Late stage:** Aching, fatigue, and weakness persist at rest.
 - Inability to sleep and to perform light duties.

<https://www.ccohs.ca/oshanswers/fitness/fitness.html>

STUDY	Sample Size	% Reporting Injury
Buschbacher (1994)	265	57%
O'Sullivan (2002)	114	67%
Liberman (2005)	608	39%
Keate(2006)(Abstract)	237	78%
Hansel (2009)	72	74%
Lee (2007)(Abstract)	94	37%
Byun (2008)	55	89%
Ponte (2008)(Abstract)	157	56%
Battexi (2009)	88	40%
Kuwabara (2011)	190	43%
Geraghty (2011)(Let Ed)	58	57%
Rutledge (2015)	684	53%

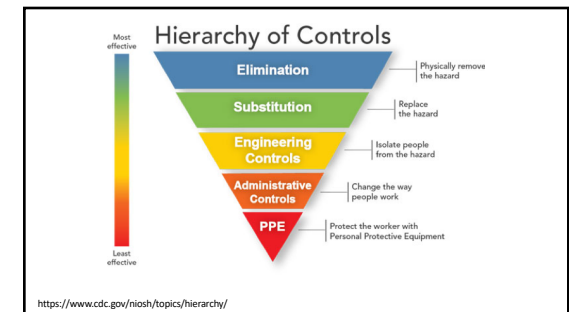
Biomechanical Risk Factors Assessment

Endoscope

- Repetition
- High Force
- Awkward joint posture
- Sustained static load

- Compared to established thresholds of risk

Rempel, JAMA 1992; 267(5): 638-42



Elimination: Prevention through Design

- PtD is a safety concept that aims to lower risks for workers by eliminating or reducing hazards as early as possible in the life cycle of equipment



Substitution: Replace the Hazard

- New technologies may obviate the need for an endoscopist to maneuver the colonoscope through the colon
 - self-propelled, and either self-navigating or guided by a joystick
- Any device substitution needs to be rigorously evaluated to ensure that other unintended exposures are not occurring as a result of the intervention

Systems Engineering Approach:

- Equipment Design: anthropometry
- Task Design: to fit capabilities/limitations of users - biomechanics
- Environmental Design: work environment – neutral postures
- Training

M. Whitmore NASA 2017: <https://ntrs.nasa.gov/archive/nasa/casi/ntrs.nasa.gov/20170008761.pdf>

Engineering Controls: Operator-tool interaction



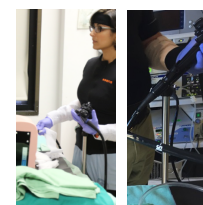
Engineering Controls: R/L Dial Adapter



Engineering Controls: Static Loads



DOW 2016 Sa1233



DOW 2018 Tu1041
Discipline: Dental Research Gift

Engineering controls: Time (tools to decrease cecal intubation time or procedure time)

• Cap assisted colonoscopy

Comparison 1. Cecal Intubation Rate

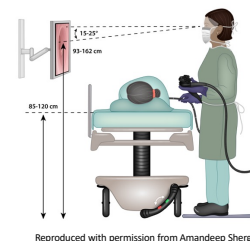
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Total Successful Intubation Rate	12	5932	Odds Ratio (M-H, Fixed, 95% CI)	1.56 [0.95, 1.95]

Comparison 2. Cecal Intubation Time

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Total Cecal Intubation Time	13	6019	Mean Difference (IV, Random, 95% CI)	-0.80 [-1.31, -0.30]

Cochrane Database Syst Rev. 2012

Engineering Controls: Work environment



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Engineering Controls: Monitor height

- viewing angle of 15 to 25 degrees below the horizon
- viewing distance of 52 to 182 cm
- adjustable from 93 to 162 cm



Shergill et al. GIE. 2009;70(1):145-153.

Engineering Controls: Bed Height

- At or below elbow height (0-10 cm below the elbow)
- adjustable from 85 to 120 cm.



Administrative Controls: change the way we work

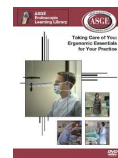
- Scheduled endoscope maintenance
- Ergonomic Education
 - Ergonomic time-out
- Design of the workday
 - Scheduled rest

Administrative Controls: scheduled maintenance

- Exposures to biomechanical risk factors are high when the endoscopes are performing at the manufacturer recommended specifications
- Over time, the responsiveness of the control section dials may decrease
 - more force required for the dials to achieve a comparable or even lesser degree of tip deflection.
- Angulation repairs are one of the most common types of endoscope repair

Administrative Controls: Ergonomic Education

- Consider formal ergonomic evaluation
- Involve all staff
 - Nurses, techs are your allies
- Fellowship curriculum



Administrative Controls:
Pre-Procedure: Ergonomic "Time-Out"



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Administrative Controls: Endoscopy Schedule

	Half-day	Full-day	Shifts
AM			
PM			
Evening			

Samaka AJG 2009
Chan CGH 2009
Harewood DDS 2009
Gurudu AJG 2011
Lee AJG 2011

Munson GIE 2011
Larix GIE 2012
Paeck Hepatogastro 2013
Thurle F100Res
Subramanian EIO 2015

Personal Protective Equipment

- “Using personal protective equipment is often essential, but it is generally the last line of defense after engineering controls, work practices, and administrative controls.”
-OSHA

Optimizing Technique: Holding the Scope



Optimizing Technique: Holding the Scope



Reproduced with permission from Roy Soetikno, MD

Maintaining physical fitness Can exercise help?

- Data mixed
 - “not enough evidence from scientific literature to guide policy/practice”
- Cochrane Review (2013)
 - Ergonomic interventions reduce pain in the long term
- Exercise: no difference
- Eerd et al BMJ (2015)
 - Stretching: moderate level of evidence (computer work)
 - Resistance training: strong level of evidence
 - Implementing a workplace-based resistance training exercise policy can help manage and prevent UEMSD symptoms and disabilities



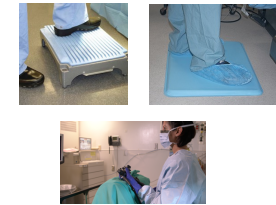
Rest

- During procedures:
 - alternate position (sit/stand)
 - larger role of assistants
 - “micro-breaks” - rest scope, shake out hands
- Post-procedures:
 - completing documentation
 - stretching



Static postures

- Footrest or low stool
 - alter posture by raising one foot
- Consider anti-fatigue mats or cushioned insoles
- Compression stockings
- “Mini-breaks”/ “Micro-breaks”



ASGE Technology Committee, GIE 2010.

Micro Breaks



Hallbusch. The impact of intraoperative microbreaks with exercises on surgeons: A multi-center cohort study. *App Ergo* 2017
<https://doi.org/10.1016/j.appergo.2016.12.007>
Application of microbreaks with exercises on surgeons: A multi-center cohort study. *App Ergo* 2017.

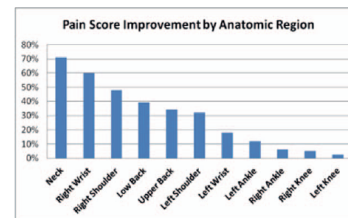
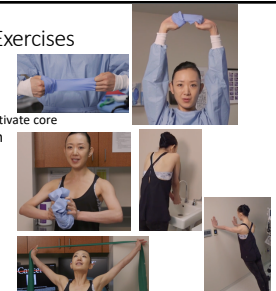


FIGURE 4. Impact of TSMB on pain scores by anatomic site.

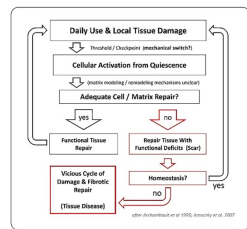
Park et al. *Annals of Surgery* 2017.

Post-procedure Stretching Exercises

- ① Periscapular stabilizing exercises
 - Using clean gloves
 - Stretch shoulder muscles, and activate core
- ② Shoulder release and side stretch
- ③ Reactivating the fingers
 - Using balled up gown
- ④ Shoulder rolls
 - When washing hands
- ⑤ Full body check-in
 - Rubber band
- ⑥ Back stretch



ASGE DVD in collaboration with GS Raju and Nao Kusuzaki



Snedeker Acta Biomater 2017

When an Injury Occurs: tendinopathy

- Tendon healing creates more collagen fibrils and less mature cross-links with stress
- Period of relative weakness before remodeling
- Repetitive load can cause heat injury, hypoxia, free-radical injury, and enzyme damage
- Degeneration becomes tendinosis

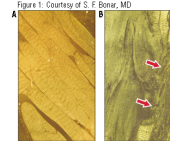


Figure 1. Photomicroscopic comparison of normal tendon and abnormal tendon as seen under a polarized light microscope ($\times 100$). Normal patellar tendon (A) consists of tightly bundled collagen fibers with a characteristic golden reflectivity. In an abnormal patellar tendon from a post-surgical patient with chronic tendinopathy (B), loss of collagen continuity, loss of reflectivity, and frank collagen defects (arrows), are easily seen.

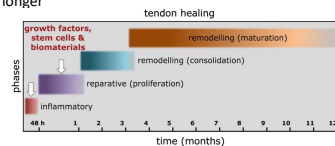
Courtesy of Anthony Luke, MD, MPH, CAQ (Sports Med)
Benioff Distinguished Professor in Sports Medicine

Trait	Overuse Tendinosis
Prevalence	Common
Time for recovery, early presentation	6-10 wk
Time for full recovery, chronic presentation	3-6 mo
Likelihood of full recovery to sport from chronic symptoms	~80%
Focus of conservative therapy	Encouragement of collagen synthesis maturation and strength
Role of surgery	Excise abnormal tissue
Prognosis for surgery	70%-85%
Time to recover from surgery	4-6 mo

Khan et al: Physician Sportsmed 2000.

Tendon Healing: 100d to synthesize collagen

- Mild: 2-4 weeks
- Moderate: 4-6 weeks
- Severe: 6-12 weeks or longer



Dorcheva Adv Drug Del Rev 2015

Treatment: the road to recovery

1. Modify Activity
 1. What are you doing?
 2. What do you need to do?
2. Reduce Stress: "biomechanical deloading"
3. Physical Therapy
 1. Stretching
 2. Strengthening
4. Pain Control
 1. NSAIDs?
 2. Steroid injections?
5. Induce Healing?



Courtesy of Anthony Luke, MD, MPH, CAQ (Sports Med)
Benioff Distinguished Professor in Sports Medicine

Disability Insurance

- Replaces a portion of your income (50-70%) when you're unable to work due to injury or illness
 - Short-term coverage: D1-14 after the incident and lasts between nine to 52 weeks, depending on your specific policy.
 - Long-term disability: takes effect after short-term policies end and can last anywhere from several years to whenever the person turns 65
- Own occupation vs any occupation
- Riders
 - Partial or residual disability benefit: pay benefits in the event of a partial loss of income
 - Future increase option: allows you to apply for additional disability insurance coverage, regardless of health, as your income rises.
 - Cost of living increase

Summary

- Risk of injury is real
 - High prevalence - survey based studies
 - High risk exposures – biomechanical risk studies
- Exposure control – hierarchy of controls
- Injury
 - Road to recovery
 - Disability insurance