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OHSU

Surgical Ergonomics, Injury and Safety

Omar Nazir MD

2025 OAOS Annual Conference

September 26, 2025

Disclosures

- Legal Consulting
- Consultant Surgeons Design Center
- None pertinent to this talk

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Inspirational Quote

- “The only reason I sit during surgery is because I have not figured out how to operate laying down.”
  – Dr. Adam Mirarchi

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Overview

- Safety
- Operating Room
- Clinic
- Practical tips

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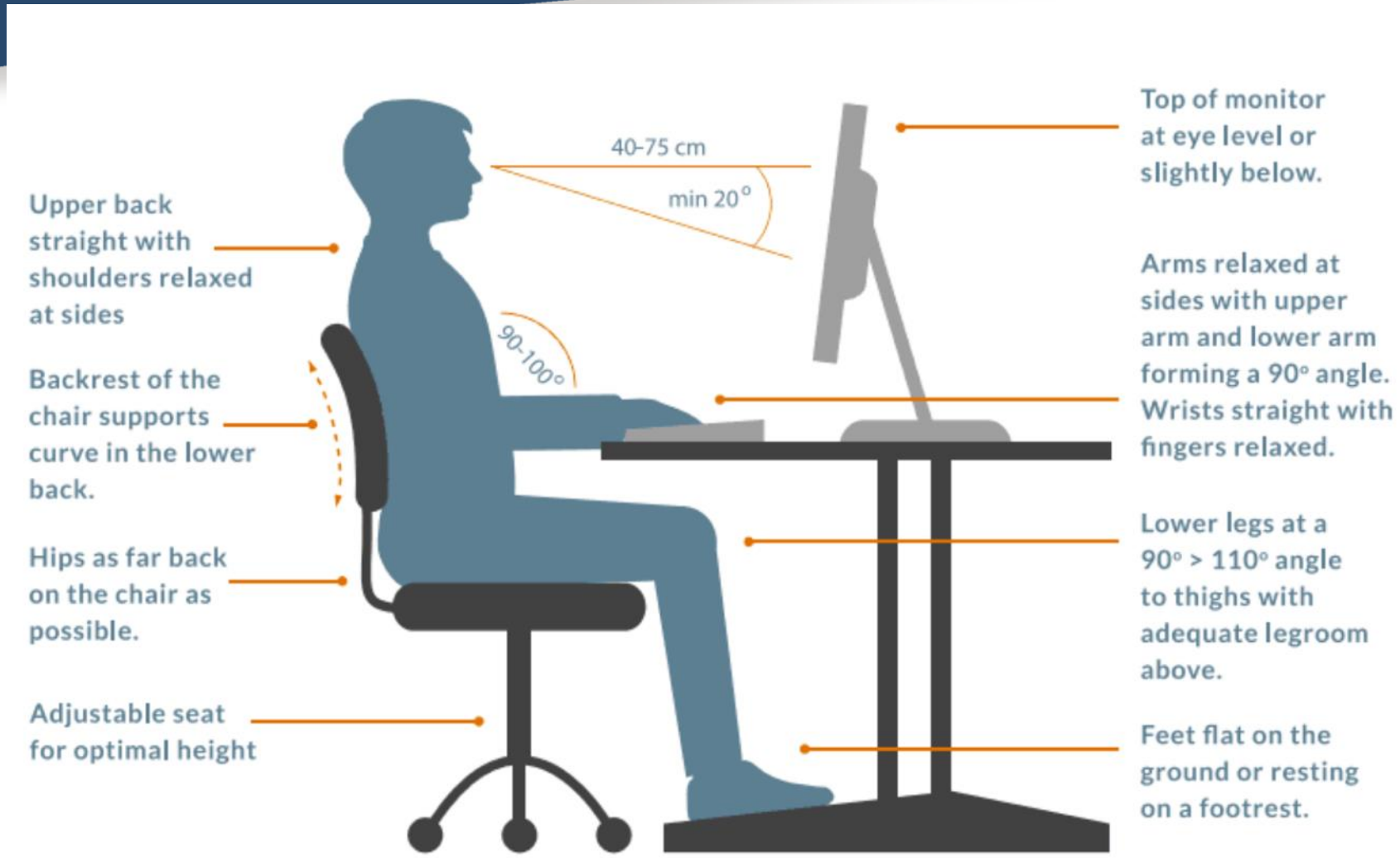
Practice



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Blood Borne Pathogens

- This is a preventable problem
  - Review of 1828 patients, 74% were preventable
- Approximately 1/3 of sticks are not reported

Are we putting ourselves in danger? Occupational hazards and job safety for orthopaedic surgeons

Robert C. Ryu [a,*], Phillip H. Behrens [b], Azeem T. Malik [a], Jonathan D. Lester [c], Christopher S. Ahmad [d]

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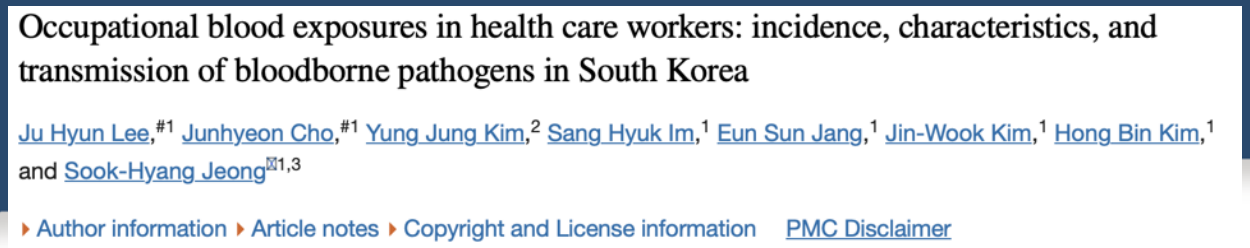
Risk of infection

- HIV percutaneous 0.3%; mucocutaneus 0.09%
  - Reduced 81% with prophylaxis
- HBV percutaneous 6-30%
  - Make sure you are immunized!
- HCV percutaneous 1.8%
  - No prophylaxis
  - Treatment with high side effect rate

Risk of infection



Occupational blood exposures in health care workers: incidence, characteristics, and transmission of bloodborne pathogens in South Korea

Ju Hyun Lee,[#1] Junhyeon Cho,[#1] Yung Jung Kim,[2] Sang Hyuk Im,[1] Eun Sun Jang,[1] Jin-Wook Kim,[1] Hong Bin Kim,[1] and Sook-Hyang Jeong[✉1,3]

Author information ▸ Article notes ▸ Copyright and License information PMC Disclaimer

- The employee infected with HCV was an orthopedic surgeon fellow. During an operation, a scalpel contaminated with blood from a patient co-infected with HBV and HCV was dropped, cutting the surgeon's heel. He presented with symptomatic, acute hepatitis C 8 weeks after the incident, undertook pegylated interferon and ribavirin therapy for 6 months, and recovered from HCV infection. In reaction to the incident, he experienced severe stress and transient depression.

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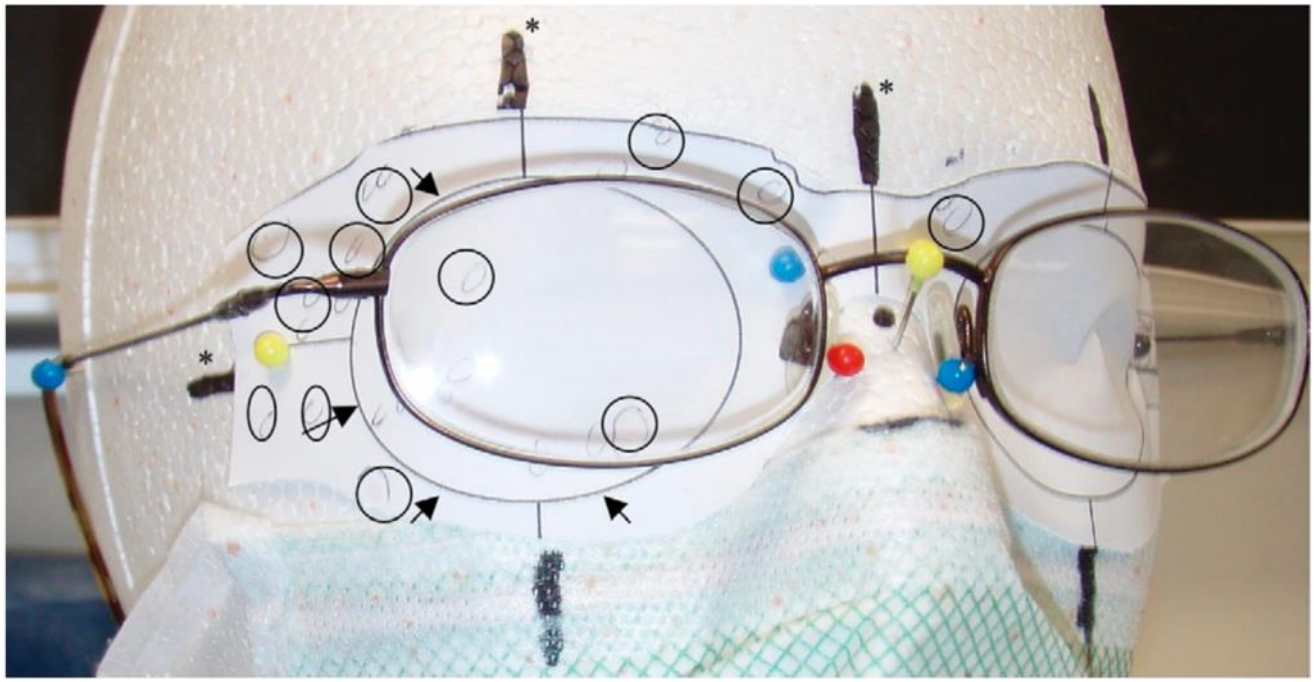
Eyes



- Rate of conjunctival contamination
  - Disposable plastic glasses 3%> hard plastic glasses 17%> combined facemask and shield 30%> surgical loupes 50%
  - “modern prescription glasses were of no benefit” 83%

Mansour AA III, Even JL, Phillips S, Halpern JL. Eye protection in orthopaedic surgery. An in vitro study of various forms of eye protection and their effectiveness. *J Bone Joint Surg Am*. 2009;91(5):1050-1054.

Skin

- Gowns?
  - Level 3 vs 4?

Skin

AAMI LEVEL	DESCRIPTION	APPLICABILITY
Level 1	• Used for MINIMAL risk situations • Provides a slight barrier to small amounts of fluid penetration • Single test of water impacting the surface of the gown material is conducted to assess barrier protection performance.	Basic care, standard hospital medical unit

Level 2	• Used in LOW risk situations
	• Provides a barrier to larger amounts of fluid penetration through splatter and some fluid exposure through soaking
	• Two tests are conducted to assess barrier protection performance:
	  ◦ Water impacting the surface of the gown material
	  ◦ Pressurizing the material
		Blood draw from a vein, Suturing, Intensive care unit, Pathology lab

Level 3	• Used in MODERATE risk situations
	• Provides a barrier to larger amounts of fluid penetration through splatter and more fluid exposure through soaking than Level 2
	• Two tests are conducted to assess barrier protection performance:
	  ◦ Water impacting the surface of the gown material
	  ◦ Pressurizing the material
		Arterial blood draw, Inserting an IV, Emergency Room, Trauma

Level 4	• Used in HIGH risk situations • Prevents all fluid penetration for up to 1 hour • May prevent VIRUS penetration for up to 1 hour • In addition to the other tests conducted under levels 1-3, barrier level performance is tested with a simulated blood containing a virus. If no virus is found at the end of the test, the gown passes.	Pathogen resistance, Infectious diseases (non-airborne), Large amounts of fluid exposure over long periods

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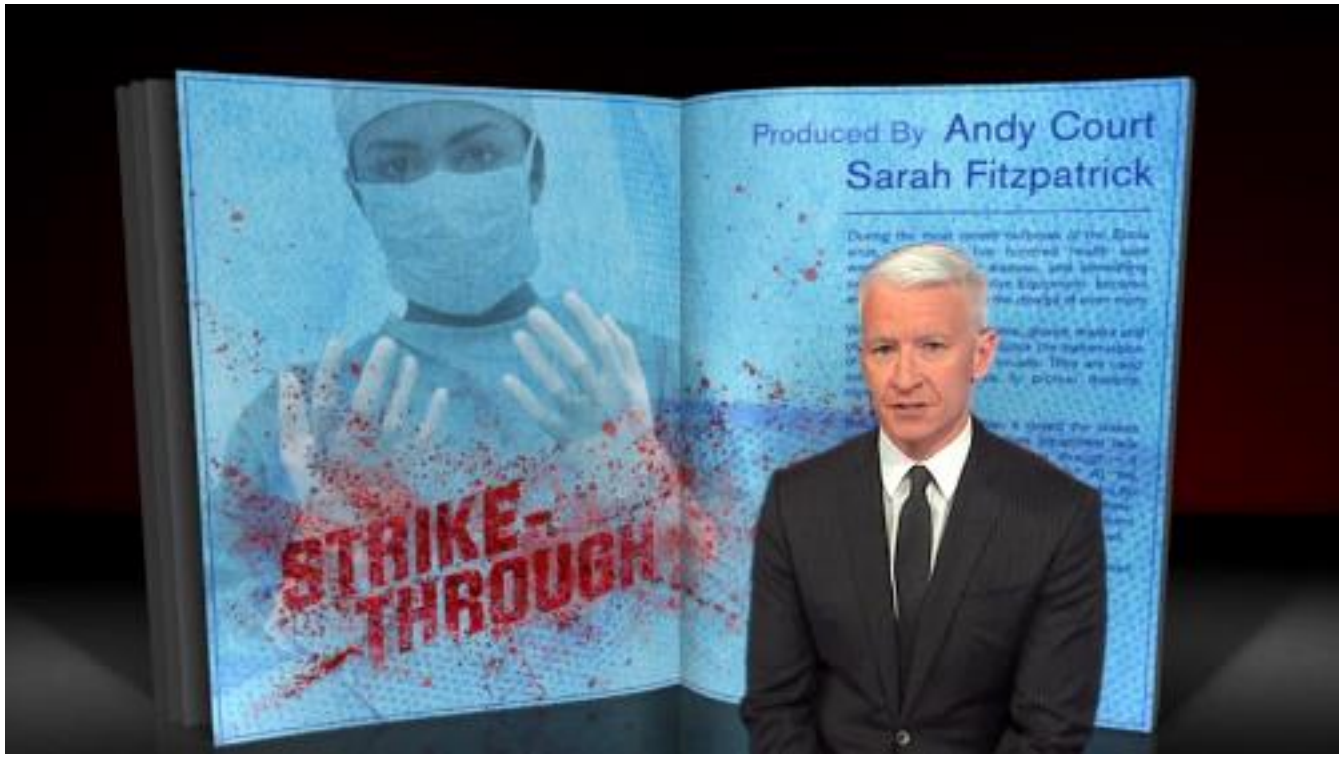
Skin

- 60 Minutes Report
  - Strikethrough 2016
    - Halyard Gowns



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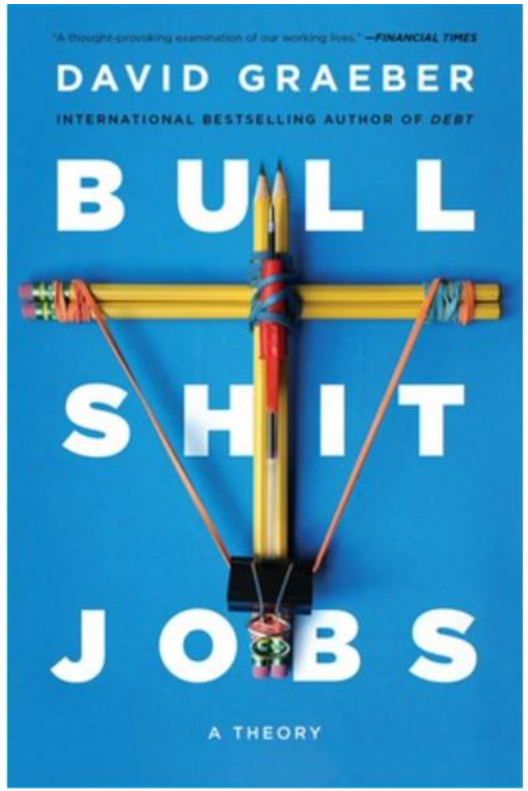
Gloves

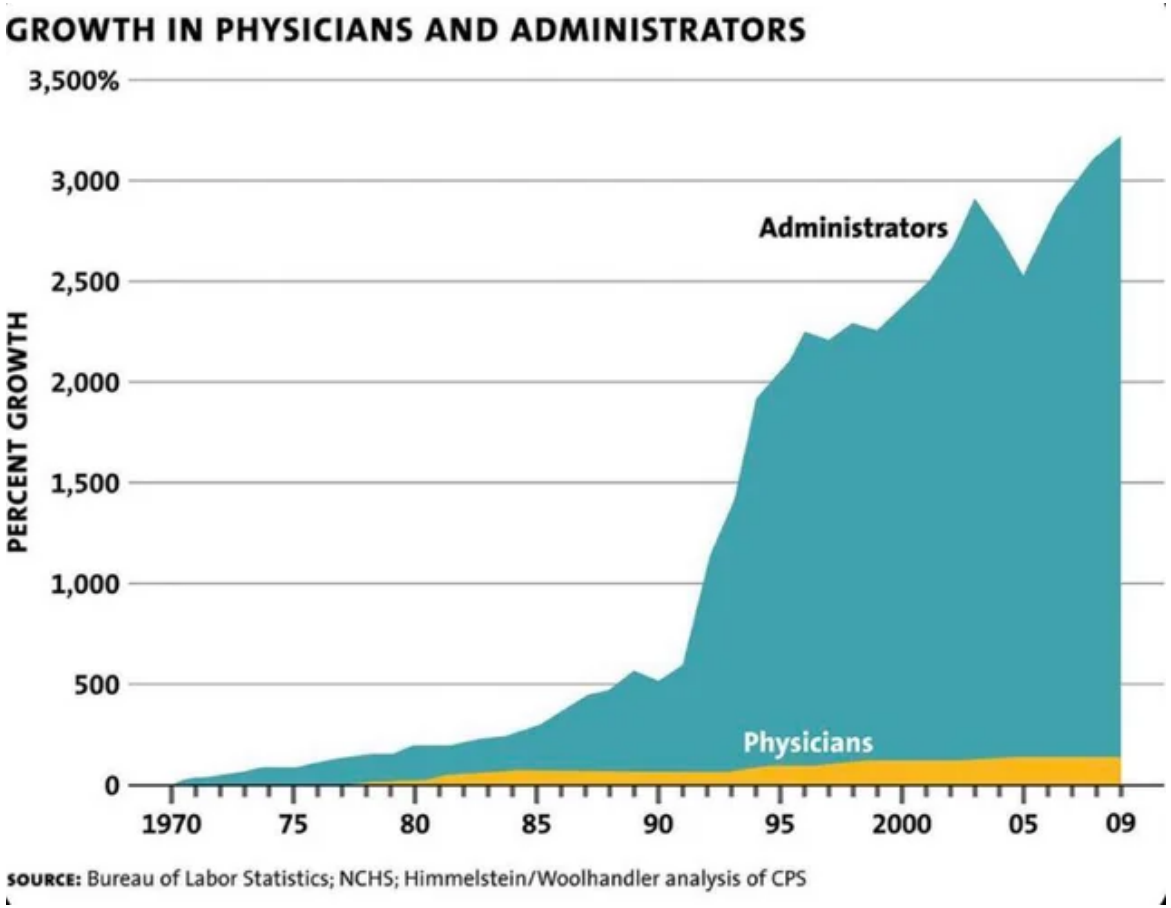
- Always double glove
  - Detection
  - Other
- Change gloves every 2 hours
- Check your titers, etc.
  - Can be checked (for free) at Occupational Health

- Tanner J, Parkinson H. Double gloving to reduce surgical cross-infection. *Cochrane Database Syst Rev*. 2002;(3):CD003087.

Report!!

- Huge pain





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Radiation

Increased cancer risk among surgeons in an orthopaedic hospital FREE

Giuseppe Mastrangelo ✉, Ugo Fedeli, Emanuela Fadda, Angelo Giovanazzi, Luca Scoizzato, Bruno Saia

Occupational Medicine, Volume 55, Issue 6, September 2005, Pages 498–500,

- Orthopaedic surgeons 5x greater radiation compared to other employees
- 29% (!!!) developed malignancy compared to 4% controls
- Problems in study
- Radiation is bad
- No “safe” amount

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Radiation

- Prevalence of cancer 85% greater in female orthopaedist than general population
- 3x increase in breast cancer
- Higher pregnancy complication rate
  - 31.2% versus 14.5%

Contents lists available at ScienceDirect

Journal of Orthopaedics

journal homepage: www.elsevier.com/locate/jor

Are we putting ourselves in danger? Occupational hazards and job safety for orthopaedic surgeons

Robert C. Ryu [a,*], Phillip H. Behrens [b], Azeem T. Malik [a], Jonathan D. Lester [c], Christopher S. Ahmad [d]

[a] Department of Orthopaedics, The Ohio State University Wexner Medical Center, Columbus, OH, USA
[b] Department of Orthopaedics, Cedars-Sinai Medical Center, Los Angeles, CA, USA
[c] Aurora Orthopaedics, Milwaukee, WI, USA
[d] Department of Orthopaedic Surgery, Columbia University, New York, NY, USA

THE ORTHOPAEDIC FORUM

Prevalence of Cancer in Female Orthopaedic Surgeons in the United States

By Loretta B. Chou, MD, Christopher A. Cox, MD, Joanna J. Tung, Alex H.S. Harris, PhD, MS, Daria Brooks-Terrell, MD, and Weiva Sieh, MD, PhD

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Radiation

- Steps to take
  - Keep hands out of the beam
    - In beam 1200- 4000 mrem per minute
    - 5 mrem per minute at 2 feet away
  - Use c-arm vertically
- Navigation decreases exposure significantly

I'll just use the mini c-arm…

- 1/10 scatter
  - More fluoro on time
  - Decreased distance
- Much more exposure to hands
  - 380 mrem in C-arm vs 1000 mrem with mini c-arm

4 steps

1. Less shots
2. More distance
3. Shielding
4. *Contamination control*

Max Allowable Radiation Dose (in rem)	
Annual total body (NRCP)	5
Annual total body (ICRP)	2
Embryo/fetus (>9mo)	0.5
Eye	15
Thyroid gland	30
All other organs (including gonads)	50
Pediatric	10% of adult dose

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Smoke

- Ablation of 1 gm of tissue= mutagenic effects of 6 unfiltered cigarettes
- The average plume created in the operating room is equivalent to smoking as many as 30 unfiltered cigarettes
- Use vacuum devices
- Surgical mask offers no real protection

- Hill DS, O'Neill JK, Powell RJ, Oliver DW. Surgical smoke - a health hazard in the operating theatre: a study to quantify exposure and a survey of the use of smoke extractor systems in UK plastic surgery units. J Plast Reconstr Aesthet Surg. 2012 Jul;65(7):914-6. doi: 10.1016/j.bjps.2012.02.012. Epub 2012 Mar 23. PubMed PMID: 22445358.

Chemical Exposure

- Methylmethacrylate
  - Data is unclear
    - Respiratory irritant, neurotoxic, skin irritant
  - Pregnancy
    - EPA says <100 ppm over 8 hours
    - One arthroplasty has >1000 ppm exposure
    - Animal models with fetotoxicity at >1000 ppm

Background

Impact of Procedure Type, Case Duration, and Adjunctive Equipment on Surgeon Intraoperative Musculoskeletal Discomfort

Presented at the Southern Surgical Association 131st Annual Meeting, Hot Springs, VA, December 2019.

Liyun Yang PhD [a, c, d], Samuel R. Money MD, FACS [e], Melissa M. Morrow PhD [a, c], Bethany R. Lowndes PhD [a, c, f], Tiffany K. Weidner MD [e], Emma Fortune PhD [a, c], Victor J. Davila MD, FACS [e], Andrew J. Meltzer MD [e], William M. Stone MD, FACS [e], M. Susan Hallbeck PhD [a, b, c]

- "Surgeons commonly prioritize performing procedures over their own health and are unlikely to report or seek medical help when having work-related pain. Surgical culture can represent a challenge for improving surgical ergonomics and preventing work related musculoskeletal disorders."

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Ergonomics

- Who has had a work related injury?
  - Alter technique?
  - Alter practice?

Disability

- 9-33%
  - Early retirement
  - Leave of absence
  - Practice restriction/modification

High Prevalence of Work-related Musculoskeletal Disorders and Limited Evidence-based Ergonomics in Orthopaedic Surgery: A Systematic Review

Nikhil Vasireddi MHA[1,2], Neal Vasireddi BS[3], Aakash K. Shah BS[1], Andrew J. Moyal MD[1,2], Elizabeth B. Gausden MD, MPH[4], Alexander S. Mclawhorn MD, MBA[4], Kornelis A. Poelstra MD, PhD[5,6], Heath P. Gould MD[7], James E. Voos MD[1,2], Jacob G. Calcei MD[1,2]

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Background

Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions

William T. Davis BS, Sarah A. Fletcher BS, Oscar D. Guillamondegui MD, MPH, FACS

- Survey study of 260 surgeons (793 solicited)
  - 40% sustained workplace injury
  - 50% received medical care
  - Only 20% reported injuries

Impact of injury on surgical performance, *n* (%)	
No impact	47 (46)
Minimal impact	43 (42)
Moderate impact	12 (12)
Severe impact	1 (1)

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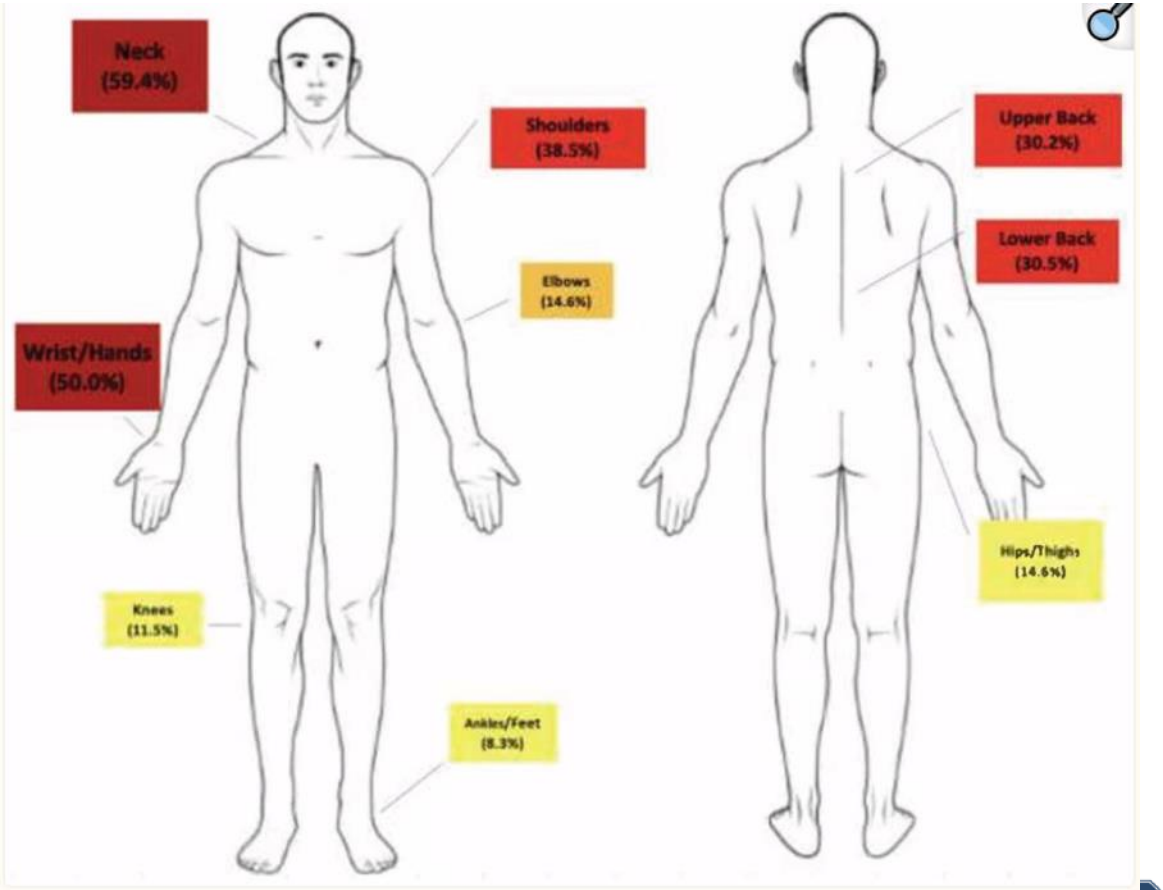
Table 4. Change* in Self-Rated Fatigue and Pain Across Body Parts (0 to 10 Scale) Compared Between Shorter and Longer Cases†

	Shorter duration		Longer duration	
Fatigue and pain	**Mean change in value**	**SD**	**Mean change in value**	**SD**
Fatigue	0.8‡	1.1	2.6‡	1.7
Neck	0.9‡	1.1	1.7‡	2
Right shoulder	0.4	0.9	0.7	1.5
Left shoulder	0.2	0.8	0.7	1.7
Upper back	0.5‡	0.9	1.6‡	2.2
Lower back	0.6‡	1.1	1.7‡	2.1
Right hand	0.3	0.5	0.4	1
Left hand	0.2	0.7	0.3	0.9

*Change value was calculated as the maximum of either during- or postoperation ratings minus preoperation rating.
†Cutoff point at the median case duration of 137 minutes.
‡Significant differences at the 0.05 level ($p < 0.05$).

But is gets better?

- Fixing Hands, Breaking Backs: The Ergonomics and Physical Detriment of the Hand Surgeon 2024
- Survey study from AAHS Members
  - 92 Attending surgeons (~70% male, 30% female)
  - 35% concerned about ability to work



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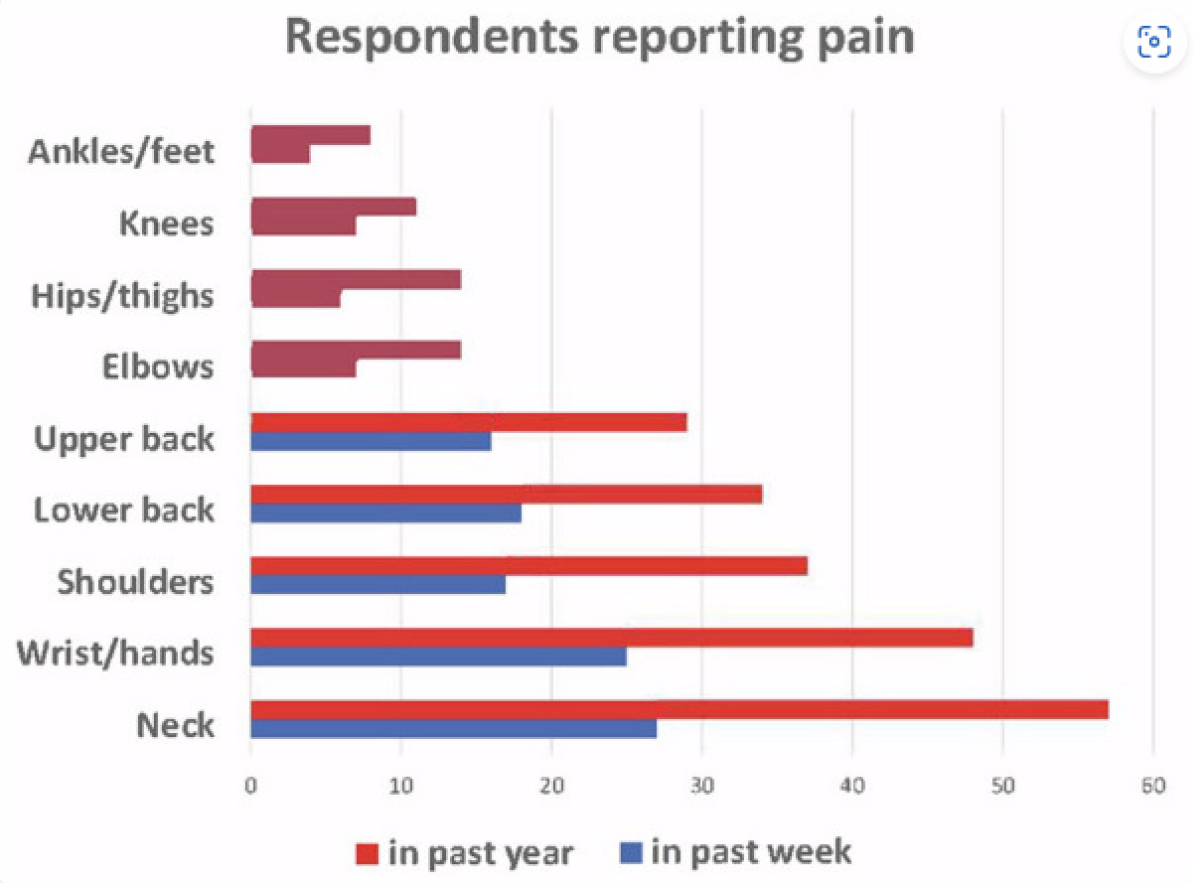
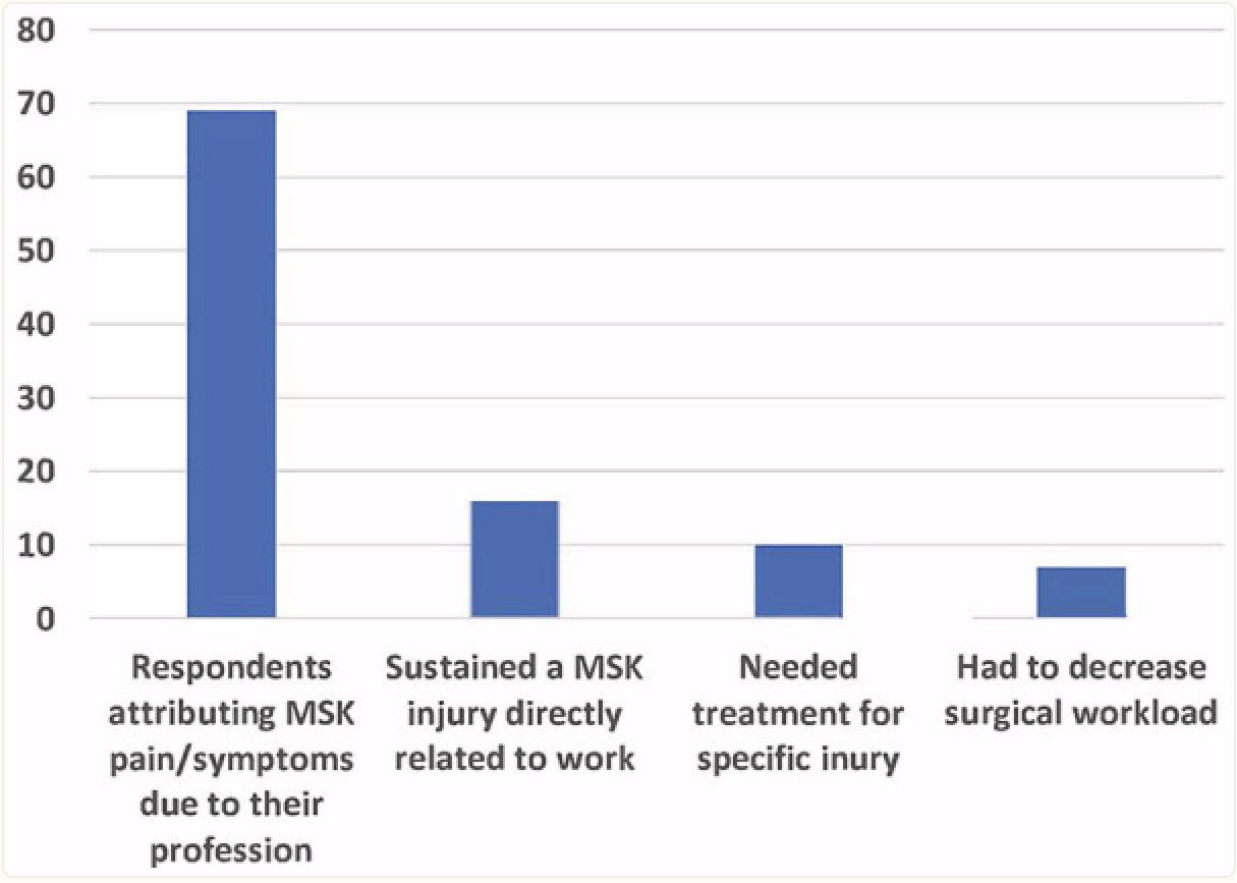
It does not





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Standing Procedures

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Standing Procedures

Upper arm is raised and abducted

Neck is twisted and bent

Back is twisted and bent

Wrist is bent and twisted

Repetitive movements

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Standing procedures

- Shoulders not abducted
- Elbows 90 +/- 20 degrees

Rosenblatt PL, McKinney J, Adams SR. Ergonomics in the operating room: protecting the surgeon. J Minim Invasive Gynecol. 2013 Nov-Dec;20(6):744. doi: 10.1016/j.jmig.2013.07.006. Epub 2013 Aug 20. PubMed PMID: 23969139.

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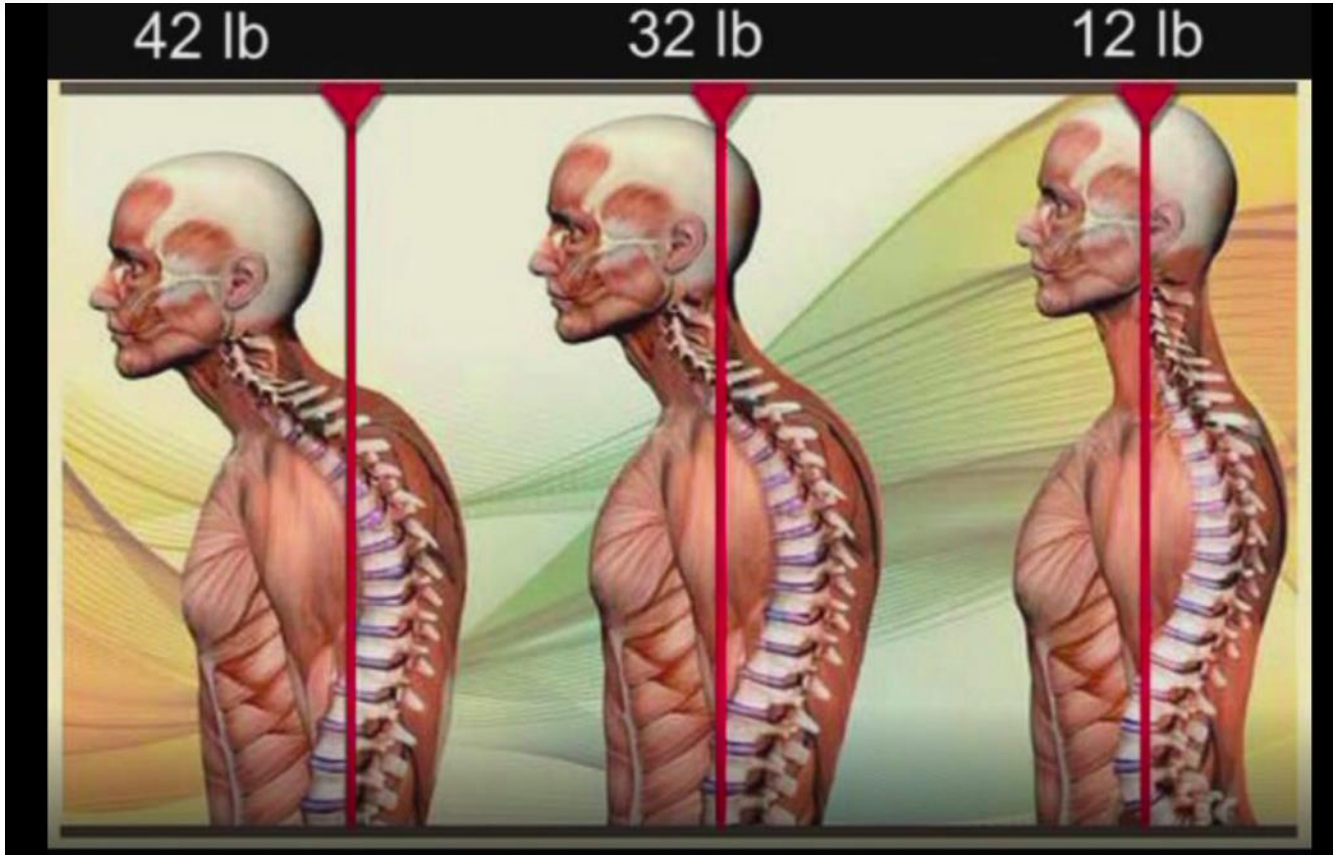
Posture



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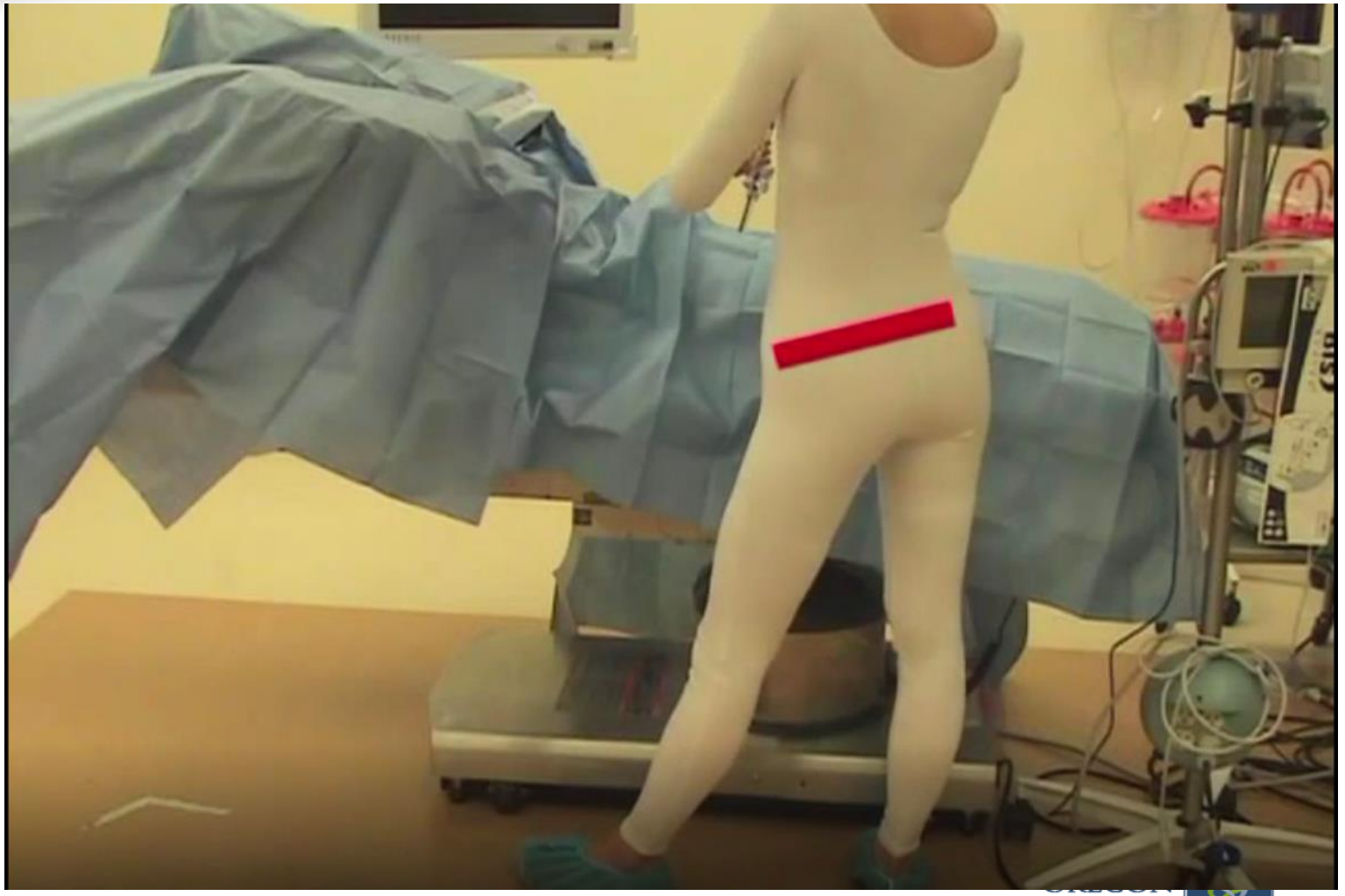
Posture

- Even weight on hips



Posture

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Posture?

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Wide stance

Contents lists available at ScienceDirect

International Journal of Industrial Ergonomics

journal homepage: www.elsevier.com/locate/ergon

The effect of stance width on trunk kinematics and trunk kinetics during sagitally symmetric lifting

Christopher J. Sorensen [1], Omid Haddad [1], Samuel Campbell [1], Gary A. Mirka*

The Ergonomics Laboratory, Department of Industrial and Manufacturing Systems Engineering, Iowa State University, Ames, IA 50011-2164, USA

- The effect of stance width on trunk kinematics and trunk kinetics during sagitally symmetric lifting
- Electrodiagnostics with feet together, shoulder width and 150% shoulder width
- No change in activity of tested muscles
  - Erector spinae, rectus abdominals, gluteus maximus, vastus lateralis and medialis
- May actually be better?
  - Less lumbar motion

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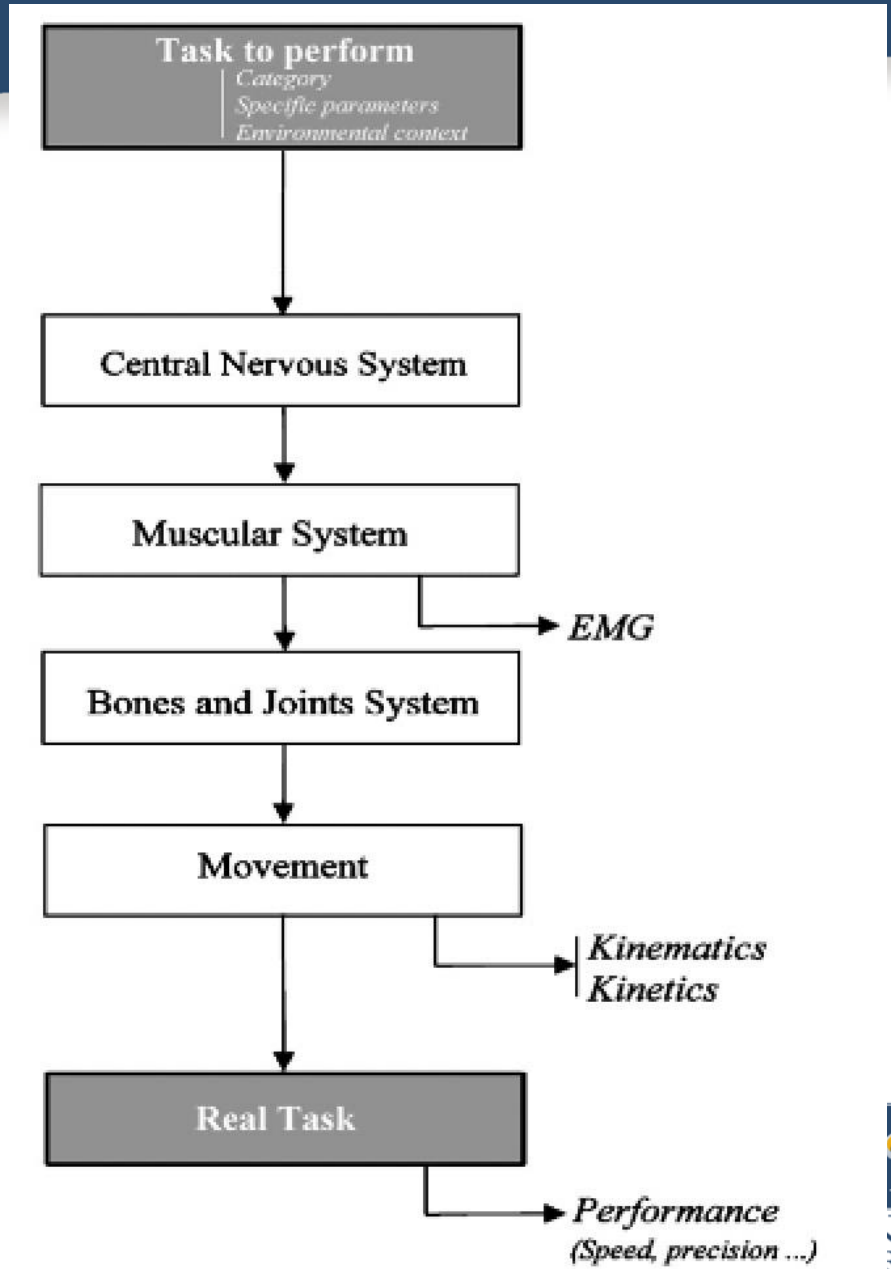
Posture

- Predictable sequence
- Core vs. smaller muscles



REVIEW/MISE AU POINT

Posture, dynamic stability, and voluntary movement

Posture, stabilité dynamique et mouvement volontaire

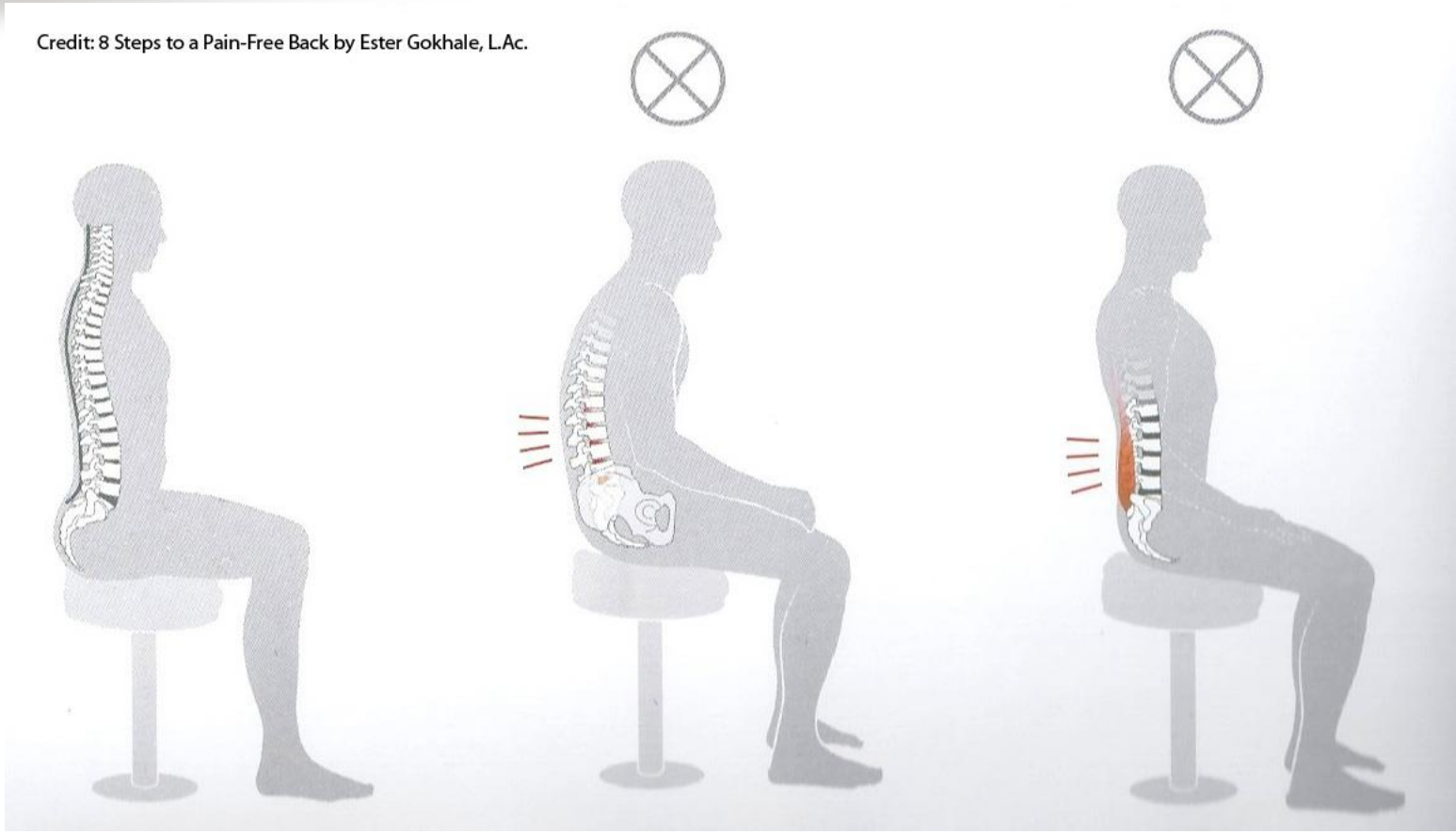
S. Bouisset*, M-C. Do

UFR-STAPS, université Paris-Sud-11, rue Langevin, 91405 Orsay, France

Received 1st October 2008; accepted 1st October 2008
Available online 18 October 2008

Sitting

- Knees bent 90
- Feet flat on floor
- Work between 0- 10 cm below elbow height



Azimuddin AF, Weitzel EK, McMains KC, Chen PG. An ergonomic assessment of operating table and surgical stool heights for seated otolaryngology procedures. *Allergy Rhinol (Providence)*. 2017;8(3):182-188.

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Wrong Way

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Microscope

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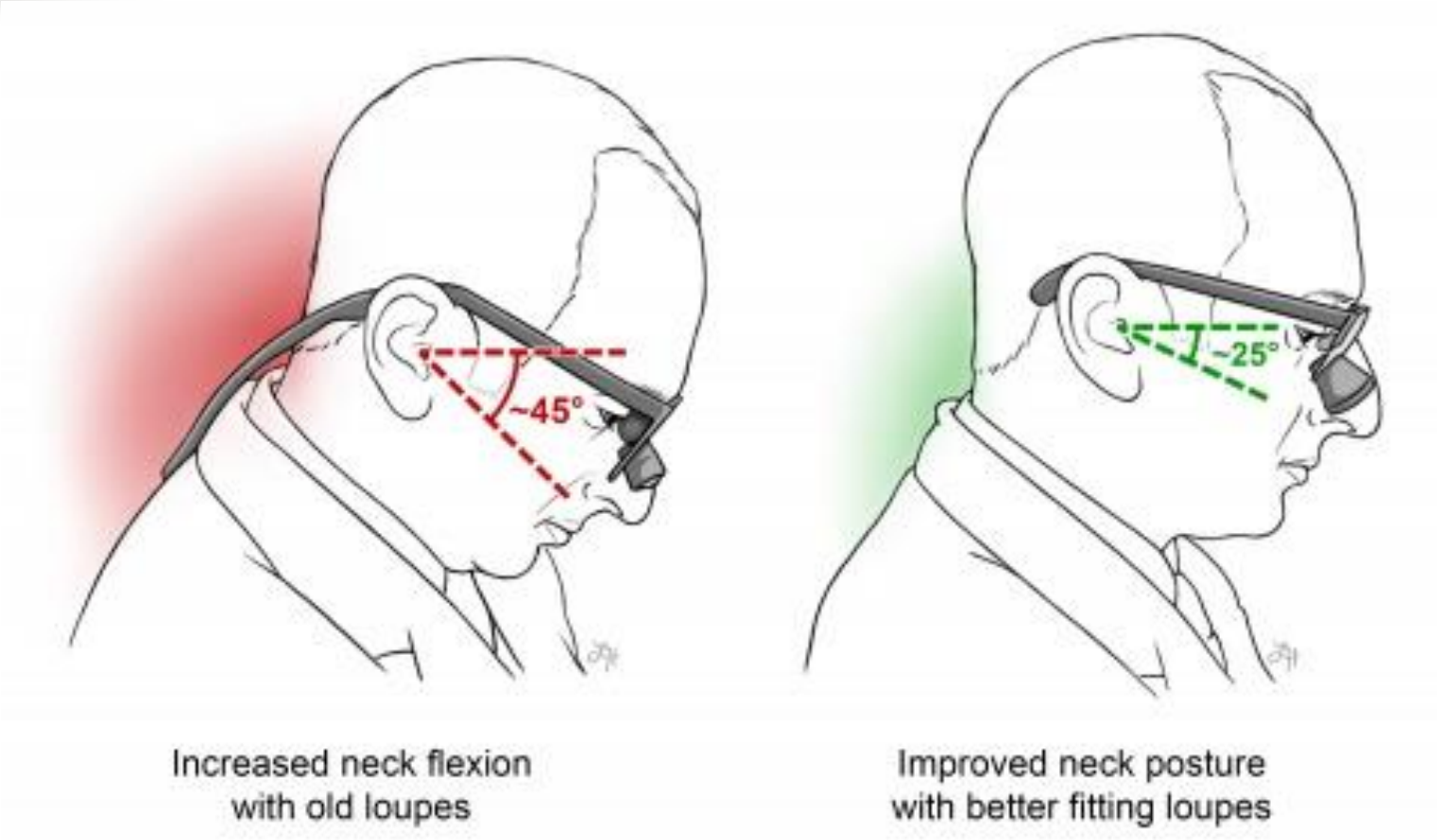
Loupes



https://surgery.duke.edu/news/duke-surgery-introduces-ergonomics-program-improve-surgeon-health

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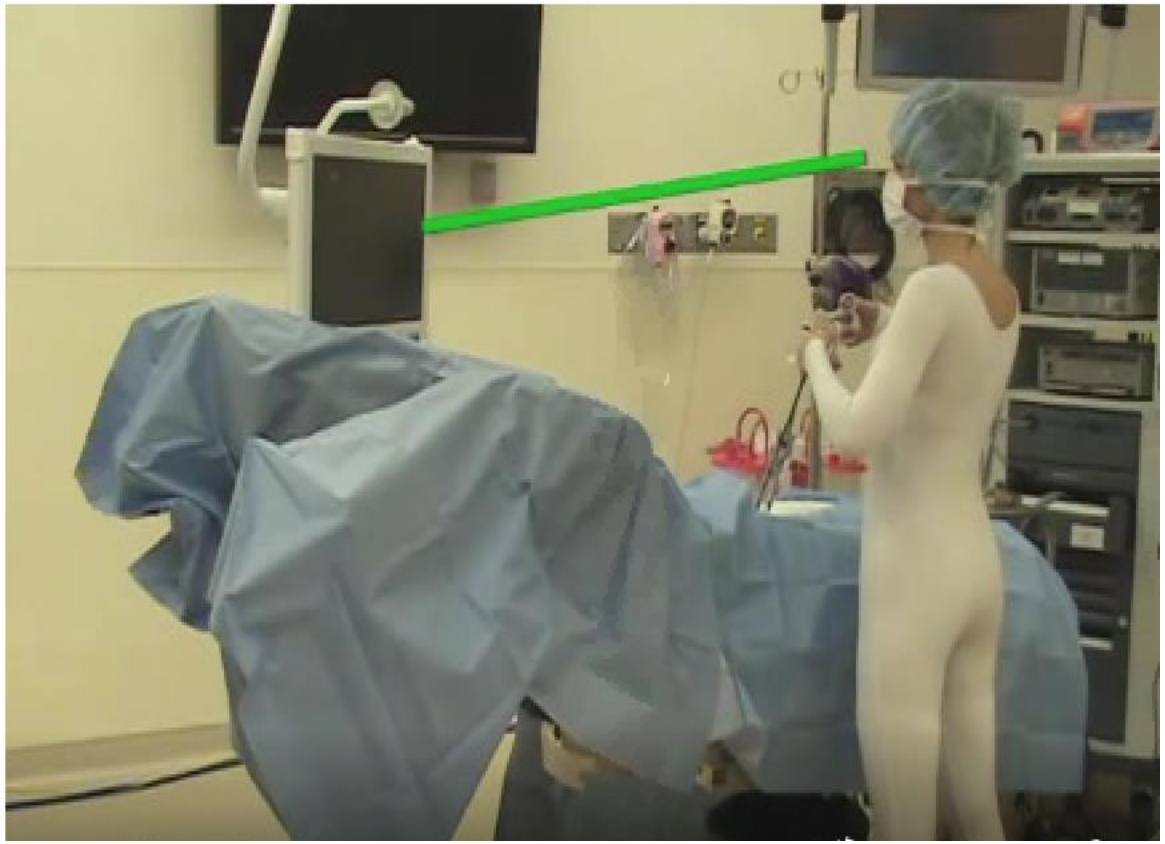
Arthroscopic Surgery

- Screen directly in front of surgeon
  - 15-40 degrees below eye level
- Foot pedals
  - Between surgeon, instrument and screen



Instruments

- Needle driver
- Screwdriver

Liston Amputation Knife

Basics

- No gold standard for tool design
- Largely survey based
- Literature largely from 70’s and 80’s
- Industrial work context
- Magnified effects
  - Greater force
  - Torque
  - Fatigue

Basics

- Most tools are not designed with ergonomics in mind
- Based on historic designs
- Work well

Basic Surgical Instruments and Their Use

Fred G. Corley MD *, Ryan Thomas MD †

Show more

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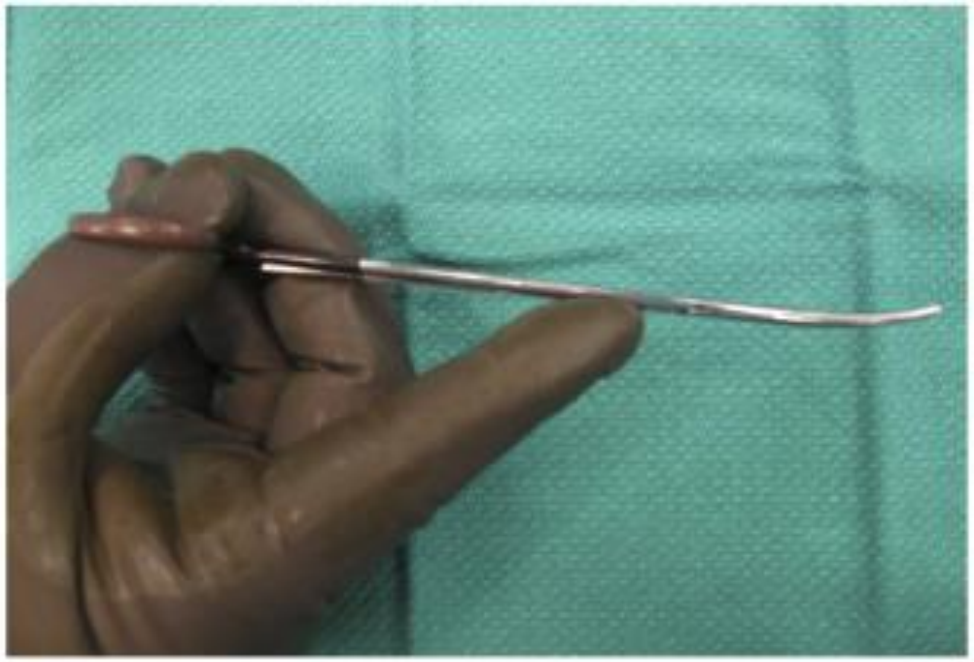
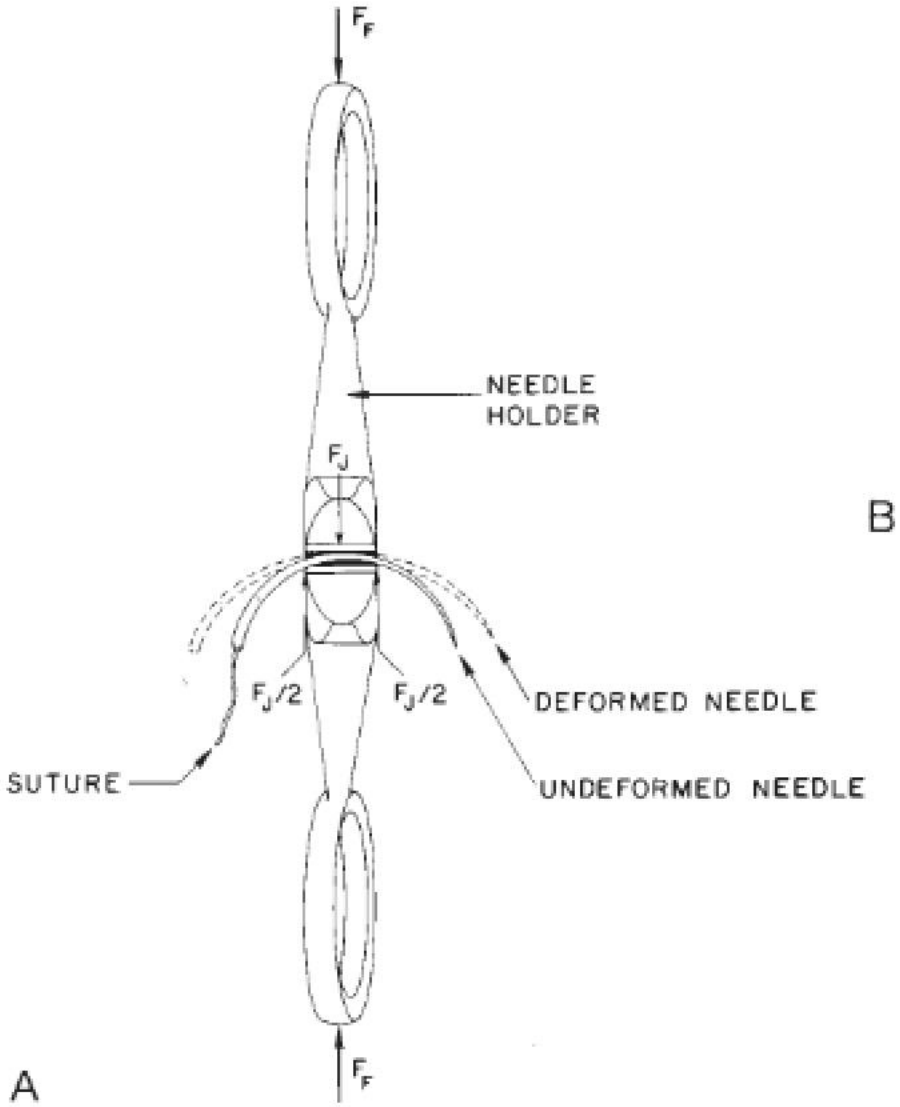


Figure 3 Proper use of scissors.

Needle Holder

- Complicated
  - Needle ductility, sharpness, size, brand
- Function
- Suture availability
- Size
- Effort
- Speed

Needle Driver Size



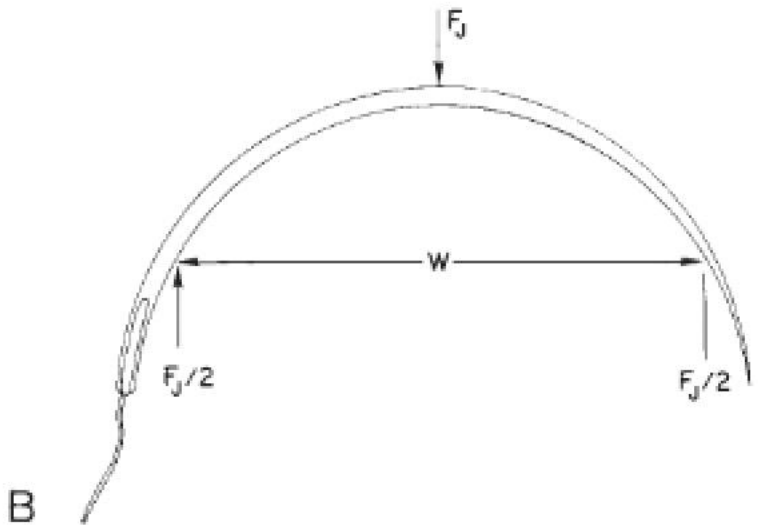


Figure 5. A, A
the needle holde

Scientific basis for selecting surgical needles and needle holders for wound closure.

Edlich RF, Towler MA, Rodeheaver GT, Becker DG, Lombardi SA, Thacker JG

Author information

Clinics in Plastic Surgery, 01 Jul 1990, 17(3):583-602
PMID: 2199147

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Needle Driver

- Teeth vs smooth
  - Less force for stable needle
  - Damage monofilament suture
- Rachets

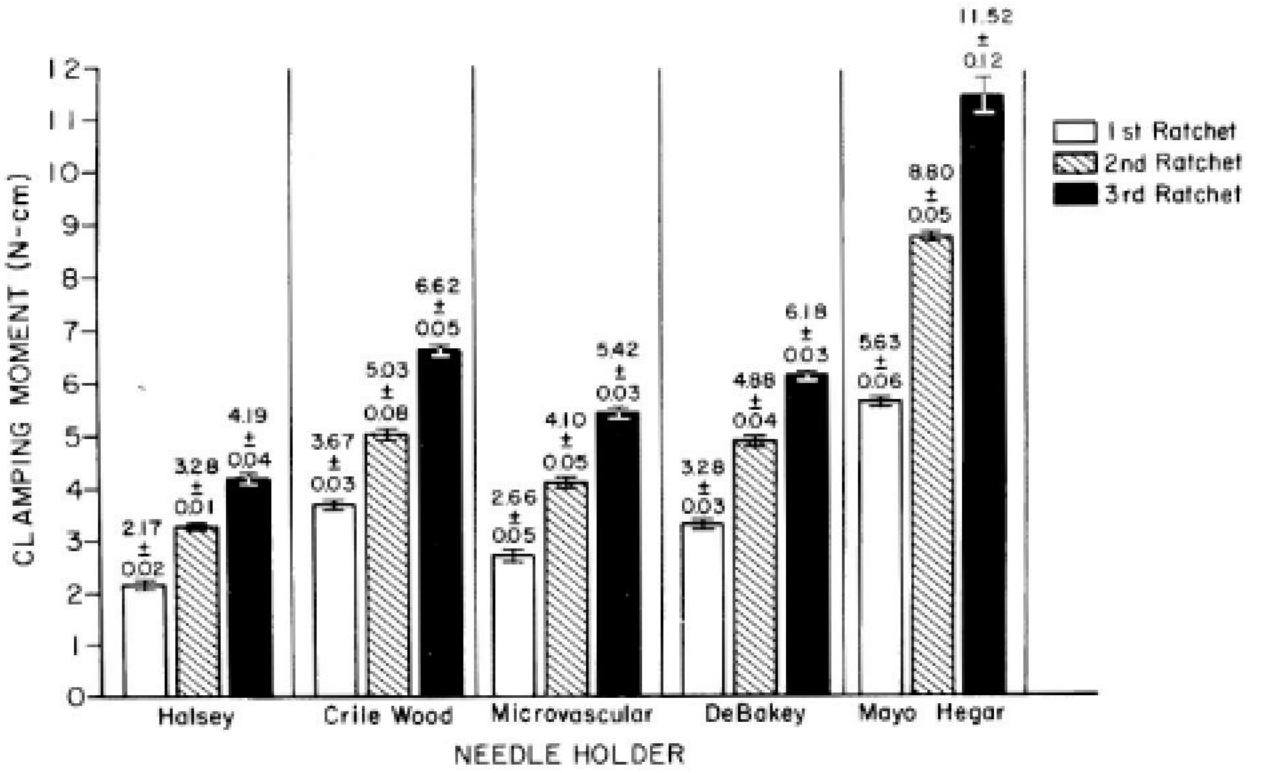

Figure 17. Advancing the ratchet settings from the first, second, and third interlocking teeth resulting in significant increases in the jaw clamping moments.

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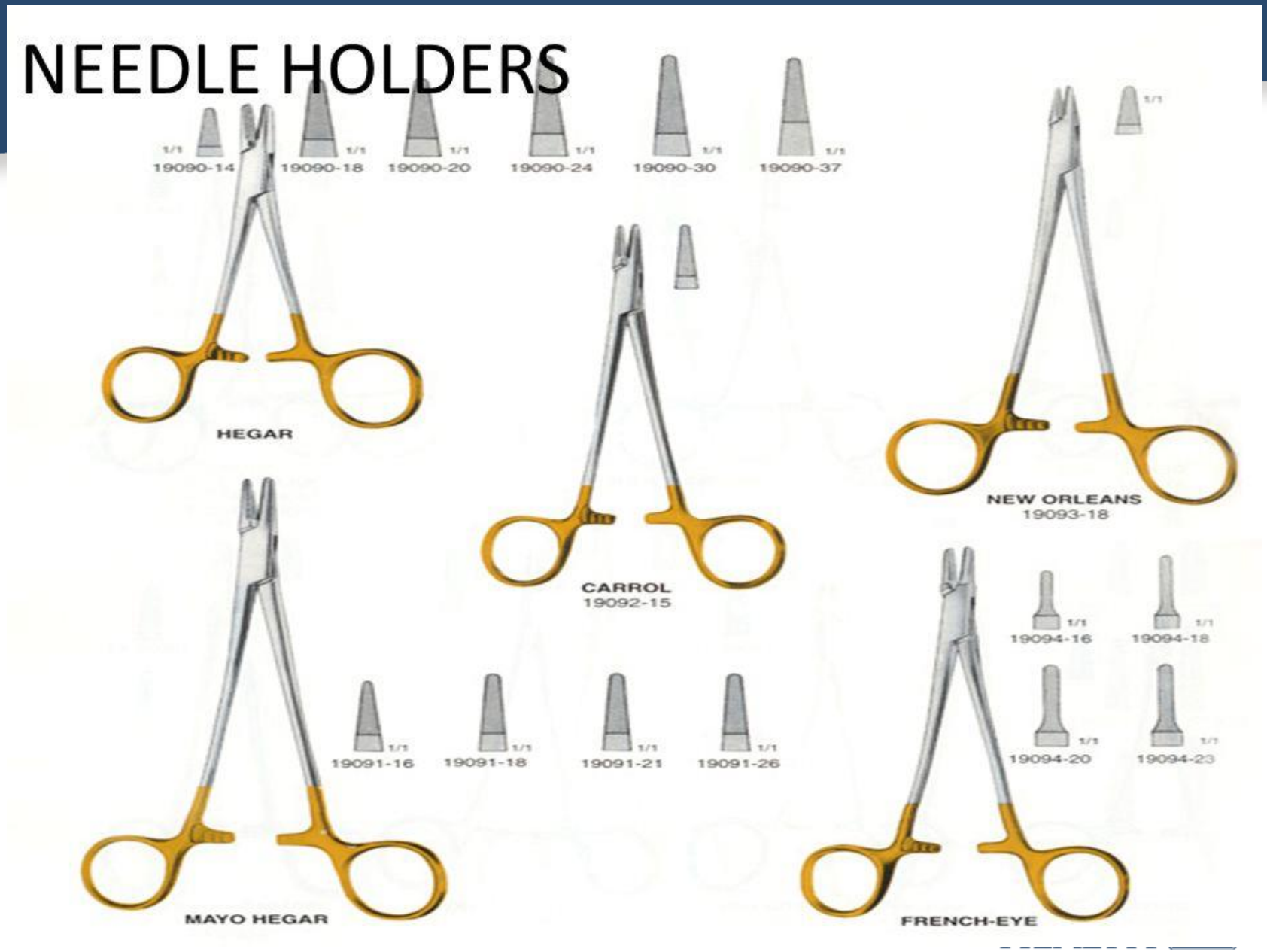
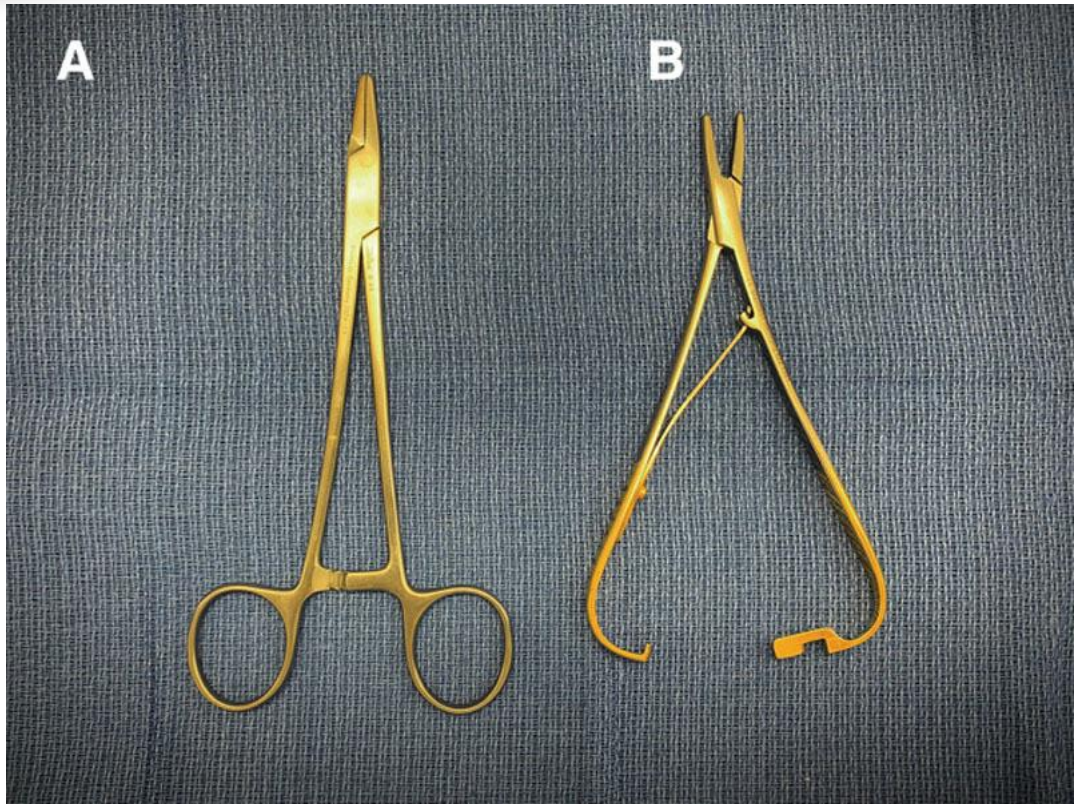
Needle Drivers

- Specialized
- “Palming”



Types of drivers



Schuth O, Powers J, Merritt W, Blanchet N. Resolution of Thumb Pain following Adoption of Mathieu Needle Holder: An Ergonomic Analysis. *Plast Reconstr Surg Glob Open*. 2020;8(4):e2768. Published 2020 Apr 24. doi:10.1097/GOX.0000000000002768

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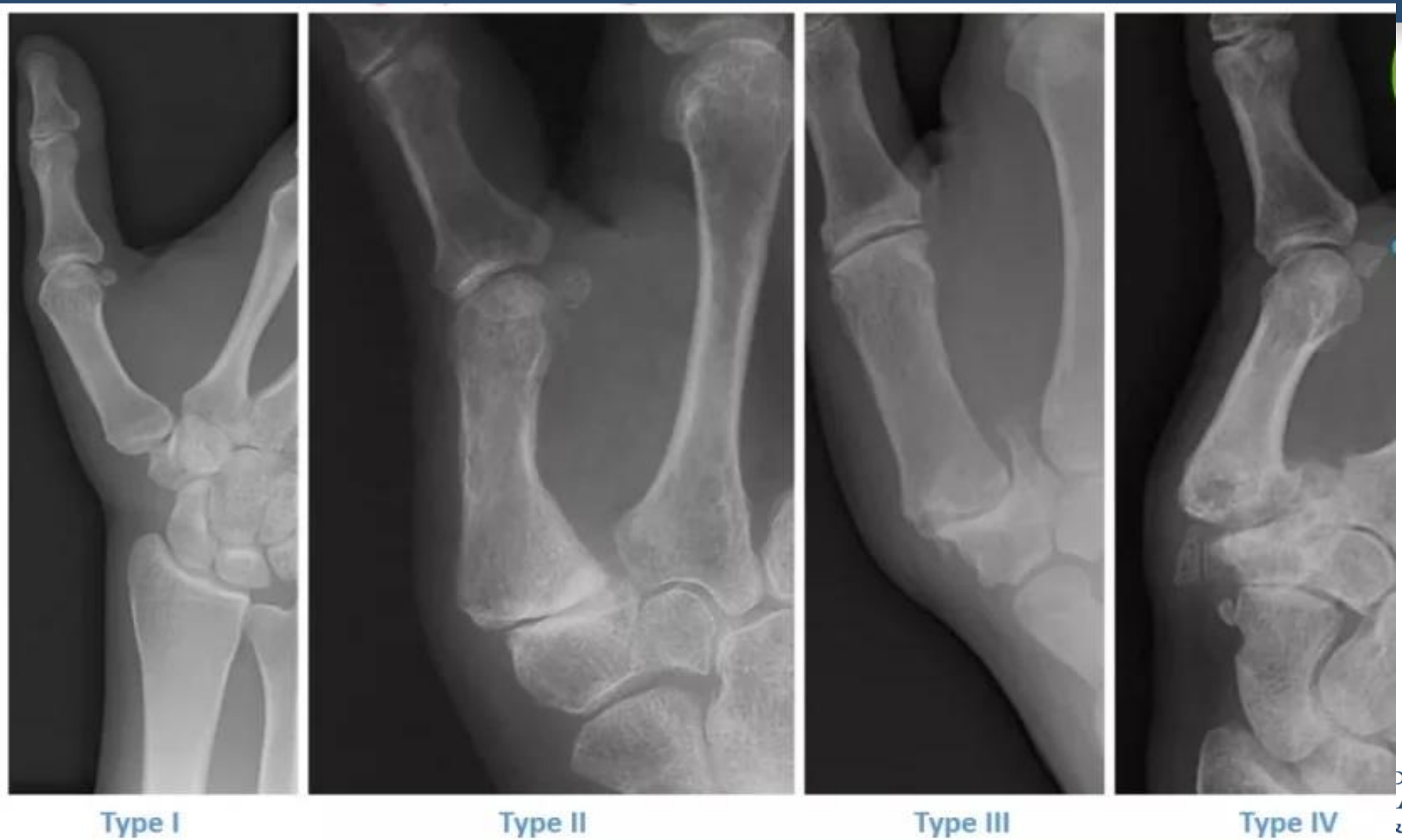
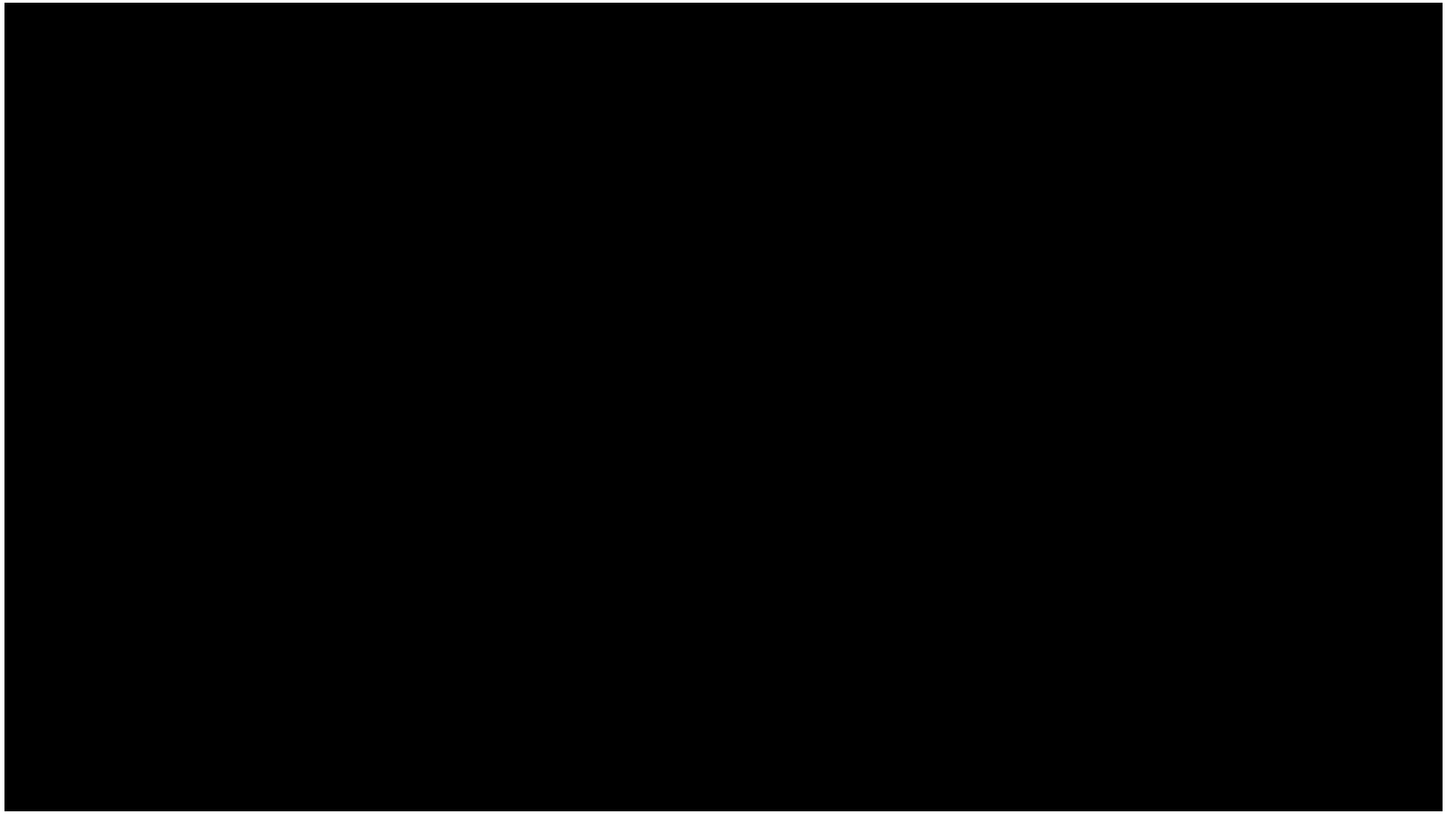
CMC Arthritis





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Needle Driver

- Intact needle
- With teeth
- Adaptable
  - If it does not work, change

Screwdrivers

- Most commonly placed implants
- Must have proper screwdriver/screw relationship
- Historic thinking
  - Smaller tools allow more precision

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Screwdrivers

An electromyographic study of maximum torques and upper extremity muscle activity in simulated screwdriving tasks

Daniel J. Habes, Katharyn A. Grant *

US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 4676 Columbia Parkway, MS C-24, Cincinnati, OH 45226, USA

Received 14 May 1996; revised 13 September 1996

- 15 male subjects
- 100% and 75% effort
- Evaluated via EMG
- Factors
  - Handle height (shoulder vs elbow)
  - Distance of handle from body
  - Handle orientation (horizontal versus vertical)
  - Handle diameter

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Screwdrivers

- Ideal configuration
  - Elbow height
  - Vertically oriented
  - Larger diameter
- Reach distance
  - Only affected by elbow height

An electromyographic study of maximum torques and upper extremity muscle activity in simulated screwdriving tasks

Daniel J. Habes, Katharyn A. Grant *

US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 4676 Columbia Parkway, MS C-24, Cincinnati, OH 45226, USA

Received 14 May 1996; revised 13 September 1996

Screwdriver

Review > EFORT Open Rev. 2020 Jan 29;5(1):26-36. doi: 10.1302/2058-5241.5.180066. eCollection 2020 Jan.

Surgical performance when inserting non-locking screws: a systematic review

James W A Fletcher [1 2], Lisa Wenzel [2 3], Verena Neumann [2], R Geoff Richards [2], Boyko Gueorguiev [2], Harinderjit S Gill [4], Ezio Preatoni [1], Michael R Whitehouse [5 6]

Affiliations + expand

PMID: 32071771 PMCID: PMC7017595 DOI: 10.1302/2058-5241.5.180066

Free PMC article

- Meta analysis 12 studies
  - 260 surgeons, 2793 screws
- 26% of all screws were irreparably damaged and stripped
- When stripped >80% of pullout strength lost
- Increased torque during course of training

Screwdrivers

- Effect of experience
  - Highly varied
  - Study of 10 surgeons
    - 16/16 stripped
    - 15/16 stripped
- 2 finger tight
  - Meaningless
  - Dynamic and varied

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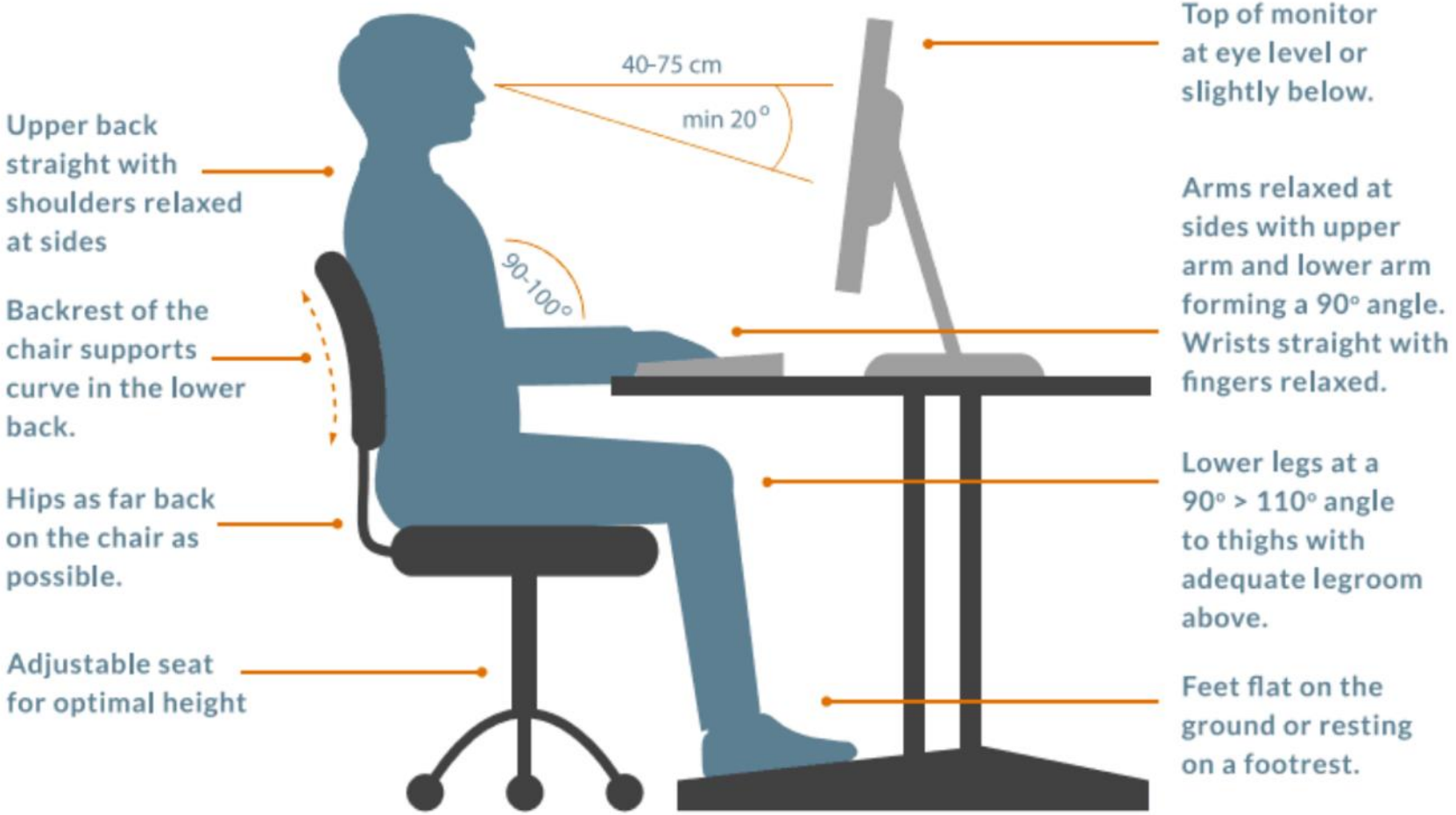
Clinic

- Ideal distance from eye to screen is 50-75 cm with 5 mm font
- Heterogenous literature
- Adjust your workstation and chair

van Niekerk SM, Louw QA, Hillier S. The effectiveness of a chair intervention in the workplace to reduce musculoskeletal symptoms. A systematic review. BMC Musculoskelet Disord. 2012 Aug 13;13:145. doi: 10.1186/1471-2474-13-145. Review. PubMed PMID: 22889123; PubMed Central PMCID: PMC3552974.



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Clinic

- Computer visual syndrome
  - 90% of people > 3 hours in front of a computer
- Workstation height
- Decrease glare
- Minimal brightness
- Increased strain looking at screen versus hard copy
- Appropriate vision correction
  - Go to the eye doctor

Rosenfield M. Computer vision syndrome: a review of ocular causes and potential treatments. Ophthalmic Physiol Opt. 2011 Sep;31(5):502-15.

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Blue Light Glasses

AMBER LENSES TO BLOCK BLUE LIGHT AND IMPROVE SLEEP: A RANDOMIZED TRIAL

Burkhart Kimberly & **Phelps James R.**

Pages 1602-1612 | Received 23 Feb 2009, Accepted 15 Jul 2009, Published online: 23 Dec 2009

Download citation https://doi.org/10.3109/07420520903523719

- Use during the day?
- Improved sleep with use 3 hours before sleep
  - UV versus blue light block
- Decreased symptoms in those with insomnia in use 2 hours before sleep
- Put your phone away at night
  - SMART goal

Int J Prev Med. 2020 Aug 6;11:114. doi: 10.4103/ijpvm.IJPVM_266_19. eCollection 2020.

Quality of Sleep Among Bedtime Smartphone Users

Bindu Krishnan [1], Rama Krishna Sanjeev [2], R G Latti [1]

Affiliations + expand

PMID: 33088442 PMCID: PMC7554597 DOI: 10.4103/ijpvm.IJPVM_266_19

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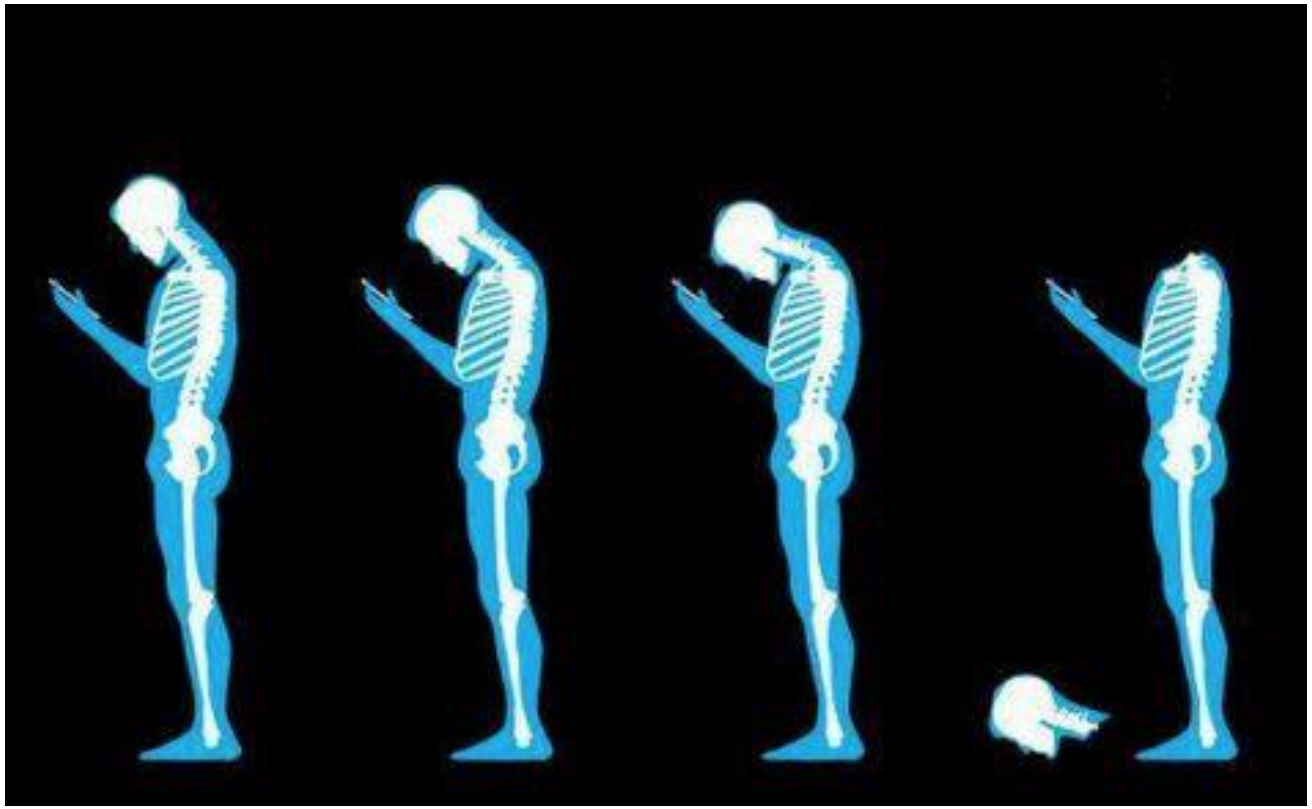
Action steps

- Say something
  - Ask for modifications
  - Mention on surveys
  - Acknowledge
- Consider adding one aspect

Questions

- Tips?
- Comments?



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