



Tribute to Ornella Sizzi

Saturday June 10th 14 – 18h
NH Leonardo Da Vinci Hotel, Rome

**Handling Endoscopic Surgery as a woman surgeon:
Ergonomics in instruments and physical approach to avoid
physical discomfort**

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POLICLINICO UMBERTO I**



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UMBERTO I
POLICLINICO DI ROMA



Talk plan

- Introduction
- Problems for laparoscopic surgeons
- Physical dangers, mental fatigue, occupational diseases
- Women surgeon problems
- Prevention
- Conclusions

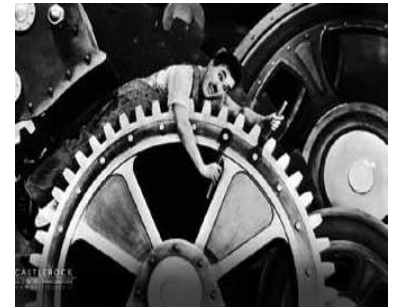
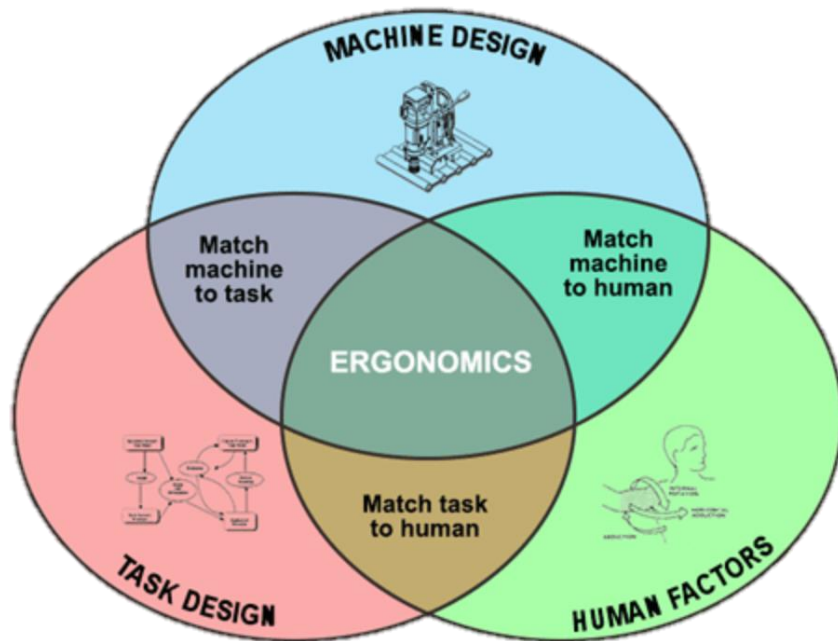
INTRODUCTION

Ergonomics: **Ergos=work / nomos=rule**

Ergonomics is "the science that deals with the design of things that people use in their work and everyday life and the environments in which they work and live, taking into consideration the human characteristics".



Ergonomics is the research of the best relationship
between function, equipment and user.



Skills and characteristics required in mini-invasive surgery

- Intellectual background
- Optimal Physical condition
- Efficient and high standard work environment

- Laparoscopy provides **great advantages** to the patient
- However, it causes **ergonomic inconveniences** for surgeons, which may result in **decreasing the surgeons' performance** and **musculoskeletal disorders**.



IN FACT, IT OBLIGES THE SURGEON TO ADAPT TO:

- **Different** operative room **organization**
- **Altered** **posture**
- **2D vision** of the operating field **magnified** on a 3D screen
- **Specific** **instruments**
- **Reduced** **proprioception**
- **Different** **eye-hand coordination**
- **Particular** **surgical movements**



Problems for laparoscopic surgeons

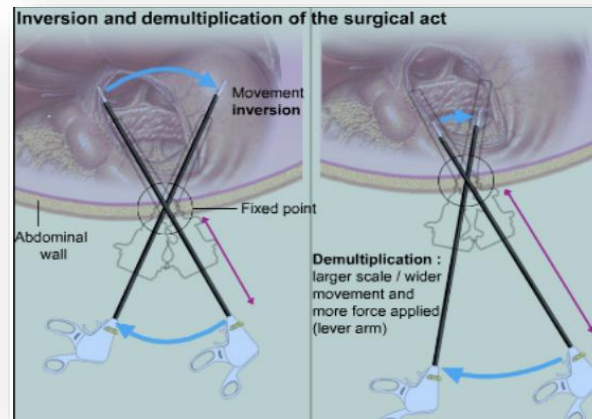
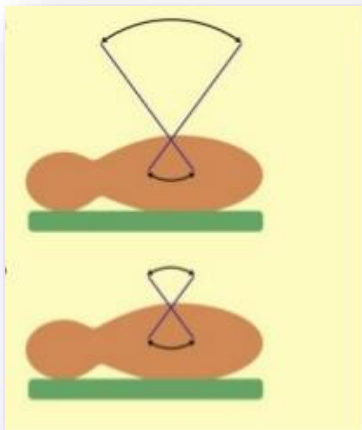


During laparoscopic procedures, surgeons are required to adopt awkward body postures, perform repetitive and precise movements and maintain prolonged static muscle contraction to achieve the best patient outcomes.



NEGATIVE ASPECTS OF LAPAROSCOPY

- Procedure can last long
- Dexterity limited due to the fixed access port position
- Only 4 degrees of freedom of instruments
- Altered and reduced haptic "perception" of the tissue characteristics
- Paradoxical movement due to fulcrum effect (the instrument tips move in opposite directions with respect to the handles)
- The fulcrum effect does not permit the surgeon to change his or her body posture
- Elongated instruments: tremor enhancement.
- Increased strength required to hold the instruments (6-fold strength required)
- "User-gap": only one measure for different hands.



- Problems for laparoscopic surgeons



EFFECTS ON THE SURGEON

- Increased time and fatigue
- Static, forced, and awkward long-term postures.
- Body deviation from the neutral position: ➔ musculoskeletal disorders
- **Surgical Fatigue Syndrome:** >4 h of intense surgical work causes: mental confusion, irritation, reduced judgment, reduced ability and physical dexterity
- **Visual fatigue**
- **Unknown long term effect**
- Possible significant **cardiovascular stress**



USEFULNESS OF ERGONOMICS



- Tension and muscular fatigue cause errors and slowness.
- The muscles can work for hours if they use 15 % of their maximum strength.
- The application of the ergonomic principles reduces the quantity of applied muscular strength and it allows to reduce fatigue and to improve safety and surgical time



- Both **male** and **female** surgeons are exposed to physical and mental effect of laparoscopic surgery
- **However women have proved** to be more exposed than men because:
 - They are often **shorter** than men
 - They have **smaller hands and thumbs**
 - They are generally **less strong** than men
 - **Instruments are designed for men**



CAUSES OF DRAWBACKS

- Long lasting static position of the surgeons
- Abnormal upper limb movements
- Time and motion
- Instruments characteristics
- Position of the monitor
- Operating table height
- Foot pedal position

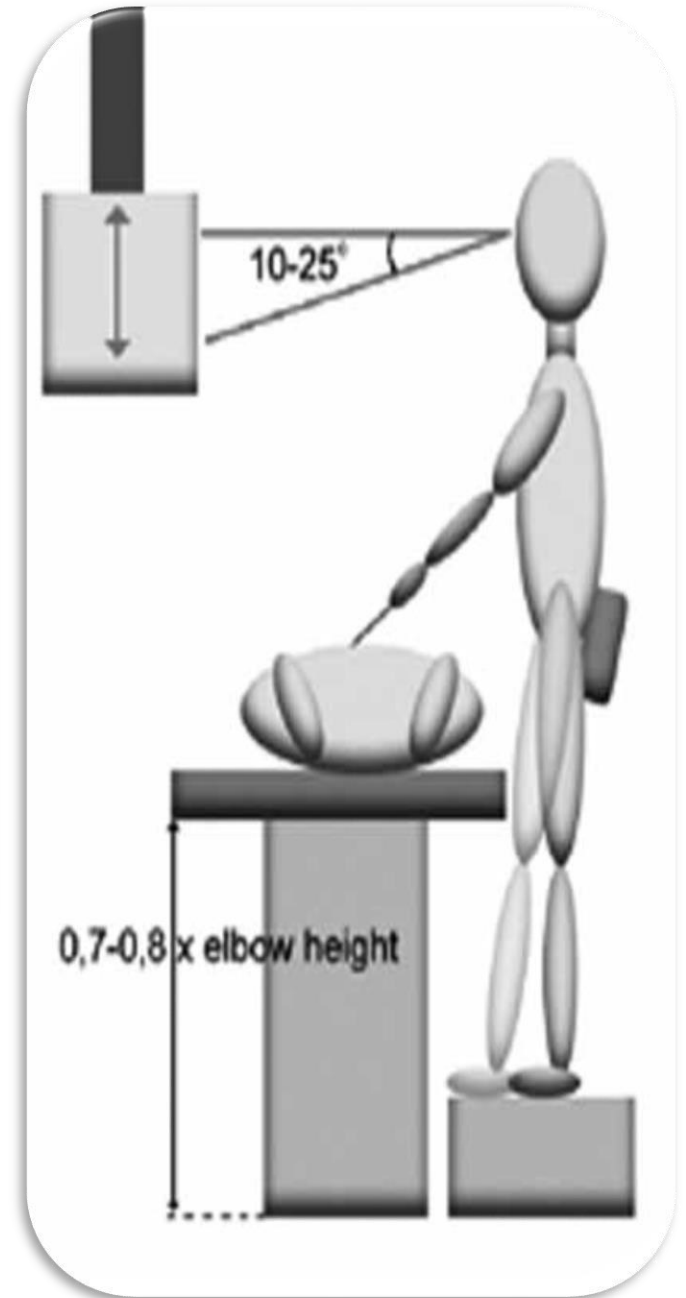


PHYSICAL EFFECTS

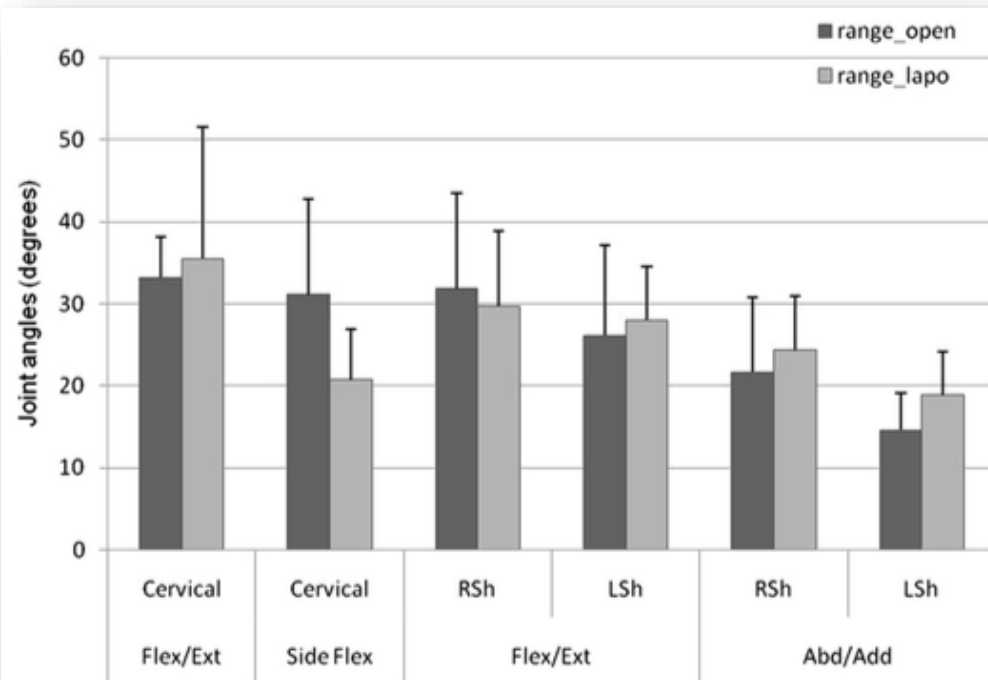
- **Discomfort and physical damage**
- **Musculoskeletal disorders (paresthesia, neuropathic compression) in different sites**
- **Hyperextension** of the cervical rachis and **tension of the neck;**
- **Back pain** (standing position with continuous and repetitive traumas to the lumbosacral column)
- **Fatigue**



Posture defects

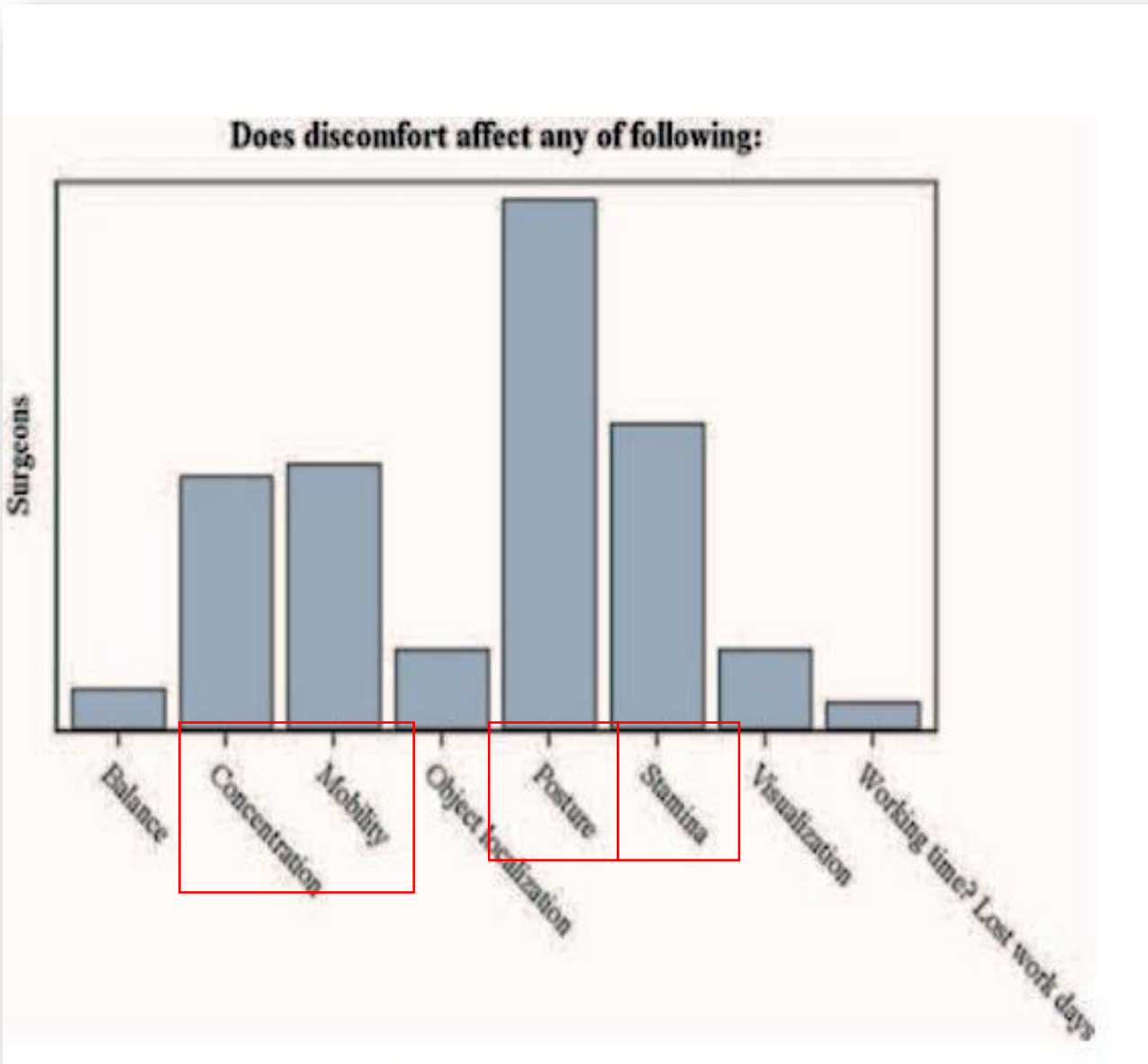


Surgeons' Static Posture and Movement Repetitions in Open and Laparoscopic Surgery



- Surgeons generally maintained a **more extended and static neck posture** during laparoscopic procedures.
- There were statistically **significant differences in mean neck posture and mean left shoulder abduction posture** between the two types of surgery.

Physical dangers, mental fatigue, occupational diseases



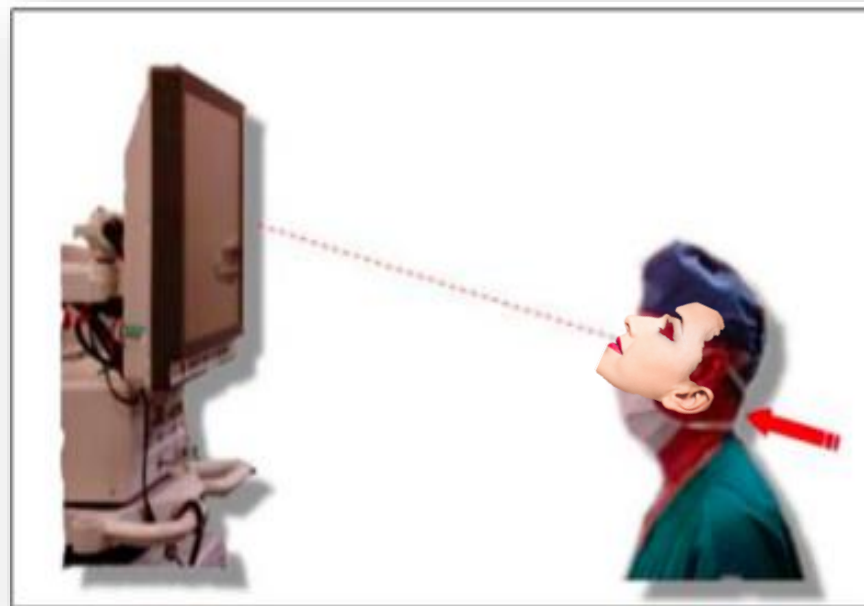
Park et al 2016

Optimal ergonomics for laparoscopic surgery in minimally invasive surgery suites: a review and guidelines

Review of the literature

Drawback in MIS:

- **Misalignment in the eye-hand-target axis** because of limited freedom in monitor positioning is the **most important important ergonomic drawback**



**Hyperextension of the cervical rachis
and tension of the neck**

Surgeons' Static Posture and Movement Repetitions in Open and Laparoscopic Surgery



14 SURGEONS:

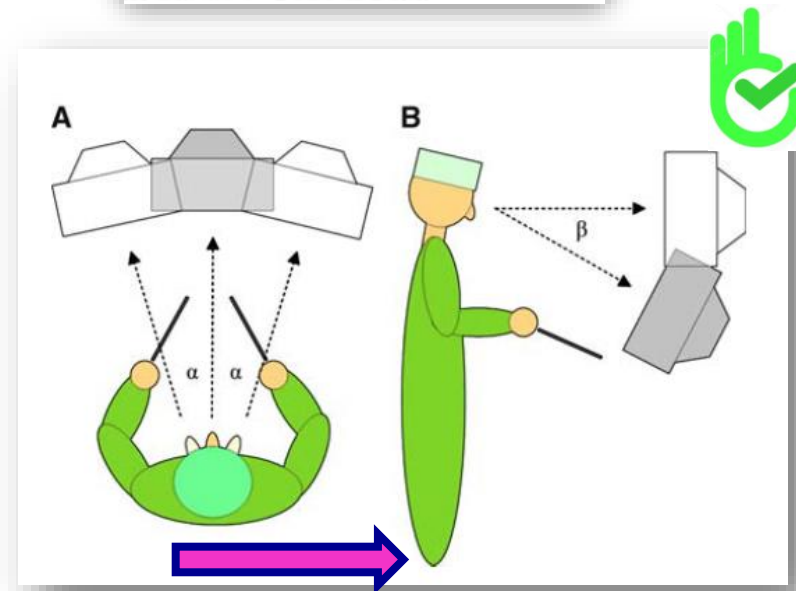
- 12 MEN
- 2 WOMEN
- MEASUREMENT of Cervical spine movements
- Real-time joint movements in sagittal and coronal planes were recorded during open and laparoscopic surgery for periods ranging from 30 to 80 min.



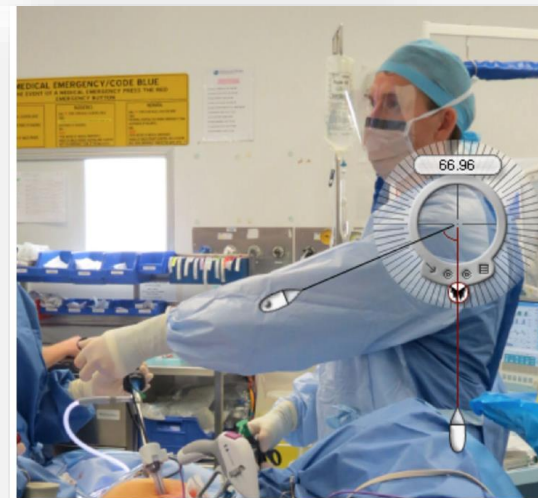
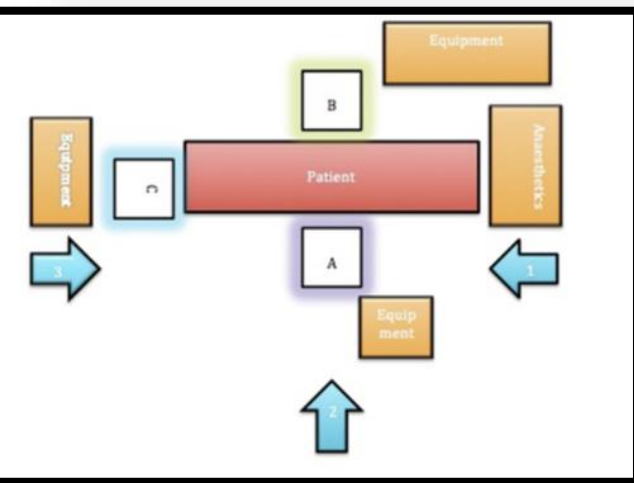
Long duration of static posture in laparoscopic surgery was closely associated with low-level **muscle tension**, which may contribute to an increased risk of surgeons developing musculoskeletal disorders

HOW SHOULD THE MONITOR BE POSITIONED ?

- In the horizontal plane  straight in front of each person and aligned with the forearm-instrument motor axis to **avoid** axial rotation of the spine.
- In the sagittal plane  **lower than eye level** to **avoid neck extension**.
- The most comfortable viewing direction is approximately **15° downward**.



The ergonomics of laparoscopic surgery: a quantitative study of the time and motion of laparoscopic surgeons in live surgical environments

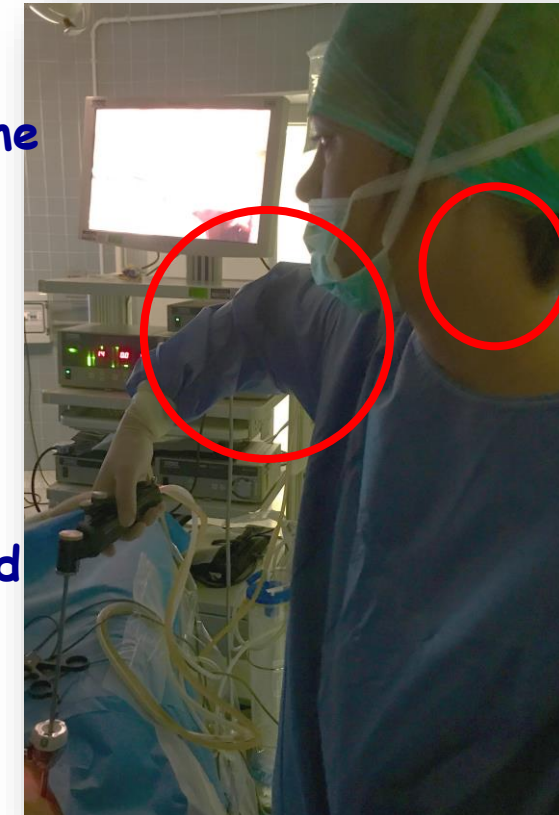


- 150 video recordings of 18 surgeons standing at the patient's left
- Postoperative processing **quantified surgeon movements** of the **neck, shoulders and elbows** using computer software to measure **extreme joint angles** and **time spent** within defined joint angle ranges

The ergonomics of laparoscopic surgery: a quantitative study of the time and motion of laparoscopic surgeons in live surgical environments



- 98% of surgical time spent in neck rotation at 21° (range 0° - 52°)
- The non-dominant arm was subjected to more extreme position
- Shorter surgeons maintained significantly greater degrees of neck rotation
- Surgeons with shorter arms spent longer in extreme positions with their non-dominant shoulder at 90° and elbow at 120° compared with taller surgeons.



Laparoscopic surgeon's thumb

- Pain or paresthesia in the thumbs during the long laparoscopic procedure
- Caused by **unergonomic** instrument handles and their **continuous compression of the lateral digital nerve**
- Particularly frequent in subjects with **small hands (size <7)**



Surg Endosc (2007) 21: 1126–1130
DOI: 10.1007/s00464-006-9061-3

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Ringed silicon rubber attachment prevents laparoscopic surgeon's thumb

N. Inaki,¹ E. Kanehira,² T. Kinoshita,³ K. Komai,⁴ K. Omura,¹ G. Watanabe¹



The RSRA is a simple and effective ways for preventing laparoscopic surgeon's thumb.

Operating table and foot pedal

- If the table is **too high**, **muscles** apply **more force** to raise and hold the shoulders and the elbows.
- This position may lead to **shoulder muscle fatigue**.
- Laparoscopic instrument **handles** should be **slightly below the level of the surgeon's elbows**.
- **The proper table height keeps shoulders down, and the angle between the lower and upper arm is between 90° and 120°**

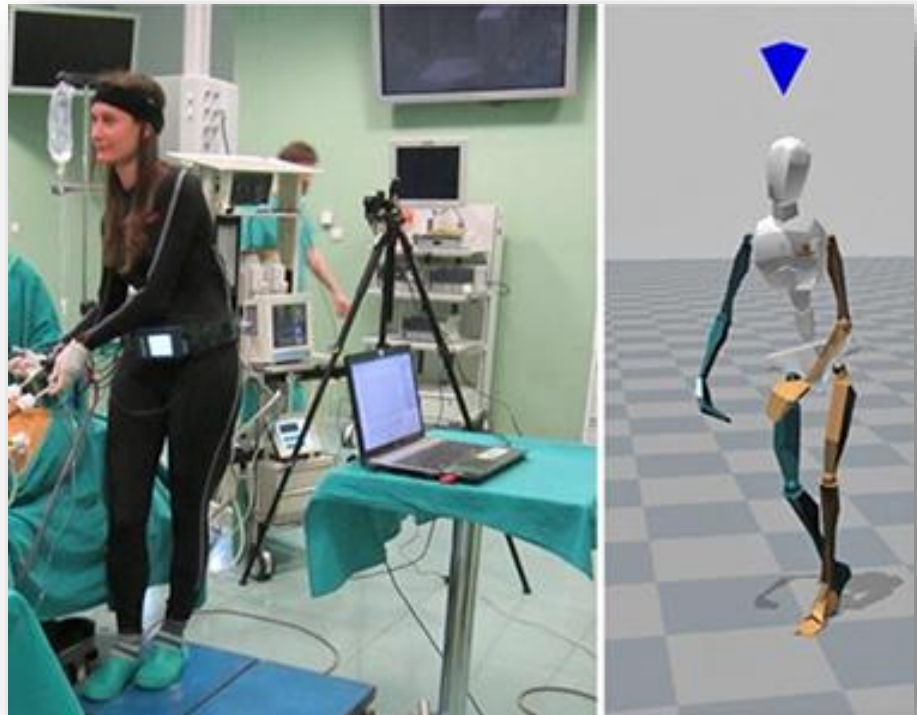


- Foot pedals are often poorly positioned and demand **awkward and unnatural postures**.
- Pedals should be **placed near the foot and aligned in the same direction as the instruments, toward the laparoscopic monitor, allowing the surgeon to activate the pedal without twisting the body or leg**.



What is ergonomic for a woman surgeon?

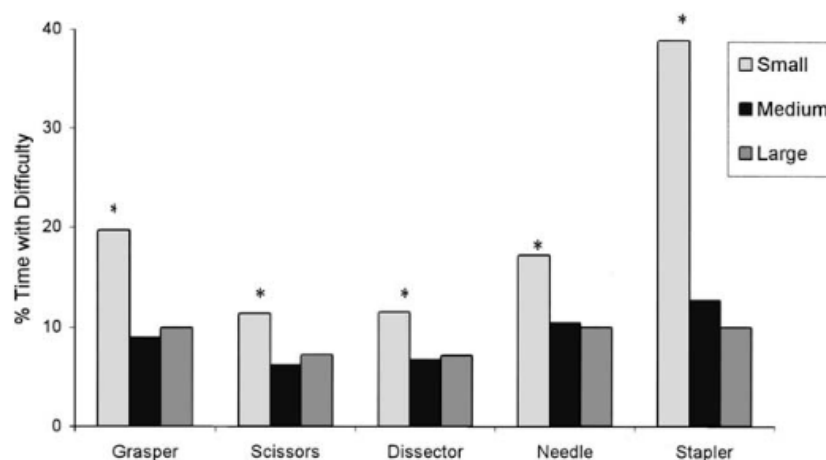
Are the problems different for men and women?



Women surgeon problems

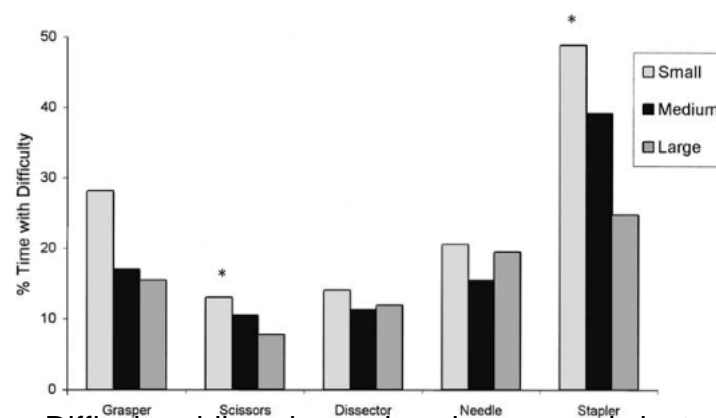
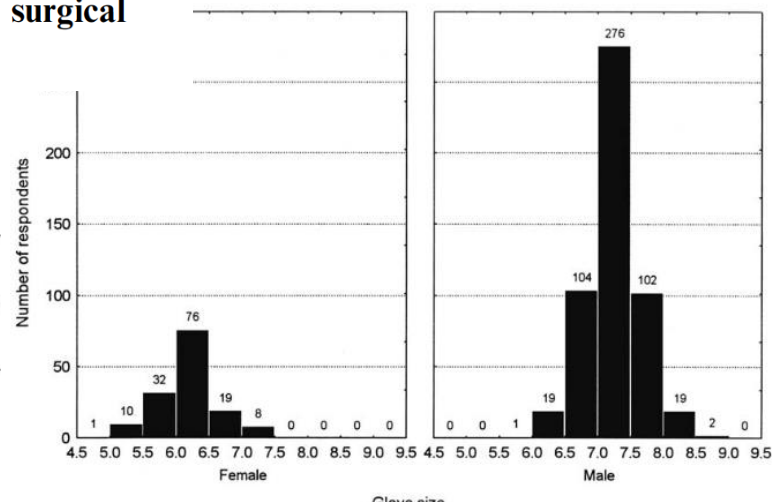
The relationship between hand size and difficulty using surgical instruments: A survey of 726 laparoscopic surgeons

R. Berguer, A. Hreljac Surg Endosc (2004) 18: 508–512



Difficulty while using various laparoscopic instruments for 726 surgeons.

In females, the scissors and staplers were more difficult to use for the Small and Medium glove size group compared to the Large size group ($p < 0.001$).

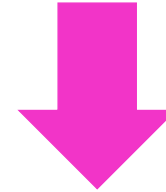


Difficulty while using various laparoscopic instruments for 159 female surgeons

Musculoskeletal Pain in Gynecologic Surgeons

Anonymous web-based survey with 495 respondents:

- LOWER BACK PAIN (75.6%)
- NECK PAIN (72.9%)
- SHOULDER PAIN (66.6%)
- UPPER BACK PAIN (61.6%)
- WRIST/HAND PAIN (60.9%)



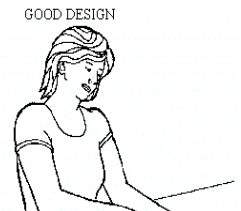
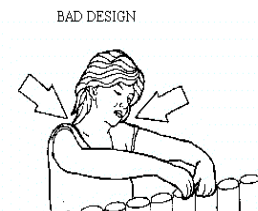
Women are at an approximately **twofold** risk of pain



One size does not fit all: current disposable laparoscopic devices do not fit the needs of female laparoscopic surgeons

- 28 women and 37 men, residents in general surgery
- Participants were asked to describe their use of four disposable lap instruments:

- ✓ The lap stapler
- ✓ Lap harmonic scalpel
- ✓ Lap ligasure tm
- ✓ Lap retrieval bag



Women surgeon problems

Table 2 Analysis by gender

	Female	Male	p value
<u>Lap GIA stapler</u>			
Use one hand only	1	18	<0.0001
Use one hand modified	13	14	
Use two hands	12	3	0.0003
Easy to use	1	14	
Occasionally awkward to use	18	20	
Always awkward to use	8	1	
<u>Harmonic scalpel[®]</u>			
Use one hand only	13	29	0.004
Use one hand modified	11	4	
Use two hands	0	0	0.02
Easy to use	9	20	
Occasionally awkward to use	10	14	
Always awkward to use	5	0	
<u>LigaSure[™]</u>			
Use one hand only	8	22	0.1
Use one hand modified	6	6	
Use two hands	0	0	0.001
Easy to use	5	21	
Occ. or always awkward to use	10	4	



Table 3 Analysis according to glove size

Glove size	6–6.5	7–7.5	8–8.5	<i>p</i> value
<i>Lap GIA stapler</i>				
Use one hand only	1	14	4	0.01
Use one hand modified	9	14	4	
Use two hands	9	6	0	0.002
Easy to use	0	12	3	
Occasionally awkward to use	12	22	4	
Always awkward to use	7	1	1	
<i>Harmonic scalpel®</i>				
Use one hand only	9	27	6	0.04

- Women were more likely to use **two hands** and described these devices as "**always awkward.**"
- Current disposable lap devices **are not designed for individuals with small hands**



The ergonomics of women in surgery

Erica Sutton · Myra Irvin · Craig Zeigler ·
Gyusung Lee · Adrian Park

	Women	Men
<i>N</i> (%)	54 (17 %)	260 (83 %)
Average age (year) ^a	40.6	45
Height (in.) ^a	65.4	70.5
Glove size ^a	6.5	7.5
Right hand dominant	51 (94.4 %)	219 (84.2 %)
Years in practice ^a	7.5	10.3

A 23-item web-based survey of 2,000 laparoscopic surgeons addressing four categories: demographics, physical symptoms, ergonomics, environment/equipment.

Table 3 Bivariate and multivariate predictors of symptoms experienced by surgeons

			Experienced symptoms	Odds ratio (95 % CI)
Experienced treatment for hands (wrist, thumb, fingers)	Gender	Female	6/54 (11 %)	3.5 (1.19–10.29)
		Male	9/261 (3 %)	<i>p</i> = 0.028
Experienced discomfort in lower body (hips, knees, ankles, feet)	Gender	Female	11/54 (20 %)	0.48 (0.24–0.97)
		Male	91/261 (35 %)	<i>p</i> = 0.038
	Surgical glove size	Experienced	7.49 ± 0.58	1.57 (1.07–2.32)
		Did not experience	7.31 ± 0.66	<i>p</i> = 0.023
	Height (in.)	Experienced	70.28 ± 2.97	1.10 (1.02–1.18)
		Did not experience	69.24 ± 3.61	<i>p</i> = 0.013
		Experienced	7.52 ± 0.62	1.88 (1.28–2.75)
		Did not experience	7.27 ± 0.63	<i>p</i> = 0.001
Experienced discomfort in lower back	Surgical glove size height (in)	Experienced	70.06 ± 3.37	1.07 (1.00–1.15)
		Did not experience	69.26 ± 3.46	<i>p</i> = 0.043

The ergonomics of women in surgery

Erica Sutton · Myra Irvin · Craig Zeigler ·
Gyusung Lee · Adrian Park

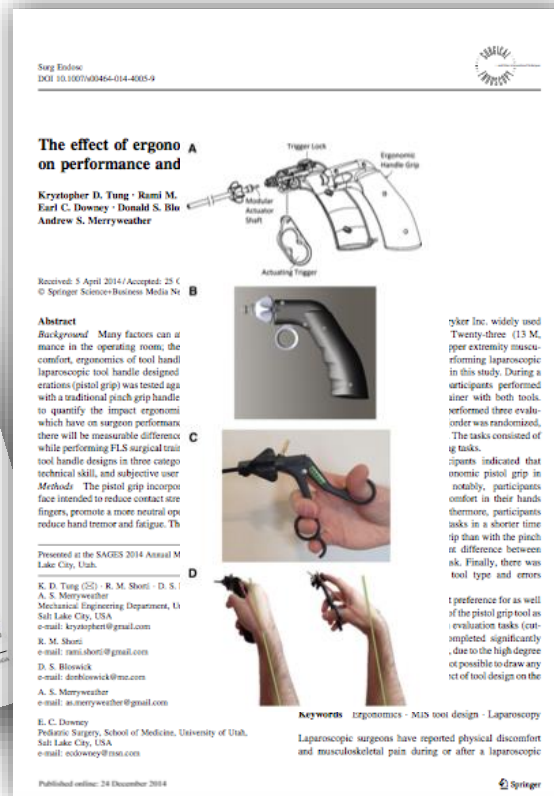
Table 4 Symptoms and treatments experienced by male and female surgeons of the same surgical glove size

	Surgical glove size	Gender	Frequency	<i>p</i> value
Experienced treatment for hands (wrist, thumb, fingers)	7–8.5	Female	3/14 (21 %)	0.016
		Male	8/243 (3 %)	
Experienced discomfort of shoulder area (neck, shoulder, upper back)	5.5–6.5	Female	30/39 (77 %)	0.004
		Male	3/11 (27 %)	
Experienced discomfort in neck	5.5–6.5	Female	24/39 (62 %)	0.016
		Male	2/11 (18 %)	

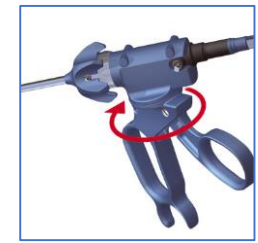


POSSIBLE SOLUTIONS ?

- New surgical devices and instrument designs have been developed.
- Several authors presented novel prototypes.



Solutions/prevention



Effect of a laparoscopic instrument with rotatable handle piece on biomechanical stress during laparoscopic procedures

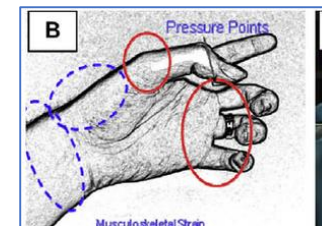
Steinhilber et al. Surg Endosc 2015

To investigate the effect of a pistol grip with a rotatable handle piece (rot- HP) on **biomechanical stress and precision** as well as a possible interaction between the instrument and **working height** (WH).



Standard laparoscopic instrument with fixed handle piece and rotatable handle piece

Conclusions The rot-HP **did not decrease biomechanical stress** in the shoulder or lower arm muscles. However, **wrist angle position may be optimized** without affecting precision.



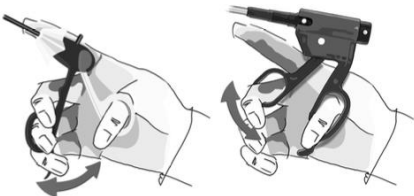


Ergonomics Problems Due to the Use and Design of Dissector and Needle Holder: A Survey in Minimally Invasive Surgery

Marcos Lucas-Hernández, MSc, Eng,* José B. Pagador, MSc, Eng,* Francisco J. Pérez-Duarte, DVM, PhD,† Purificación Castelló, MSc, Eng,‡ and Francisco M. Sánchez-Margallo, DVM, PhD§

This study analyzed the problems and consequences associated with prolonged use of laparoscopic instruments (dissector and needle holder)

Laparoscopic instruments with axial handle lead to a more ergonomic posture for the wrist compared to a ring handle.



Dissector: (type 1) ring handle, pistol grip, thumb manipulation, and (type 2) ring handle, pistol grip, finger manipulation



Needle holder: (type 1) axial handle with rings, (type 2) axial handle, and (type 3) pistol handle.

	Dissector Respondents (%)	Needle Holder Respondents (%)
Types of handles normally used		
Ring handle, pistol grip, thumb manipulation	66 (55.90)	
Ring handle, pistol grip, finger manipulation	52 (44.10)	
Other	1 (0.80)	
Axial handle with rings		15 (13.40)
Axial handle		59 (52.70)
		33 (33.90)
		3 (3.60)
		16 (16.10)
		77 (77.70)
		2 (2.70)
Very small	0 (0.00)	0 (0.00)
Do you take uncomfortable or forced posture?		
Yes	80 (67.80)	68 (60.70)
No	38 (32.20)	44 (39.30)
Elements that need improvement		
Handle-sheath angle	41 (34.75)	25 (22.32)
Handle shape	60 (50.85)	30 (26.79)
Handle size	53 (44.92)	26 (23.21)
Texture and materials	14 (11.86)	14 (12.50)
Required force to use	39 (33.05)	26 (23.21)
Weight	12 (10.17)	29 (25.89)
Length	16 (13.56)	12 (10.71)
Security	8 (6.78)	9 (8.04)

	Yes (%)	
	Dissector	Needle Holder
Monitor position	20 (16.95)	17 (15.18)
Table height	38 (32.20)	35 (31.25)
Patient position	29 (24.58)	29 (25.89)
Staff position	21 (17.80)	13 (11.61)
Type of surgical instrument	39 (33.05)	38 (33.93)
Foot pedal	42 (35.59)	—
Electrocautery wire	17 (14.41)	—

Elements causing forced postures

Solutions/prevention

JOURNAL OF SURGICAL RESEARCH 188 (2014) 88–99

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

Design and evaluation of a new ergonomic handle for instruments in minimally invasive surgery

Ramon Sancibrian, PhD,^{a,*} María C. Gutierrez-Diez, MD, PhD,^b
Carlos Torre-Ferrero, PhD,^c María A. Benito-Gonzalez, RN,^d
Carlos Redondo-Figuero, MD, PhD,^e

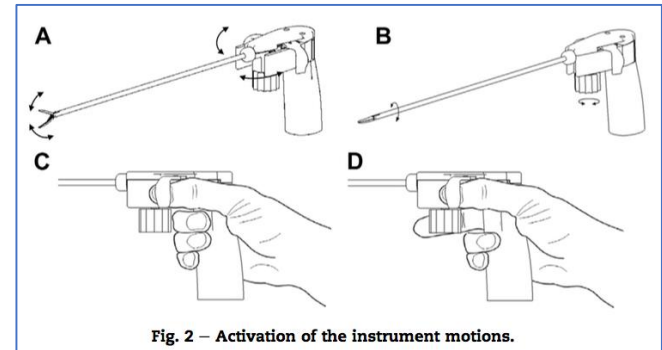
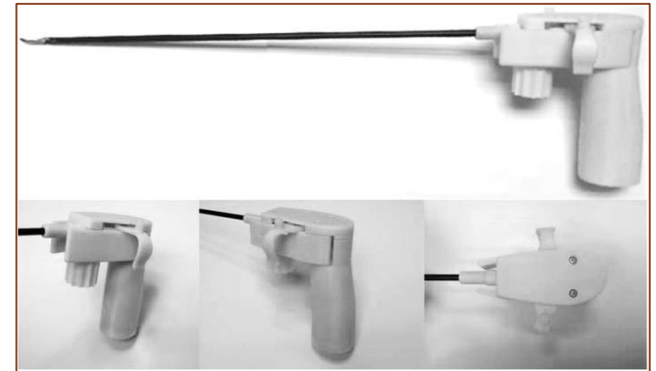


Fig. 2 – Activation of the instrument motions.



Handle designed using ergonomic principles, to provide

- More intuitive manipulation of the instrument
- **REDUCTION OF HIGH-PRESSURE ZONES IN THE CONTACT WITH THE SURGEON'S HAND.**

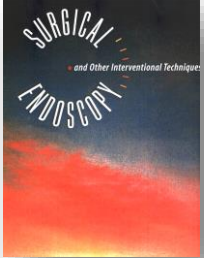
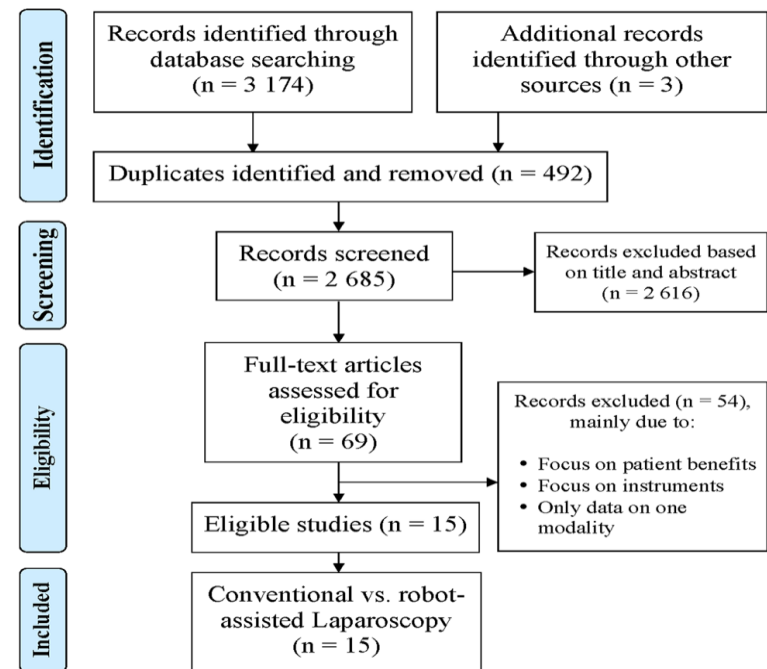
- The whole surface of the hand is in contact with the handle
- It keeps the hand and wrist close to neutral position during surgery.



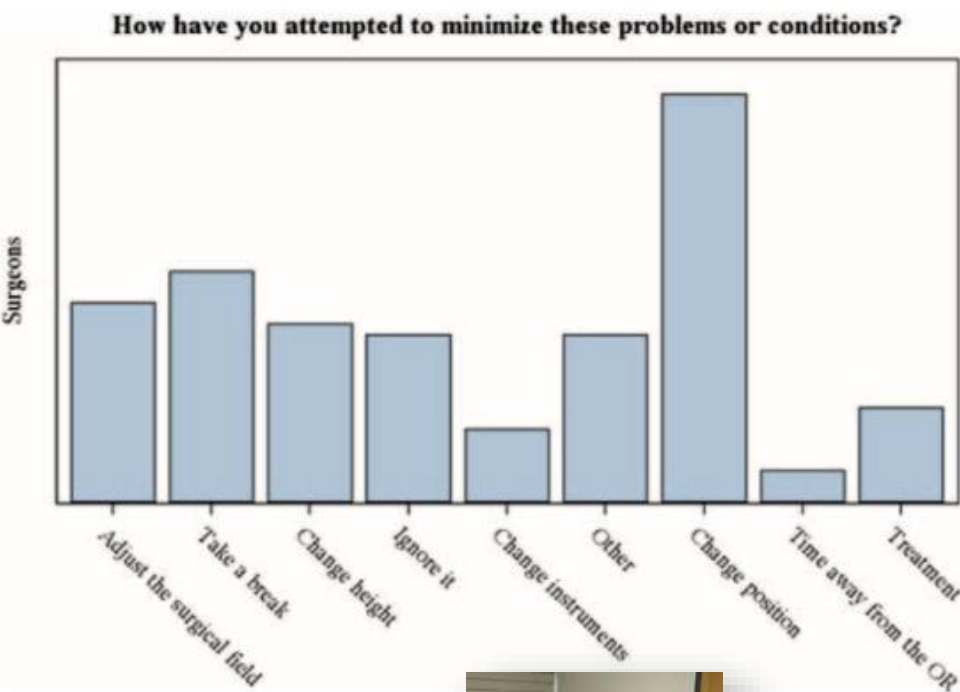
- 64.2% expressed their preference for the new handle
- The new handle fitted well in the hand, reducing the pain, providing secure and comfortable handling
- It reduced the high-pressure areas and the extreme motions of the wrist.

Musculoskeletal pain among surgeons performing minimally invasive surgery: a systematic review

- 2685 records were screened but only 15 articles were included in the analysis.
- None of the studies fully fulfilled the criteria
- Physical and cognitive ergonomics with robotic assistance were significantly less challenging when compared to conventional laparoscopic surgery.
- There is a need for more knowledge on how the surgical techniques impact surgeons physically under real-time surgical conditions



Most popular counter strategies by surgeons against pain and fatigue.



- A standardized **(1.5 minutes) micro-breaks (TSMB)** at appropriate 20 to 40-minute intervals
- Targeted the neck, shoulders, upper back, lower back, wrists, hands, knees, and ankles.

Micro-breaks !

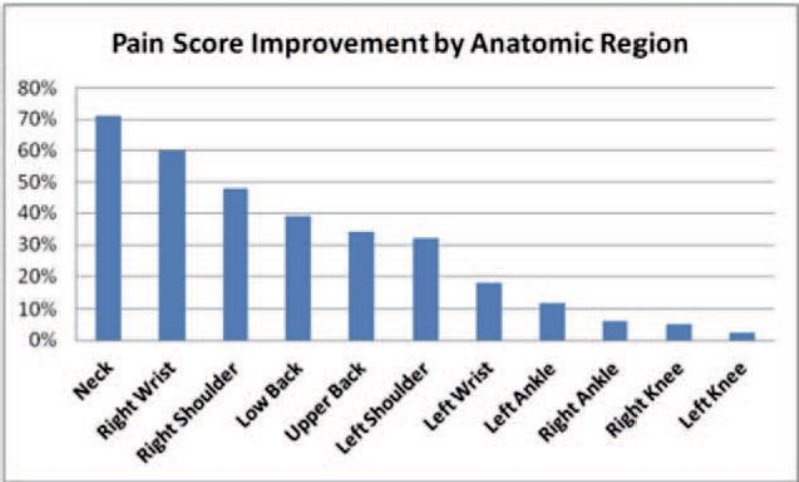
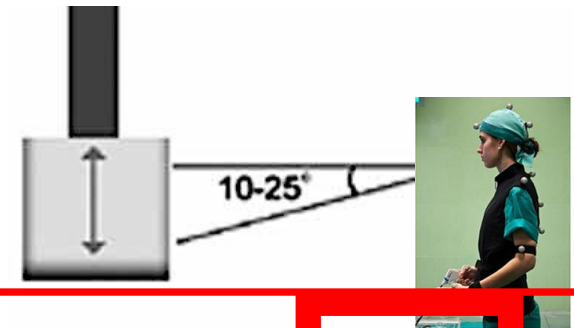


FIGURE 4. Impact of TSMB on pain scores by anatomic site.

-
- The diagram shows a control panel with a vertical bar and a horizontal bar. A vertical double-headed arrow indicates the height of the vertical bar. A horizontal line extends from the right side of the vertical bar, and a diagonal line extends from the bottom right corner of the vertical bar. The angle between these two lines is labeled $10-25^\circ$. To the right of the diagram is a photograph of a person wearing a head-mounted display (HMD) and a green shirt, looking down at a control panel.



WHAT CAN WE DO?



SUGGESTIONS AND HELPFUL TIPS

- "Micro Breaks" every 20-30 minutes
- **Avoid** painful positions or **interrupt** a painful activity
- **Prompt** identification of the first signs of inflammation
- Keep the **neutral** position
- Avoid long static positions
- **Activate the circulation**

Change your habits!

- Alternate the movements
- **Avoid repetitive** and prolonged activities
- **Avoid** abnormal movements of the wrist
- **Frequent interruption** to move the hands

CONCLUSIONS

- Injuries or symptoms are reported by **87% of laparoscopic surgeons**
- **Ergonomic changes** in the **organization of the operating room and instruments** could significantly **reduce the surgeon's discomfort**
- **Female surgeons** more often **complain of pain or disorders in their hands** (including wrist, thumb, and fingers) and **the shoulder area** (neck, shoulder, upper back)
- It is important to **recognize** that optimal ergonomics **may widely differ between male and female surgeons.**
- **Ergonomic problems** of female surgeons **pose new challenges to** instruments and equipment production .
- **More ergonomic laparoscopic instruments, operating table height and monitor position according to the characteristics of the women** are required
- For both genders **ergonomic awareness and physical exercise** may be useful to reduce short- and long term discomfort

"ERGOSCOPY"

THANK YOU FOR YOUR
ATTENTION