

Ergonomic Analysis of Muscle Activity During Laparoscopy Using Surface Electromyography (EMG) and Influence of Training



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Introduction

- Laparoscopy entails certain inconveniences for surgeons
- SAGES Task Force¹- >55% surgeons experience stiffness, pain in shoulder, neck, arm, hand
- Surgical experience and training- improves ergonomics

Aims and Objective

Primary Objective

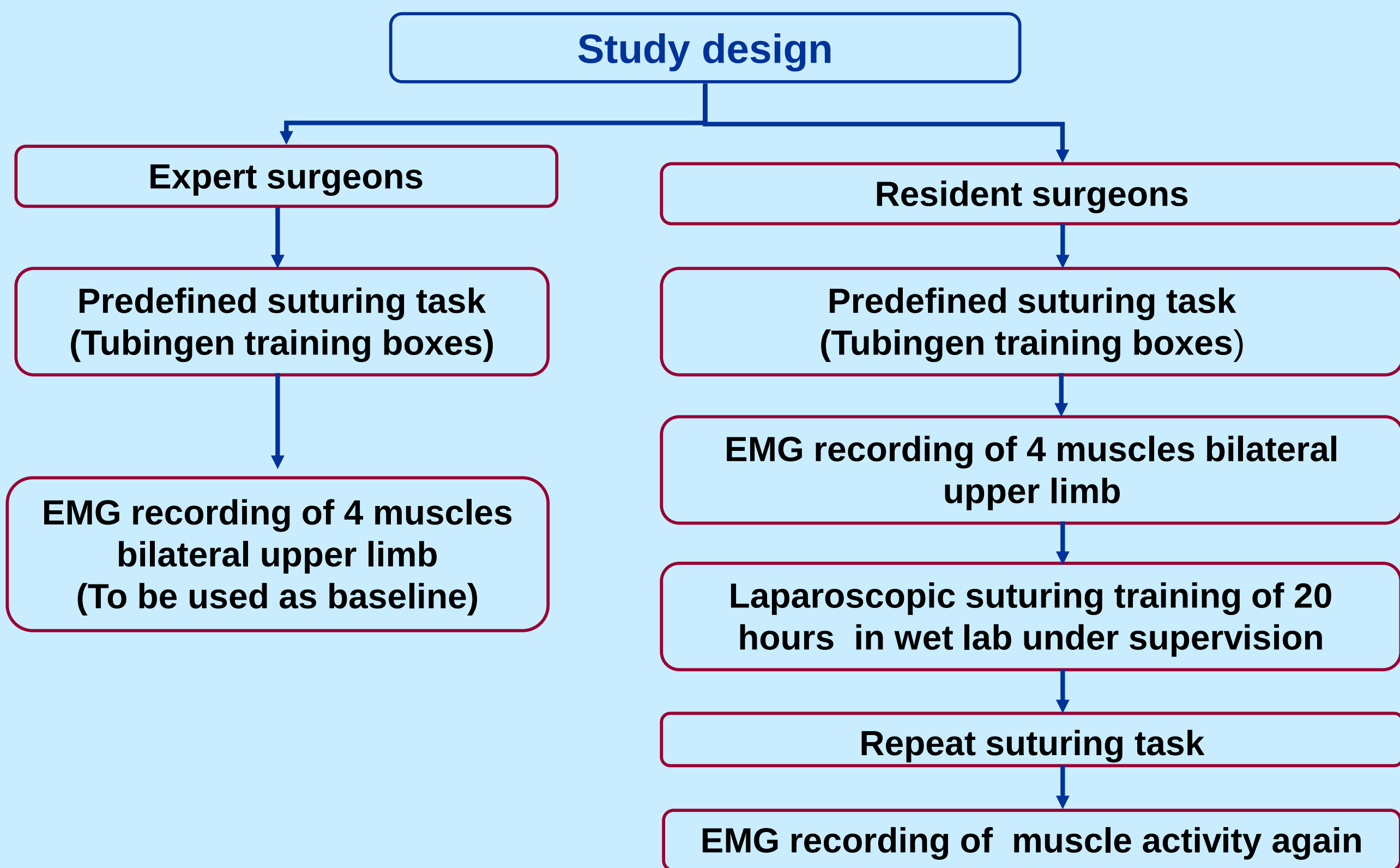
- Impact of training in terms of reduction in ergonomic stress and economy of muscle work

Secondary Objective

- To quantify and compare the work of group of muscles involved in laparoscopic intracorporeal suturing in trained and novice laparoscopic surgeons

Material and Methods

- Type of study: Prospective comparative
- Study duration: 18 months (Feb 2018- July 2019)
- Groups:
 - Group A: “Expert” laparoscopic surgeons
 - At least 5 years of experience in performing basic and advanced laparoscopic surgeries
 - Group B: “Novice” laparoscopic surgeons
 - Surgical residents in their third, fourth and fifth year of residency (including senior residents)
- Scrubbed and assisted in laparoscopic surgeries and suturing/ Never performed laparoscopic surgery or suturing
- Sample size: 3 and 10



Primary outcome

- Quantitative assessment the effect of training on muscle activity of resident surgeons while performing laparoscopic suturing

Secondary outcome

- Evaluation of pattern of muscles activation during lap suturing for experts and residents (pre and post training)
- Comparison of muscle activation between experts and residents
- Details of intra-corporeal suturing task
- 3 cm vertical gastrotomy closure
- Tubingen trainer
- 15cm 2-0 vicryl
- Details of the EMG machine
- 8 channel octal bio-amplifier EMG machine
- Patch electrode (Neurosoft)
- Details of sEMG recording
- Four muscles in each upper limb
 - Pronator teres/ common forearm extensors/ biceps brachii / deltoid
 - Electrode placed on belly of muscle



Training

- 20 hours, supervised suturing
- Cloth model, porcine tissue (Stomach, Bowel, Bile duct)
- Gastrotomy closure, Gastro-Jejunostomy, Side to side and end to end Bowel anastomosis, Hepatico-Jejunostomy

Details of sEMG interpretation

- Activation time
- % Maximal Voluntary Contraction (Root Mean Square- absolute value)

Results

	Experts	Resident
Age (years)	39.3 ± 1.9	32.9 ± 2.3
Open exposure (years)	11 ± 3	4.95 ± 2
Lap exposure (years)	7.7 ± 1.5	2.2 ± 1.2
Open Surgery Performed (cases)	1363.7 ± 211.1	323.4 ± 165.4
Lap Surgery Performed (cases)	728.3 ± 182.7	0
Lap Cases assisted (cases)	Not Applicable	58.8 ± 23.9

All Right Dominant

% MVC

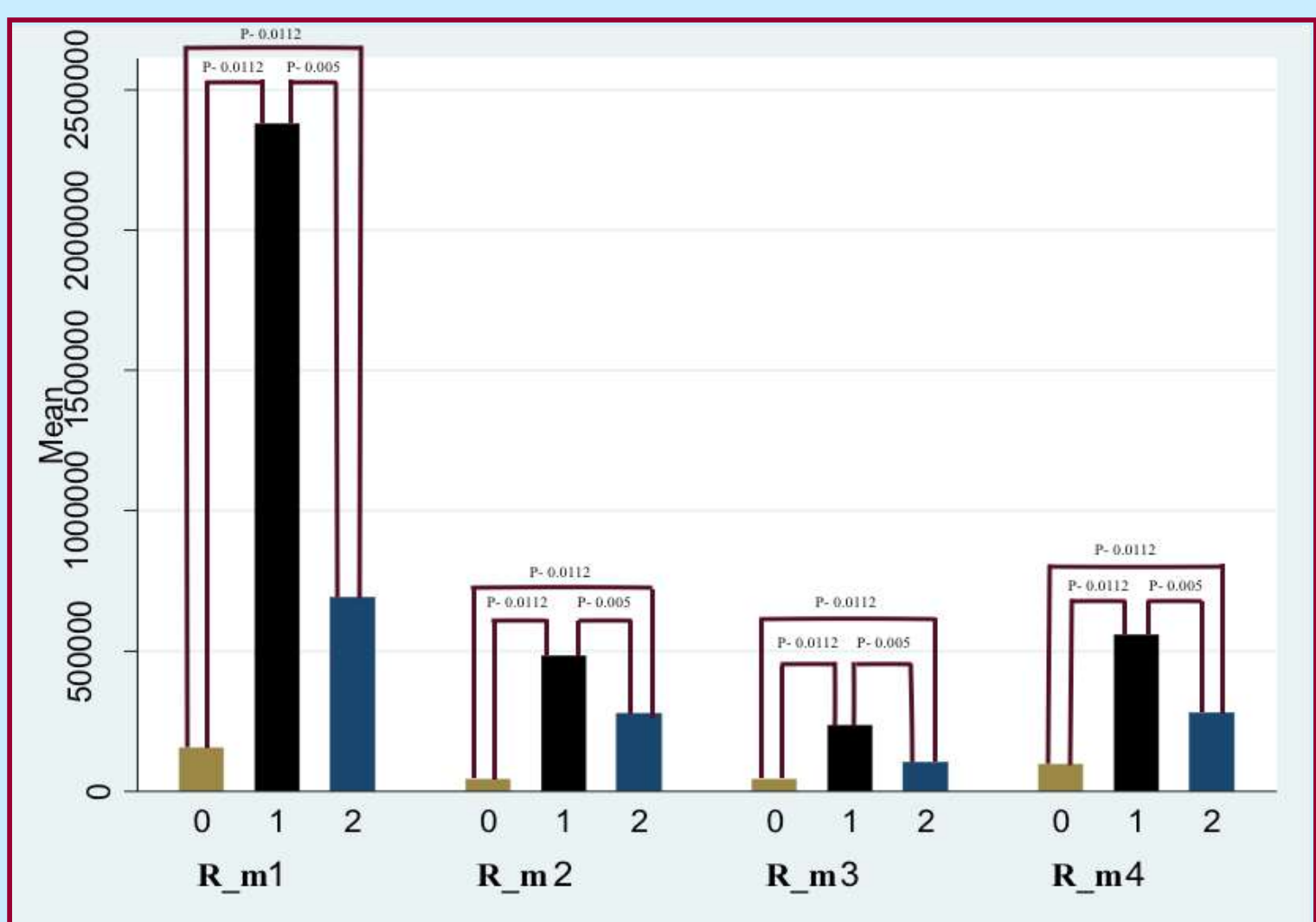
- Right deltoid- Highest Activation time for Experts/ Residents(Pre & Post-training)
- Right pronator- Second most common In residents
- Significantly higher in Pre-training residents (all 8 muscles)
- Significant decrease in Post-training (all 8 muscles)

Average % MVC : Right v/s Left

	Experts	Residents pre-training	Residents post-training
Right-side	24.7 ± 2.8	64.9 ± 3.3	44 ± 2.9
Left-side	17.7 ± 1.5	37.5 ± 1.6	27.9 ± 1.5
Difference	7	27.5	16.1
P value	0.1	0.005	0.005

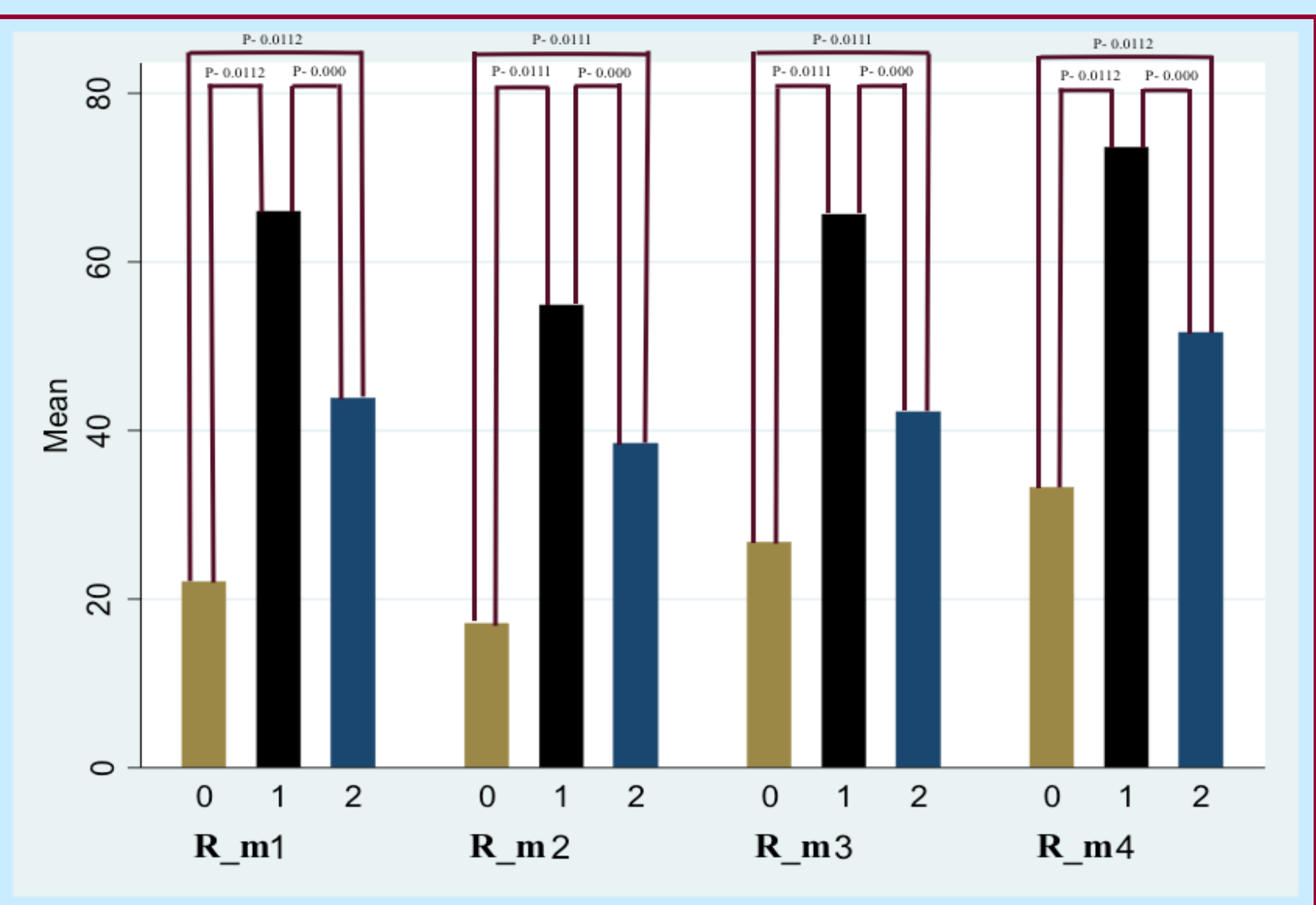
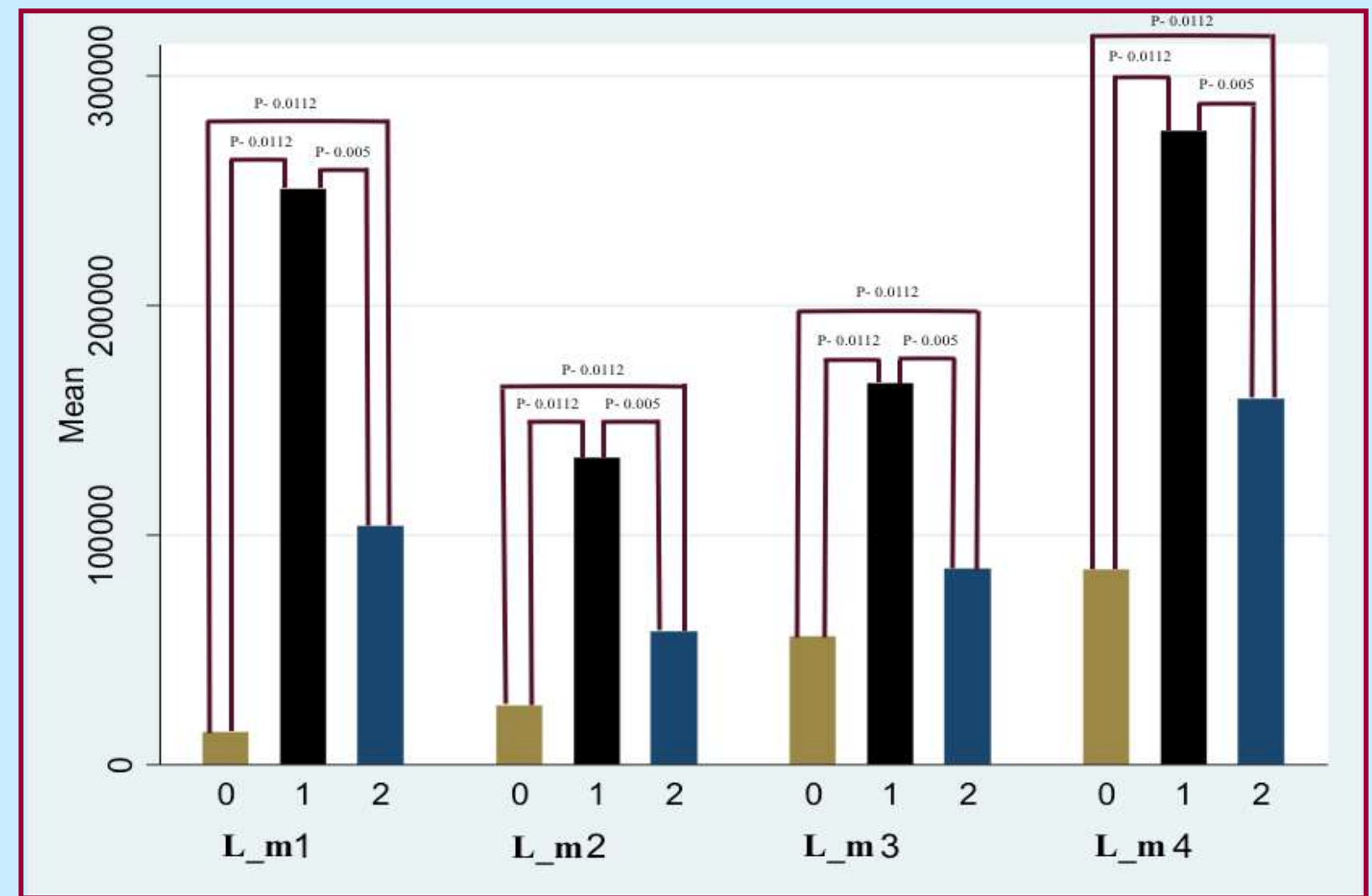
Average Activation Time: Right v/s Left

	Experts	Residents pre-training	Residents post-training
Right-side (millisec)	82633.5 ± 24428.7	913005.2 ± 569832	338056.2 ± 93731.8
Left-side (mili sec)	45041 ± 6023.6	206518.7 ± 45303	101493.3 ± 17213.9
Difference (milli sec)	37592	706486	236562.9
P value	0.1	0.005	0.005



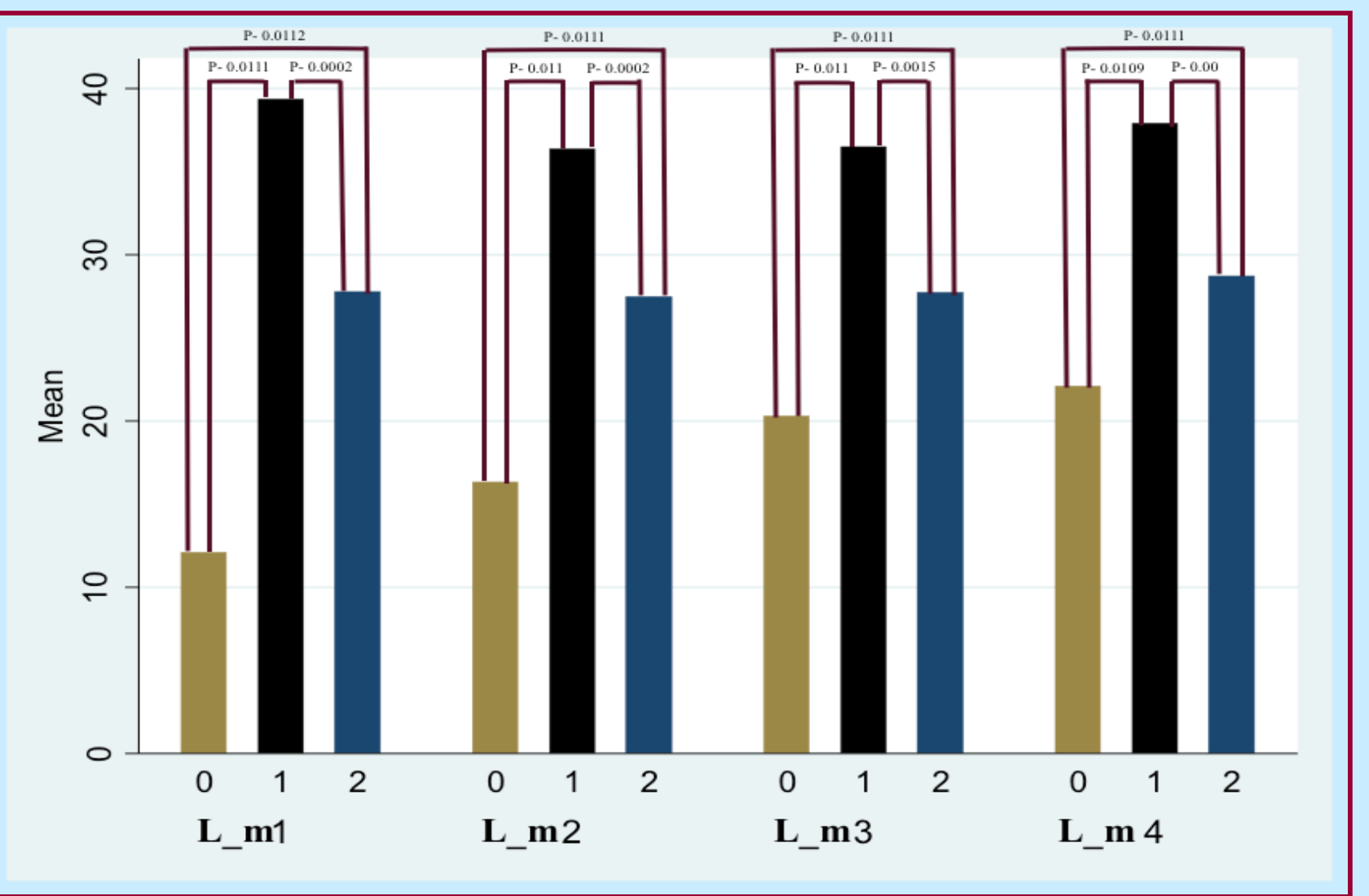
Comparison of total activation time of all right sided muscles between experts and residents (pre and post training); R_m1- Right pronator teres, R_m2- Right common forearm extensors, R_m3- Right biceps, R_m4- Right deltoid; 0- Experts, 1- Residents (pre-training), 2- Residents (post-training)

Comparison of total activation time of all left sided muscles between experts and residents (pre and post training); L_m1- Left pronator teres, L_m2- Left common forearm extensors, L_m3- Left biceps, L_m4- Left deltoid; 0- Experts, 1- Residents (pre-training), 2- Residents (post-training)



Comparison of %MVC of all right sided muscles between experts and residents (pre and post training); R_m1- Right pronator teres, R_m2- Right common forearm extensors, R_m3- Right biceps, R_m4- Right deltoid; 0- Experts, 1- Residents (pre-training), 2- Residents (post-training)

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Conclusion

- Focused training can significantly reduce unnecessary muscle activation of novice laparoscopic surgeons

References

- Berguer R, Forkey DL, Smith WD. Ergonomic problems associated with laparoscopic surgery. Surg Endosc. 1999 May;13(5):466–8