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A PROSPECTIVE RANDOMIZED CONTROLLED STUDY OF THE EFFECTIVENESS OF TRAINING IN LAPAROSCOPIC INSTRUMENTATION SKILLS USING BOX TRAINER IN NOVICES

Dr. Saurav Majumdar[1], Dr. Akshita Khare[2]

[1]Senior Resident, General Surgery West Bengal University of Health Sciences, WB, India.
[2]MBBS, General Surgery, West Bengal University of Health Sciences, WB, India.

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Keywords	***Abstract***
Laparoscopic training, Box trainer, Simulation, Surgical education, Suturing skills, Skill transfer, Randomized Controlled trial, Bimanual dexterity.	**Background:** Laparoscopic surgery demands advanced hand-eye coordination and psychomotor skills, which are challenging for novices to acquire. Simulation-based training, such as the use of box trainers, has been proposed as an effective method for skill development. This study aims to evaluate the effectiveness of structured training using a boxing trainer in improving laparoscopic instrumentation skills among novices. **Methods:** A prospective randomized controlled study was conducted at KPC Medical College and Hospital from April 2021 to April 2024. Hundred participants, comprising first-year surgical residents and residents from non-surgical departments with no prior laparoscopic experience, were enrolled. Participants were randomized into two groups: an intervention group that underwent structured training using a boxing trainer and a control group that received no formal training. Pre- and post-training assessments were conducted using standardized suturing tasks performed on the box trainer and evaluated based on time to completion, accuracy, and error rate. **Results:** The intervention group demonstrated statistically significant improvement in all performance metrics following training ($p < 0.05$), whereas the control group showed minimal or no improvement. The

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	intergroup comparison revealed a significant difference favouring the trained group, confirming the efficacy of simulation-based skill acquisition. **Conclusion:** Laparoscopic box trainer-based training significantly enhances key laparoscopic skills in surgical novices and facilitates the effective transfer of these skills to the clinical environment. Given its low cost, accessibility, and use of equipment identical to actual laparoscopic surgery, we recommend the incorporation of box trainers into early surgical training curricula.

1. INTRODUCTION

- ✓ Laparoscopic surgery requires a steep learning curve.
- ✓ Laparoscopic skills include

(1) Depth perception

(2) Adjustment to fulcrum effect

(3) Hand-eye coordination

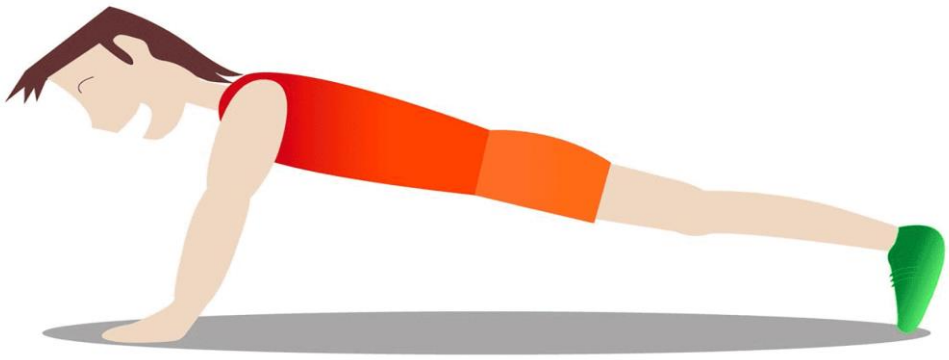
(4) Bimanual manipulation

(5) Handling of laparoscopic instruments

(6) Ambidexterity

- ✓ Virtual reality (VR) VS-Box trainers

Secret to success= WARM UP



2. AIMS & OBJECTIVES

- AIM: To study the effect of training for laparoscopic instrumentation skills using a boxing trainer and assess for performance in actual laparoscopic surgery.
- OBJECTIVE: To study whether skills as a novice were transferable to the operating theatre after training on predesigned fundamental laparoscopic instrumentation tasks on a boxing trainer

3. MATERIALS AND METHOD

- STUDY AREA: KPC MEDICAL COLLEGE with an isolated room with a boxing trainer. Participants were given a task to perform suturing by using box trainers.
- STUDY POPULATION: Surgical novices (1st-year surgical residents without any prior training in laparoscopic skills as well as residents in other departments (Non-surgical)
- STUDY DURATION: April 2021 to April 2024.
- STUDY DESIGN: A Randomized control study conducted in the DEPARTMENT OF GENERAL SURGERY, KPCMCH.
- SAMPLE SIZE: 100
- RANDOMIZATION: Simple computer-generated randomization.

o INCLUSION CRITERIA:

Surgical novices (1st-year surgical residents without any prior training in laparoscopic skills as well as residents in other departments (Non-surgical) with no prior experience in laparoscopic camera handling).

o EXCLUSION CRITERIA:

- Previous participation in projects involving laparoscopic training.
- History of holding a laparoscopic camera or handling laparoscopic instruments during laparoscopic surgery (=/>1procedures)

A. What do we need? (Training 1- DAY 1 and 2)

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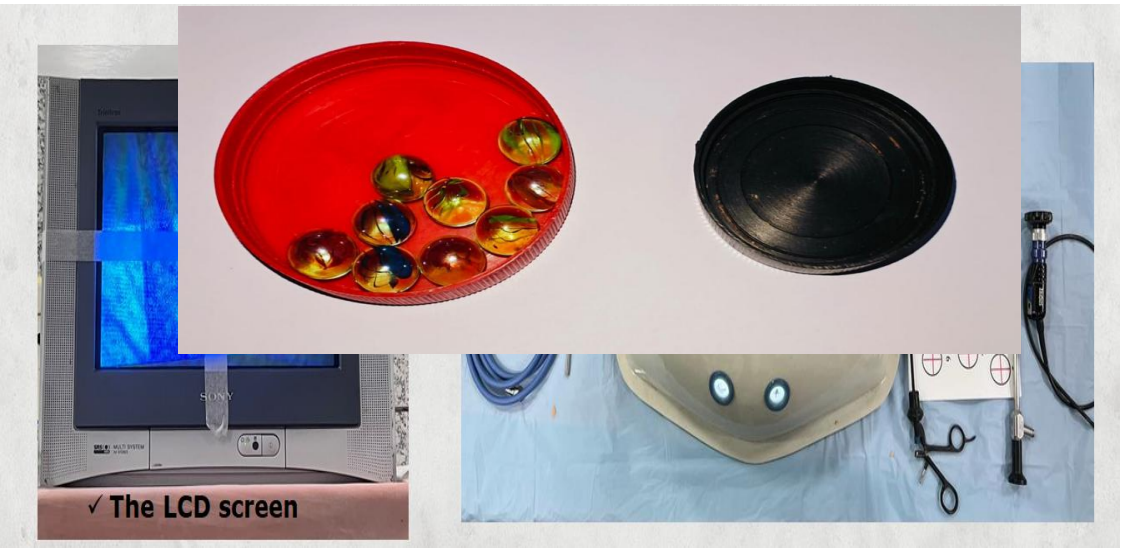
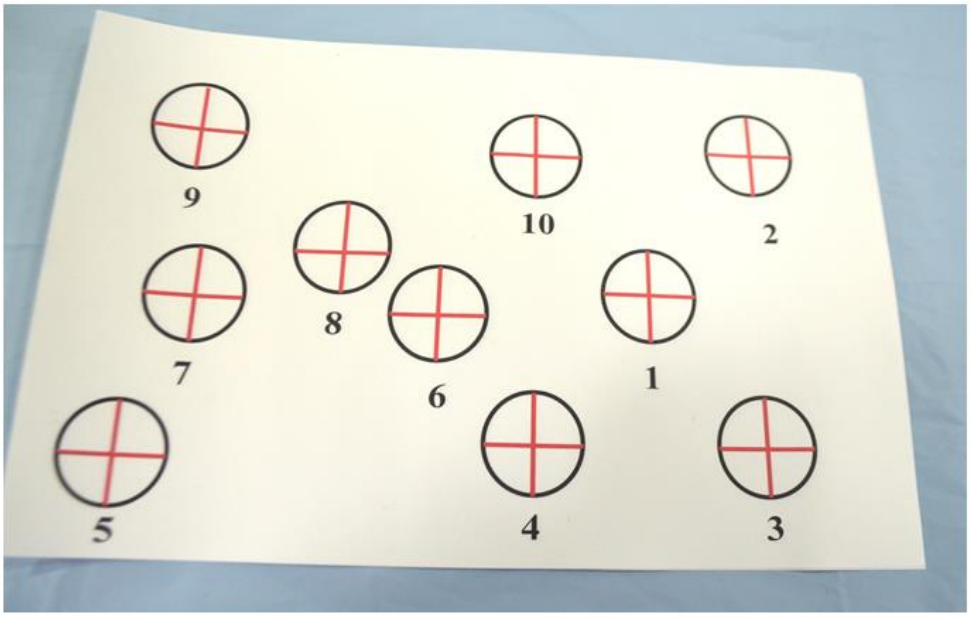
A



laparoscopic box trainer.

- ✓ 30-degree 10mm scope.
- ✓ A Maryland forceps

A. White sheet of paper measuring 15x15 cm was placed inside, with 10 marked points on it in a jumbled-up manner.

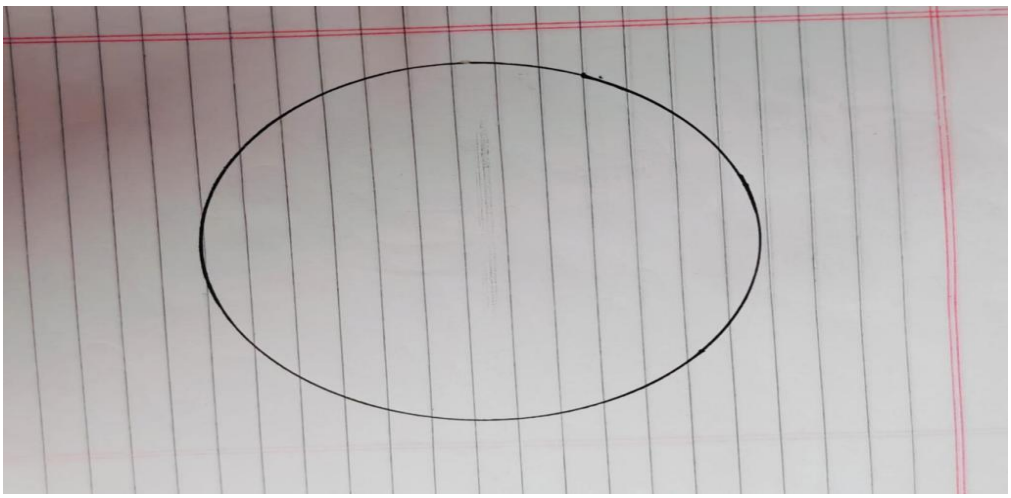


B. Training 3, Day 3: Advanced bimanual instrumentation tasks

Transfer of marbles-

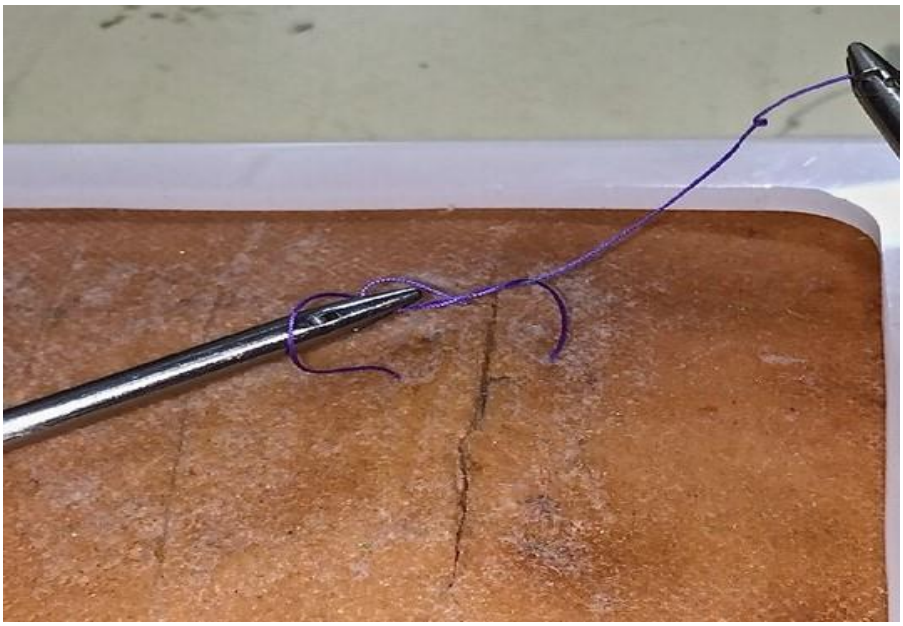
a) From one container to another

b) From a container to a specimen bag



Pattern cutting

Feeding the loop



Suturing tasks

4. METHOD

- Participants were randomized into 2 groups

✓ (50 in Intervention and 50 in Control)

✓ Using computer generated random numbers.

- INTERVENTION GROUP (Training 1)

✓ 10 mins demonstration of the task

✓ 5 mins to orient themselves to the equipment.

✓ The task was to simultaneously maintain optimal distance, horizon, and centering of a laparoscopic image displayed on the screen using the camera and a Maryland forceps

- Training 2

✓ 10 mins demonstration of task

✓ Bidexterous tasks like peg transfers, feeding the loops, pattern cutting and suturing using a traumatic grasping forceps, maryl and forceps, scissors and needle holders

✓ The task was to complete as many cycles of the task possible in the given time.

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Training

Day 1

- Total intervention time was 60 mins per participant.
- Time taken to complete the 1st & last cycle, number of cycles completed in 60 mins (recorded by the primary investigator)

Training

Day 2

- Purpose- stimulate hand eye coordination
- Aim-move the instrument in the right hand through the points while keeping the image in the center.
- Total intervention time was 60 min per participant
- Time taken to complete 1st and last cycle and number of cycles completed in 60 mins were recorded by the primary investigator.

Training

Day 3- 60 mins

- Purpose- use the skills of camera training and extrapolate on certain predesigned task to improve dexterity
- Each task was repeated at least 4-5 times during the 60 mins and Time taken to complete 1st and last cycle and numbers of cycles completed for each task in 60 mins were recorded by the primary investigator.

Transfer of marbles into the specimen bag

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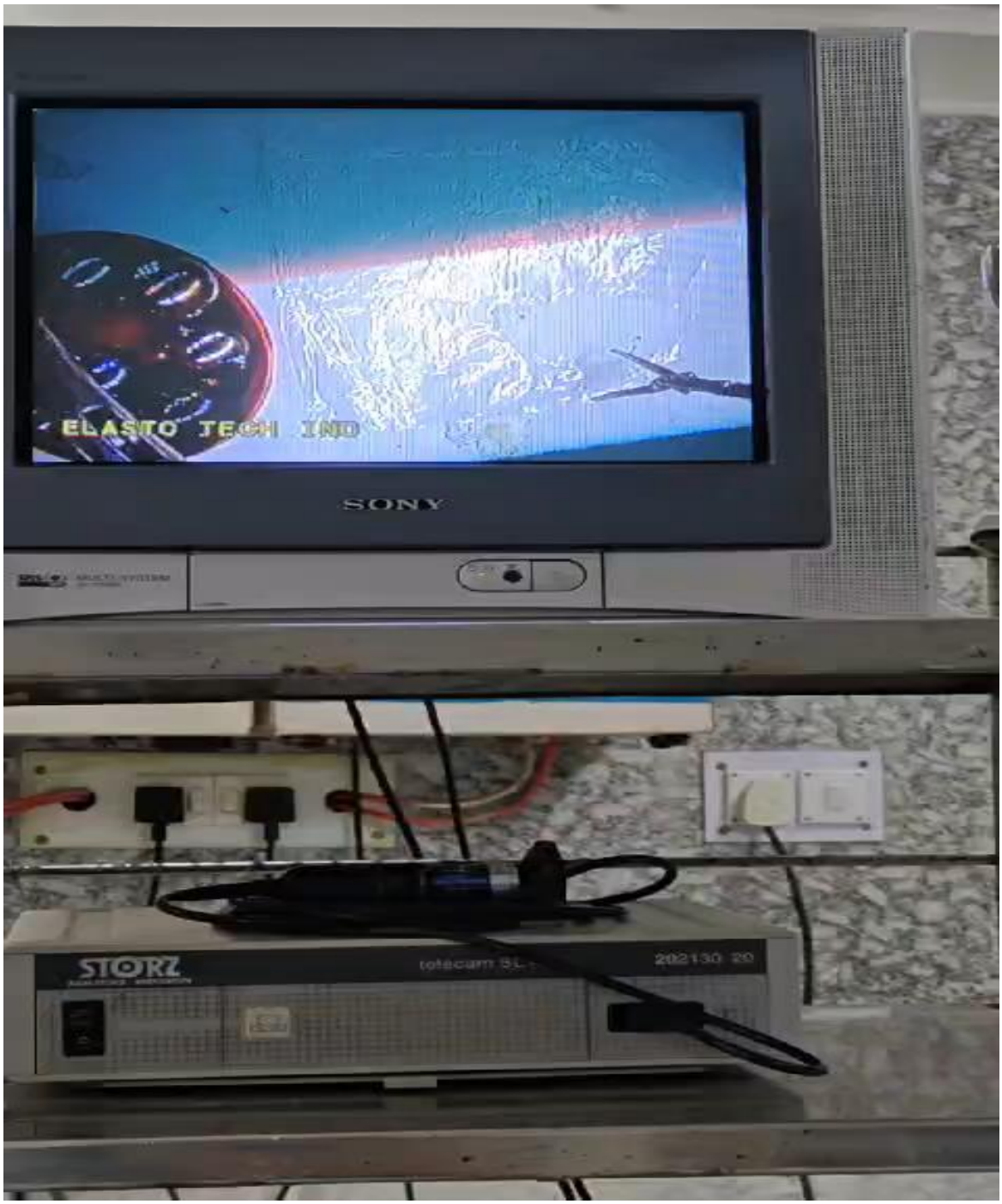

Peg Transfer

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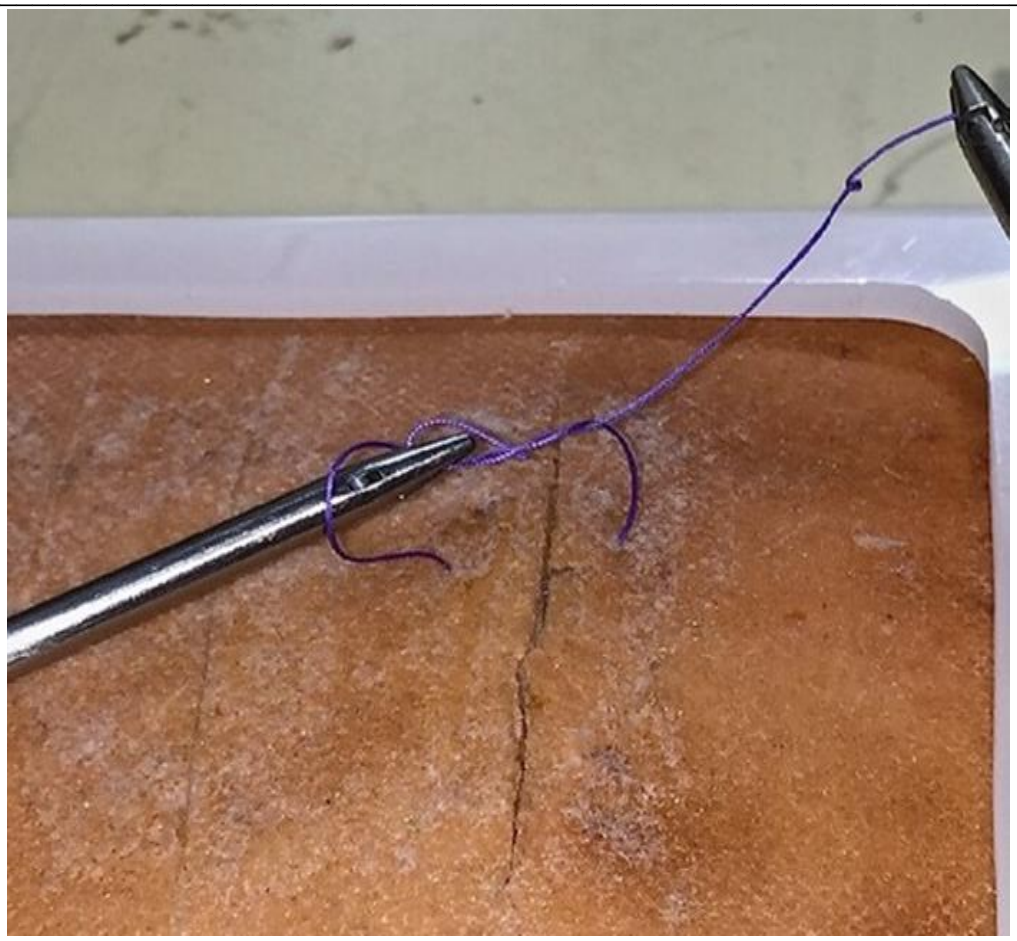
Patterned Cutting

Suturing



At the end of 3rd day of training

Assessment

Following end of training at the end of Day 3, any surgical novice who attained a score of <= 7 was advised to go for another day's training.

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	1	2	3	4	5
Tip of instrument continuously visible on screen*	Instrument tip frequently out of view		Instrument tip mainly in sight but sometimes out of view		Instrument tip continuously visible on screen
Smooth movement and Dexterity*	Many ineffective and rough movements		Smooth movements, occasional inadvertent movements		Smooth movements and Dexterity
Depth Perception**	Constantly overshoots the target, wide swings, slow to correct		Some overshooting or missing of target but quick to correct		Accurately directs instruments in the correct plane of the target
Bimanual Dexterity**	Ignores non dominant hand, poor coordination between the hands		Uses both hands but does not optimise coordination between the hands		Expertly uses both hands in a complimentary manner to provide the best exposure
Efficiency**	Uncertain, inefficient efforts, many tentative movements, constantly changing focus		Slow but planned movements		Confident and efficient, maintains focus
Autonomy**	Unable to complete task even with verbal guidance		Able to complete task with moderate guidance		Able to complete task independently without guidance

* OSATS (Objective and Structured Assessment of Technical Skills)

**GOALS (Global Operative Assessment of Laparoscopic Skills)

TIME TO COMPLETE TASK_____

A feedback form was also filled up at end of training

FEEDBACK FORM

	1(POOR)	2(AVERAGE)	3(GOOD)	4(EXCELLENT)
TRAINING STRUCTURE				
SESSION LENGTH				
TRAINER				
EQUIPMENT				
I HAD FUN				
I LEARNT SOMETHING USEFUL				
IM GLAD, I CAME				

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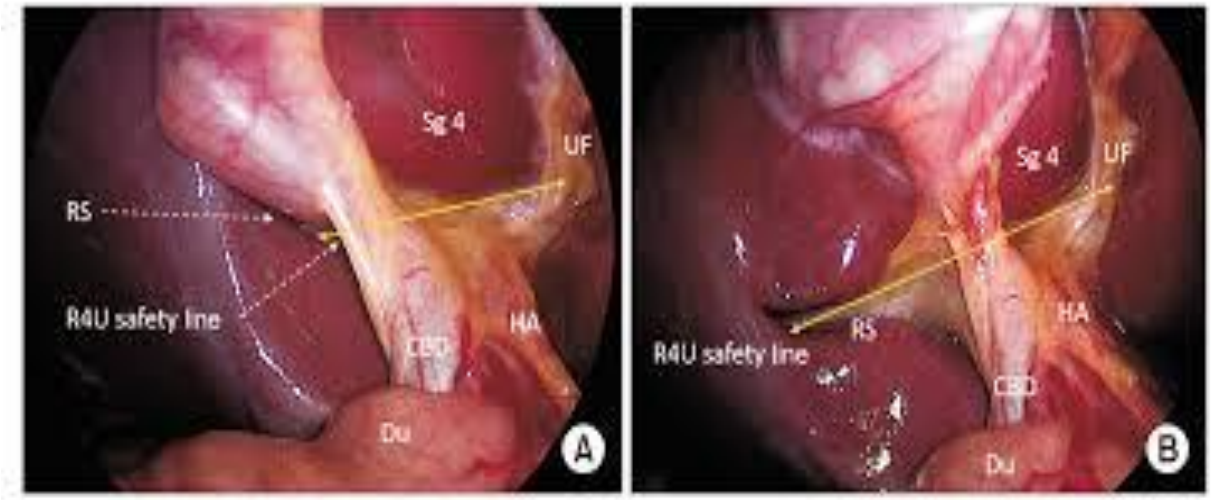
C. Control Group

- No training
- Shown video describing laparoscopic camera and instrument handling + video showing laparoscopic cholecystectomy.



Following training the participants were asked to perform a short part of the surgery in a live laparoscopic cholecystectomy (dissection of gall bladder off the gall bladder fossa) while an assistant handles the camera

- ✓ Scoring was done by a single observer

  (2nd investigator who had no knowledge if participant had received training or not)

- ✓ The primary end point:

  Performance of the participants with respect to a predesigned assessment tool (GRS Score)

✓ Secondary end points

Measured in terms of time taken to complete 1st and last cycle and total number of cycles performed in 60 mins.

Assessment scoring was done using the Global Rating Scoring System (GRS score)

Respect for tissue	1	2	3	4	5
	Frequent unnecessary force on tissues or caused damage by inappropriate use of instruments		Careful handling of tissue but occasionally caused damage		Carefully handles tissue appropriately with minimal damage to tissues
Time and motion	1	2	3	4	5
	Many unnecessary moves		Efficient time motion, but some unnecessary moves		Clear economy of movement; maximum efficiency
Instrument handling/knowledge	1	2	3	4	5
	Tentative/awkward moves or inappropriate use		Competent use of instruments; occasionally awkward		Fluid moves with instruments; no awkwardness
Flow of operation	1	2	3	4	5
	Stopped frequently, seemed unsure of next move		Some forward planning; reasonable progression		Obviously planned course; effortless flow
Depth perception	1	2	3	4	5
	Consistently overshoots, swings wide, slow to correct		Some overshooting but quick to correct		Accurately directs instruments to correct plane
Bimanual dexterity	1	2	3	4	5
	Uses only one hand, poor coordination between hands		Uses both hands, but does not optimize their interaction		Expertly uses both hands to provide optimal exposure

5. STATISTICAL ANALYSIS

- The data collected-entered in Microsoft Excel.
- Continuous data - Age and comorbidities were measured as mean and standard deviation.
- Sex distribution, distribution of residents and nurses, previous video game experience were analyzed by Chi square test.

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- Significance of difference in task completion time between 1st cycle and last cycle on Day-1 and day-2- analyzed by Wilcoxon Signed Rank test.
- Mann Whitney Test was used to compare the Post procedure assessment score between two groups

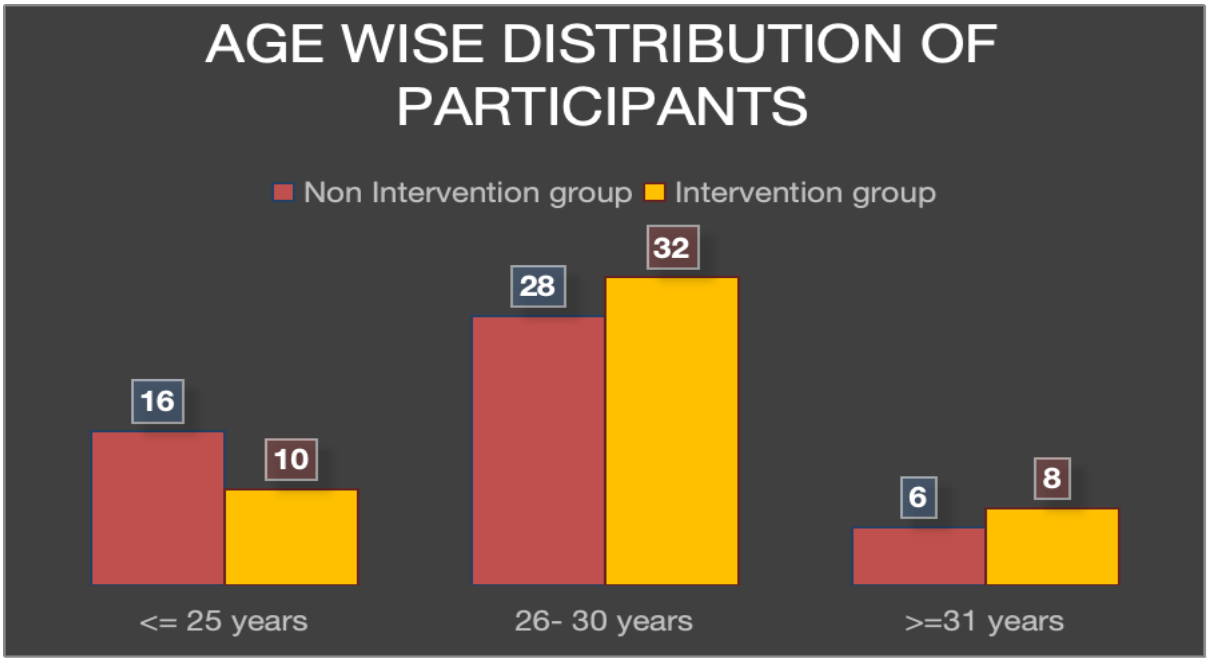
6. RESULTS & ANALYSIS

DEMOGRAPHIC ASSESSMENT:

Age wise distribution of participants

Table 1.

		Group		Total
		Non-Intervention	Intervention	
Age (years)	<=25	16	10	26
	26-30	28	32	60
	31+	6	8	14
Total		50	50	100



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SEX DISTRIBUTION OF PARTICIPANTS

Table 2.

		Non Intervention	Intervention	
Gender	Female	34	26	60
	Male	16	24	40
		50	50	100

Sex Distribution (Chi square test) p=0.248, Nothing significant.

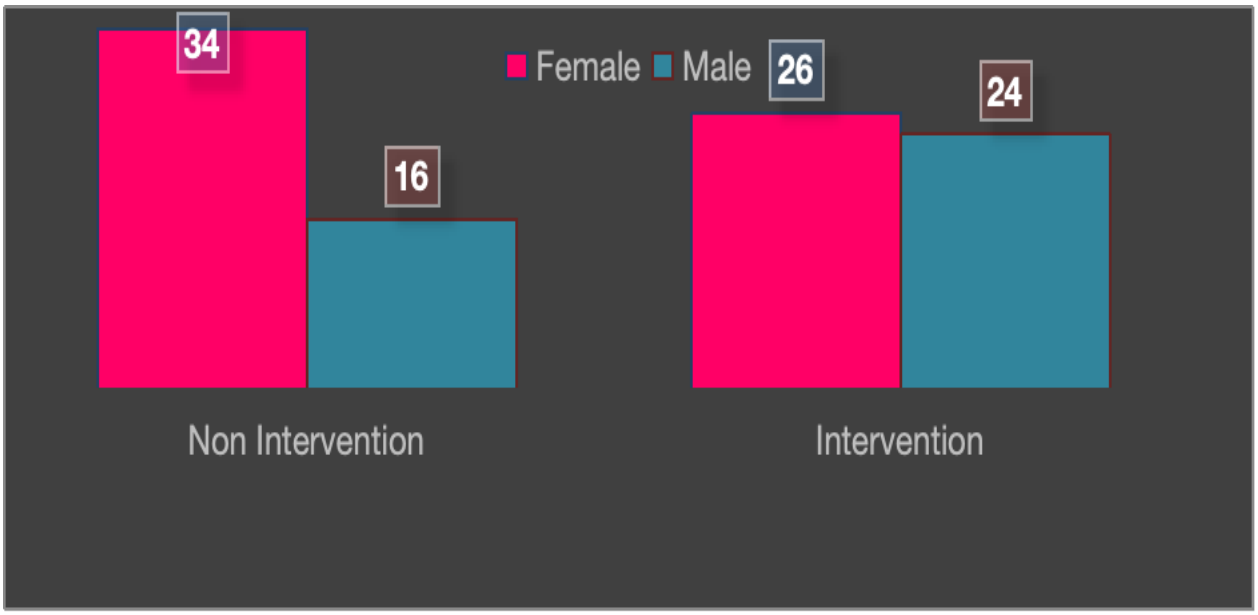

Table 3: Significant difference in task completion time between 1st cycle and last cycle (Day 1)

	No of participants	Minimum (mins)	Maximum (mins)	Median (mins)
1st Cycle	50	7	13	10
Last Cycle	50	2	8	5

Significant difference in task completion time between 1st cycle and last cycle (Day 1)

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Table 4. Significant difference in task completion time between 1st cycle and last cycle (Day 2)

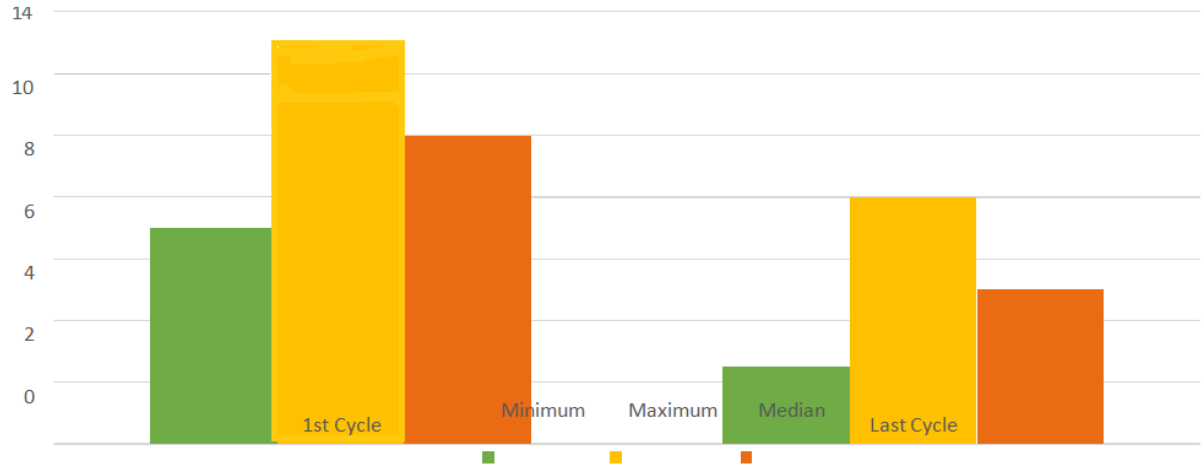

Table 4. Significant difference in task completion time between 1st cycle and last cycle (Day 2)

	No of participants	Minimum (mins)	Maximum (mins)	Median(mins)
1st Cycle	50	9	14	12
Last Cycle	50	5	9	7

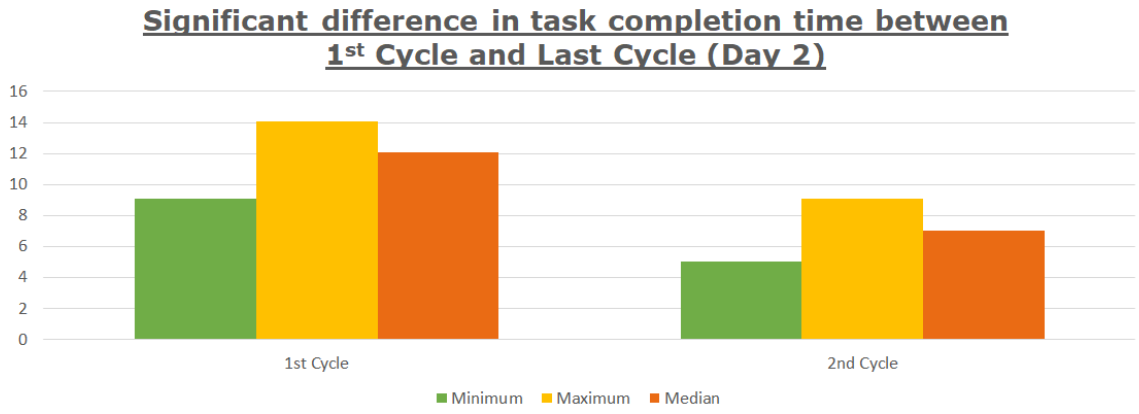

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Table 5. Significant difference in task completion time between 1st cycle and last cycle (Day 3)

	No of participants	Minimum (Mins)	Maximum (Mins)	Median (Mins)
1st Cycle	50	15	22	17
Last Cycle	50	8	14	11

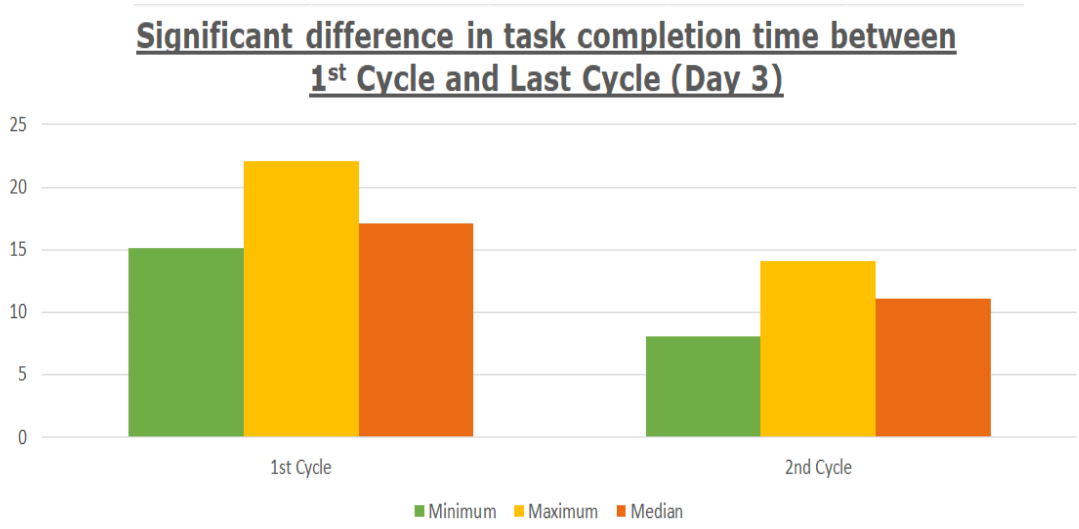

Table 6. Post Training Completion Score with respect to Age

	Number of participants	Minimum	Maximum	Median
<= 25 years	10	18	26	21
>= 25 years	40	20	24	22

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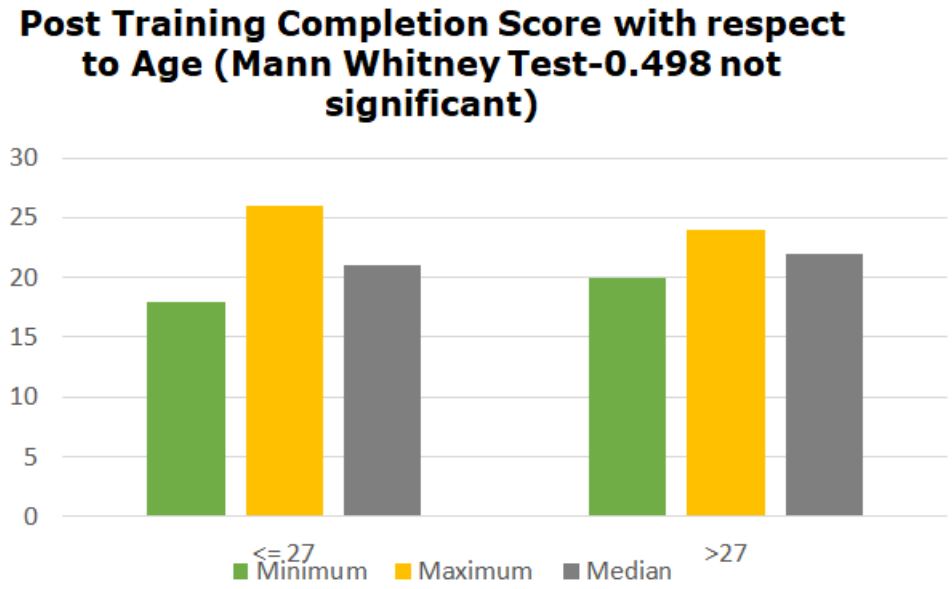

Table 7. Post training completion score Vs Sex

	Number of participants	Minimum	Maximum	Median
Male	24	18	26	22
Female	26	20	25	22

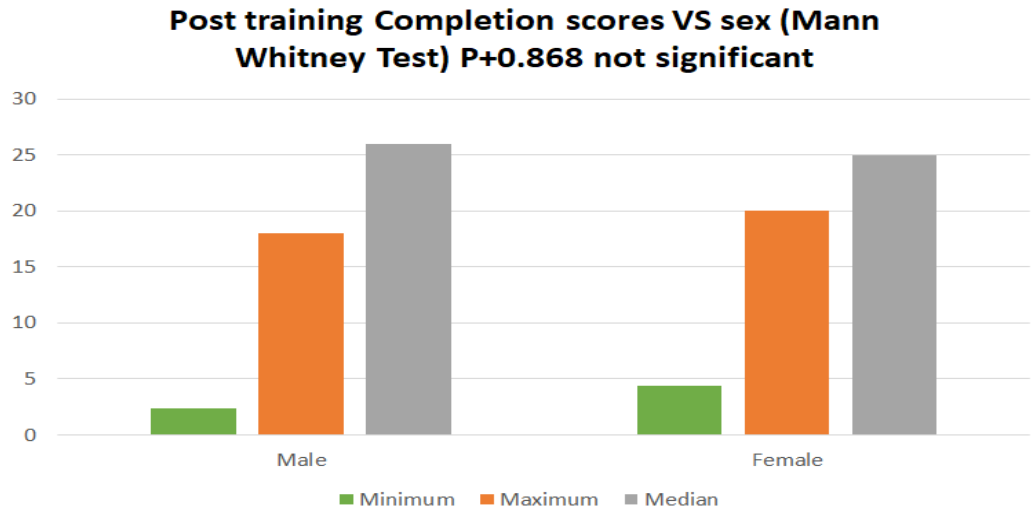

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Table 8. Significant difference between post procedure score between intervention and Non-Intervention group

	Number of participants	Minimum	Maximum	Median
Non Intervention	50	7	12	9
Intervention	50	10	20	14

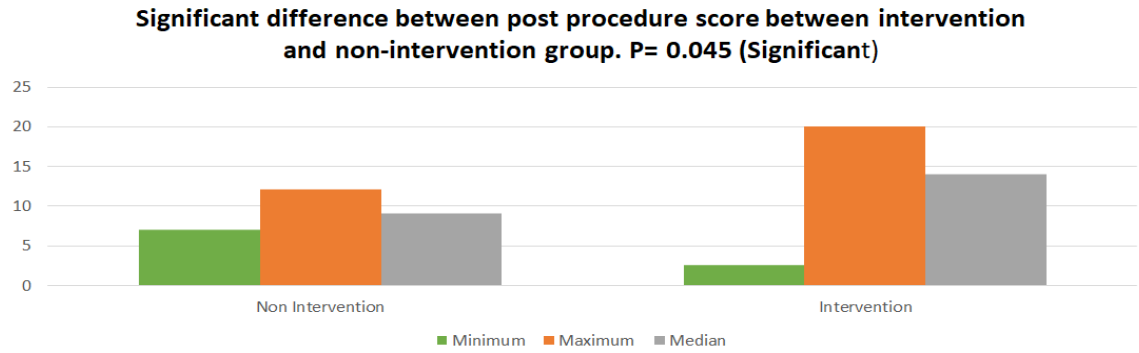
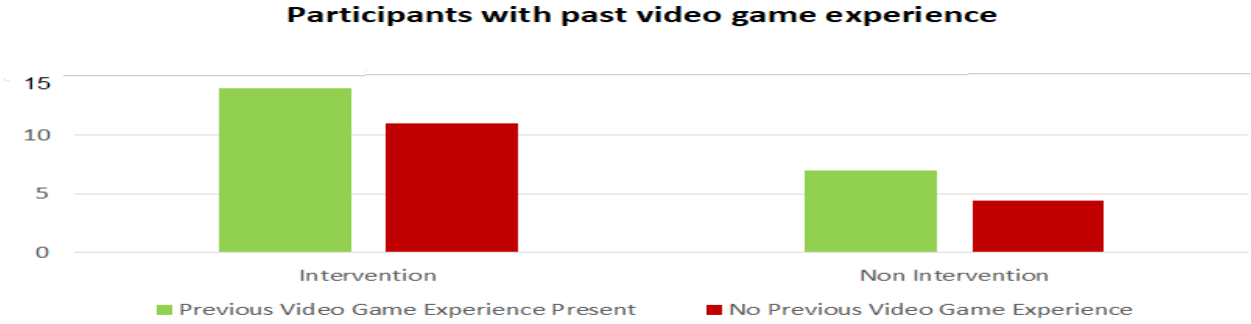


Table 9. Participants with past video game experience

		Group		Total
		Non Intervention (mins)	Intervention (mins)	
Previous Video Game Experience	NO	36	22	58
	YES	14	28	42
Total 15		50	50	100



7. DISCUSSION

- Simulation based training in Laparoscopic surgery emphasizes on basic coordination skills and tactile feedback from the simulator
- 3key tasks essential for laparoscopy:

a) Centering of the image
b) Maintenance of horizon
c) Optimum viewing distance and bimanual dexterity in case of dissection.

- significant difference in post procedure scores between Intervention and Non-Intervention groups

Our study, using a novel training design, objectively demonstrates a proficiency gain curve which can be translated into real life performance gains and comparable to other previous studies

8. CONCLUSION

- In our study there was improvement in navigation skills, haptic feedback and bimanual dexterity after training and these skills were able to transfer to the operating theatre.
- Participants in the intervention group performed well when compared to control group.
- We recommend laparoscopic box trainer as simulator because of its low cost, its equivalence to real-life laparoscopy in terms of use of identical equipment.

9. AUTHOR(S) CONTRIBUTION

The writers affirm that they have no connections to, or engagement with, any group or body that provides financial or non-financial assistance for the topics or resources covered in this manuscript.

10. CONFLICTS OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

11. PLAGIARISM POLICY

All authors declare that any kind of violation of plagiarism, copyright and ethical matters will taken care by all authors. Journal and editors are not liable for aforesaid matters.

12. SOURCES OF FUNDING

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