Original Research Article

Does Smartphone Gaming have a positive effect on the acquisition of Laparoscopic Skills?

ABSTRACT

Aims: Videogaming has been shown to have a positive effect on hand-eye co-ordination, improve visuo-spatial ability and improve cognitive flexibility. However, the majority of the literature examining the subject utilise gaming consoles where physical controllers are used to dictate on-screen movements. The current evidence examining the association between laparoscopic skills and smartphone or touch-based gaming is extremely limited. This study seeks to examine whether smartphone gaming has a positive effect on laparoscopic skill acquisition.

Study design: Prospective cohort study

Place and Duration of Study: Department of Urology, Sarawak General Hospital, Kuching Sarawak between August 2020 and January 2021.

Methodology: We included 74 medical students (26 male, 48 female, age range 22 – 24 years) without any prior exposure to either laparoscopy or surgery. Subjects were assigned to either Gamer or Non-Gamer groups based on a self-reported questionnaire. Formal testing of laparoscopic skills was undertaken via the Modified MISTELS (McGill Inanimate System for Training and Evaluation of Laparoscopic Skills) to establish a baseline. The Gamer group were then asked to play at least 30 minutes of a smartphone game for 21 days whilst the Non-Gamer group were asked to refrain from commencing any virtual games. Repeat assessment of laparoscopic skills was performed and scores between the 2 groups was compared using 2-tailed independent t-test.

Results: In total 74 medical students completed the study with 34 in the Non-Gamer Group and 40 in the Gamer Group. There was no statistically significant difference between groups at baseline assessment. Following the intervention period, the Gaming Group performed significantly better than the Non-Gaming Group with a mean Overall score of 261.05 vs 154.99 ($p<.001$). Additionally, the Gaming group showed statistically significant higher scores in all three component tasks, with most marked difference in Intracorporeal Suturing.

Conclusion: Smartphone gaming requiring the use of multi-action gestures improves the ability of novices to acquire laparoscopic skills compared to no exposure. The findings support the use of smartphone gaming to be used as an adjunct to laparoscopic training due to the convenience, portability and ease of access to most medical students and professionals

Keywords: Smartphone gaming, Video games, Laparoscopic Skills, Visuospatial skills, Training, MISTELS assessment

1. INTRODUCTION

The era of minimally invasive surgery has made acquisition of laparoscopic skills a fundamental part of training for Urologists worldwide. Laparoscopic radical nephrectomy has replaced open approaches as the standard of care for T1-T3a renal tumours(1,2). Similarly for benign adrenal tumours, laparoscopic adrenelectomy has again become the standard of care(3,4). Within the field of reconstructive surgery, the laparoscopic dismembered pyeloplasty in adults with pelvi-ureteric junction obstruction has become the gold standard procedure of choice replacing the classical open Anderson-Hynes(5,6). It is evident that the role of laparoscopic surgery in Urology is ever expanding with a growing list of procedures for which this approach not only become possible, but oftentimes preferable. Integrating adjuncts early in the surgical career to facilitate laparoscopic skill acquisition is a valuable training goal.

Laparoscopic surgery places additional demands on the surgeon compared to open surgery. Factors which contribute to the challenge of laparoscopic surgery are: Conversion of 2D image information to real life 3D movements, differences of visuospatial processing with unfamiliar hand movements and the change in field of vision when appreciated through a laparoscopic camera(7).

Video gaming has been shown to have a positive effect on hand-eye co-ordination(7), improve visuo-spatial ability(8,9) and improve cognitive flexibility(10). It has been studied as a means to improve laparoscopic skill acquisition due to the similar requirement of developing 3D-visual spatial skills, translating movements through an instrument (or controller) and interpreting the effects of these movements through a video image(11,12). The first paper showing a positive link between Laparoscopic Skills and Video game exposure was published in 2003 by Rosenburg et al(13). In this study of 25 surgical residents with limited prior exposure to Laparoscopic surgery, it was found that videogame players achieved better results in first-time laparoscopic skill assessment than non-videogamers. Since then, numerous papers have likewise supported the positive effect of videogaming on laparoscopic skill acquisition. A review by Yanwen et al reached a conclusion that ongoing videogame exposure improved laparoscopic skill simulator performance in the domains of improved efficiency, lower error score and shorter completion time. These improvements were seen in medical students as well as surgeons already adept in laparoscopic surgery (11). However, the majority of these studies conducted utilised console gaming such as the Sony Playstation, Xbox and Nintendo Wii where physical controllers are used to dictate on screen movements. With respect to examining the association between laparoscopic skills and smartphone – or touch based gaming, the current evidence is extremely limited. In modern day practice, a smartphone is an easily accessible mobile device possessed by almost all clinicians. Hence, the potential for gaming exposure is greater and more convenient compared to console platforms. The goal of this study was to address whether the positive effect of video-gaming on laparoscopic skill acquisition can be extended to smartphone gaming.

2. MATERIAL AND METHODS

2.1 Study Participants

This study recruited seventy-eight medical students between the age of 22 – 24 years in their 4th and 5th year of training at Universiti Malaysia Sarawak (UNIMAS). Exclusion criteria were previous exposure to either laparoscopic surgical procedures or training. Participants were recruited to the study after filling in a questionnaire detailing their age, gender, gaming habits and level of surgical experience in either laparoscopic or open surgery. To assess previous smartphone gaming exposure, participants were asked to report the frequency of gaming over the last year via a self-reported questionnaire. Participants who reported no previous smartphone gaming experience were assigned to the Non-gamer group (n=35), whilst those who were currently playing smartphone games were assigned to the Gamer group (n=43). The number of self-reported hours per week of smartphone gaming was recorded.

Table 1. Participant Characteristics

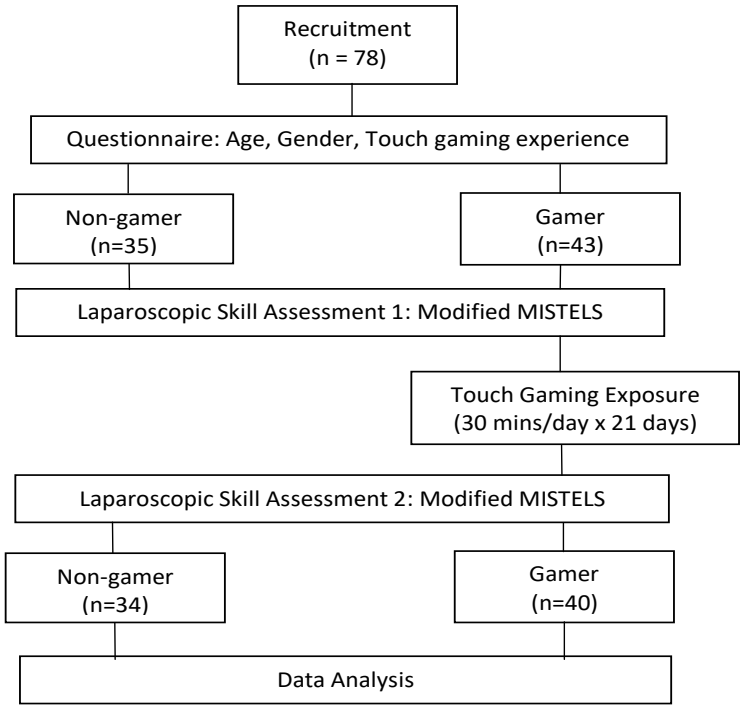
	Non-Gaming (n=34)	**Gamer (n=40)**
Mean Age (Years)	21.35 (SD 0.55)	22.90 (SD 0.74)
Gender Ratio (F:M) **Females** **Males**	2.43 20 14	2.33 28 12
Smartphone Gaming Experience	-	1 – 3hrs/week: n=17 4 – 6hrs/week: n=9 >7hrs/week: n=14

2.2 Study Design

Subjects within the Non-gamer group were instructed to not start playing any smartphone games or new videogames during the study period. The Gamer group were instructed to play at least 30 minutes of the smartphone game Temple Run 2 each day for a period of 21 days and record the time spent gaming and daily high scores. All study participants' Laparoscopic skills were assessed using the Modified McGill Inanimate System for Training and Evaluation of Laparoscopic Skills (MISTELS) at baseline, and again at the end of the 21-day intervention period.

In total 74 subjects completed the study. Of the original 78 subjects, there was 1 drop-out from the Non-gamer group due to inability to attend the 2nd MISTELS assessment session and 3 drop-outs from the Gamer group due to inability to log 30 minutes of smartphone gaming daily for the intervention period.

Fig. 1. Overview of Study Design



2.3 Smartphone Gaming

Subjects assigned to the Gamer Group were tasked with playing 30 minutes per day of the Smartphone Game Temple Run 2 by Imangi Studios. In this game, a player-controlled avatar continually 'runs' from pursuing beasts and is met with various obstacles which are avoided through on-screen touch gestures and tilting of the smartphone. A higher 'survival' time with collection of on-screen bonuses results in a higher final score. This particular game was chosen as it involved using 'swipe' gestures in all directions to control the game character's movements in a precisely timed manner. The required use of the accelerometer to 'balance' left and right movements adds an element of fine motor control. The 3D setting of this game and the requirement of responding quickly to evolving on-screen events additionally integrates a required level of visuo-spatial co-ordination.

2.4 Laparoscopic Skill Assessment

The MISTELS model(14) is an established validated assessment tool for Laparoscopic Skill assessment in terms of construct validity, external validity, interrater reliability and test-retest reliability(15). The participants in this study were assessed with the Modified MISTELS model which uses three of the five tasks in the unabridged MISTELS which has also been proven as a valid tool(16).

A description of the tasks as per the MISTELS model are as follows:

"*Task 1: Pegboard transfer.* The operator is required to lift each of six pegs from one board, transfer it to the other hand, and place it on a second pegboard. The procedure then is reversed. This requires the use of both the dominant and non-dominant hands in a complementary manner. The cut-off time is 300 s, and the penalty score is calculated as the percentage of pegs not transferred as a result of being dropped outside the field of view.

Task 2: Precision cutting. The operator is required to cut a circular pre-drawn pattern 4 cm in diameter from a 10 x 10 cm2 piece of suspended gauze. The cut-off time is 300 s. The penalty is calculated as the percentage of the area of deviation from a perfect circle.

Task 3: Intra-corporeal knot. A simple suture 12 cm in length must be placed through two pre-marked points in a longitudinally slit Penrose drain. The suture then is tied using an intra-corporeal knot-tying technique. The cut-off time is 600 s. The penalty score is the sum of the distance in millimetres that the suture placement misses the pre-marked points, plus the gap in millimetres if the suture failed to approximate the edges of the slit. An additional penalty is assessed if the knot is loose or insecure."

Each participant was provided with an explanation of each task together with a pre-recorded video prior to the MISTELS assessment sessions. Only 1 attempt was allowed at each task, and time scores, error scores and overall scores were recorded for each participant. They were not permitted to observe each other or provided with practice sessions. All participants underwent MISTELS assessment at baseline and 21 days later.

2.5 Statistical Analysis

Data was analysed using SPSS Statistics Software Version 26. A 2-tailed independent t-test was used to compare the difference in MISTELS Scores in Gamers and Non-gamers at both assessment sessions, the difference in scores between genders, as well as the differences between evolution scores.

3. RESULTS

3.1 Laparoscopic Skill Performance

3.1.1 Gender Differences

In order to assess if there were significant differences between Females and Males in the performance of Laparoscopic Tasks, we performed a 2-tailed Independent t-test comparing the MISTELS score at each session.

In the 1st MISTELS assessment, Females (M = 107.54, SD = 76.53) had higher mean scores than Males (M = 88.09, SD = 60.90). However this difference was not statistically significant (t(72) = -1.06, *P* = *.29*). Additionally, in the 2nd MISTELS assessment, Females (M = 222.94, SD = 151.57) had higher mean scores than Males (M = 205.23, SD = 134.13). This difference was again not statistically significant (t(72) = -0.48, *P* = *.64*).

3.1.2 Effect on Smartphone Gaming on Laparoscopic Performance

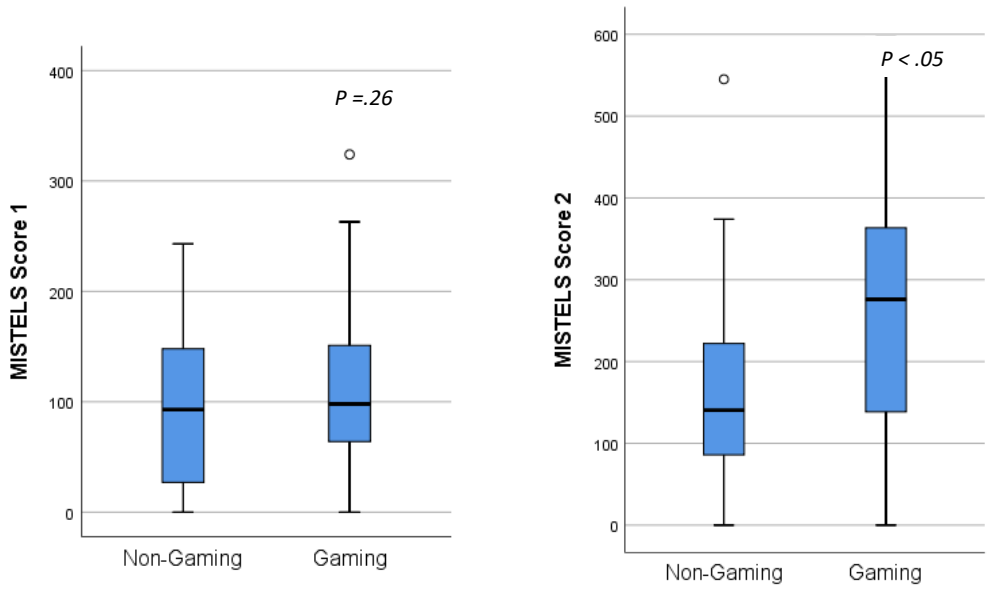
To test the effect of smartphone gaming, the MISTELS Scores at baseline and after the intervention period were compared with a 2-tailed Independent t-test.

3.1.2.1 Overall performance

At the 1st MISTELS assessment, there was no statistically significant difference (t(72) = -1.129, *P* = *.26*) between the Non-gamer (M = 91.47, SD = 69.88) and Gamer (M = 110.50, SD = 74.18) groups in terms of Overall MISTELS Score indicating laparoscopic skills were similar between groups prior to the intervention period.

At the 2nd MISTELS assessment, the Gamer Group (M = 271.05, SD = 144.98) performed statistically significantly better (t(72) = -3.70, *P* = < *.05*) than the Non-Gamer Group (M = 154.88, SD = 121.43) in terms of Overall MISTELS Score.

Fig. 2. Box and whisker plots comparing the MISTELS Score between groups before (MISTELS 1) and after (MISTELS 2) the Intervention period



3.1.2.2 Performance differences between tasks

In the 2nd MISTELS assessment, the Gamer group additionally showed statistically significant higher scores in all three individual tasks:

Task 1: Gamer Group (M = 51.48, SD = 53.78) vs Non-Gamer Group (M = 24.74, SD = 40.45), t(72) = -2.38, *P* = *.02*

Task 2: Gamer Group (M = 136.35, SD = 9.27) vs Non-Gamer Group (M = 105.82, SD = 11.39), t(72) = -2.10, *P* = *.04*

Task 3: Gamer Group (M = 83.23, SD = 85.09) vs Non-Gamer Group (M = 24.32, SD = 60.98), t(72) = -3.37, P < .05

Table 2: Mean MISTELS 2 scores comparing Laparoscopic Skill Assessment after the intervention period in Non-Gamer and Gamer groups

	Mean MISTELS 2 Score		
	Non-Gamer	**Gamer**	**P-value**
Overall	154.88 (SD = 121.43)	271.05 (SD = 144.98)	<.05
Task 1: Pegboard transfer	24.74 (SD = 40.45)	51.48 (SD = 53.78)	.02
Task 2: Precision cutting	105.82 (SD = 11.39)	136.35 (SD = 9.27)	.04
Task 3: Intra-corporeal knot	83.23 (SD = 85.09)	24.32 (SD = 60.98)	<.05

3.1.2.3 Quantum of improvement of Laparoscopic Performance

To test if there was a significant difference between the non-gamer group and the gamer group with regards to the quantum of improvement between the 1st and 2nd MISTELS assessment, an independent t-test was performed on the evolution score between each task (defined as the 1st MISTELS score subtracted from the 2nd MISTELS score).

The Gamer Group (M = 160.55, SD = 132.61) showed statistically significant higher evolution scores (t(72) = -3.38, P <.05) than the Non-gamer Group (M = 63.41, SD = 111.09).

4. DISCUSSION

This prospective cohort study in medical students with no previous experience to laparoscopic surgery evaluated the effect of touch-based Smartphone gaming and the performance on a laparoscopic skill simulator. Exposure to a smartphone game for a minimum of 30 minutes per day for 21 days resulted in significantly higher scores in the Modified MISTELS Laparoscopic Skill assessment. This effect was seen in all three component tasks within the Modified MISTELS assessment. The findings of this study support the notion that previously observed positive effects of video-gaming with console platforms can be extended to include gaming on a smartphone(11,17,18). It thus can be inferred that despite the mechanics of interaction differing between consoles and smartphones, the benefits in visuospatial conditioning and cognitive flexibility remain to some degree.

Comparing the performance in each individual task of the Modified MISTELS assessment, Task 3 involving intra-corporeal suturing showed the most marked difference between Gamer and Non-gamer groups. As intra-corporeal suturing is regarded as an advanced laparoscopic skill, it may be suggested that smartphone gaming improves the acquisition of laparoscopic skills unique to intra-corporeal suturing to a greater degree. To our knowledge, there is no known study to date that examines this phenomenon to which we may compare.

Overall, both Gamer and Non-Gamer groups showed improvement between the first and second laparoscopic skill assessment period. This suggests that there is a learning effect

that occurs after the first session and is sustained after 21 days. However, the quantum of improvement in the Gamer group after the period of intervention was significantly higher. Relating this to real-world training scenarios, it suggests that whilst practicing laparoscopic tasks improves performance in itself, supplementing this regime with a period of smartphone gaming may result in even greater improvements.

This study did not demonstrate a significant difference in laparoscopic skill performance between the Gamer and Non-Gamer group during the 1st Modified MISTELS assessment to test baseline laparoscopic performance. This suggests that self-declared questionnaires are unable to accurately measure smartphone gaming exposure. This is in contrast to earlier findings by Rosser et al (17) which examined past-gaming experience on console based games, suggesting that previous gaming experience of more than 3 hours per week correlated with better overall simulator scores, lower error rates and faster task completion. A potential reason for this difference in result may be due to the fact that whilst the smartphone game Temple Run 2 was standardised as an intervention tool, there was heterogeneity in the types of games played by participants within the Gamer group prior to the intervention period. Schlickum et al(18) found that certain types of videogames were less effective at improving laparoscopic performance than others.

The study did not demonstrate a significant gender differences in laparoscopic skill performance either at baseline or after the intervention period. This finding contrasts with earlier work that suggested females scored less in laparoscopic skills and had a slower learning curve than males(19,20) and strengthens the findings put forward by Rosenburg et al(13). This is an important finding with regards to training as it refutes the notion that gender inherently influences the ability to acquire laparoscopic skills.

The subjects within this study were complete novices to laparoscopic surgery, having had zero prior exposure. As this study did not include participants who had already performed laparoscopic surgery, it could not evaluate whether the positive effect seen in complete novices extended to those who started with basic laparoscopic proficiency.

4.1 Limitations

A limitation of this study was that it did not take into account video-game exposure on different gaming platforms when assigning subjects to their designated groups. As certain videogames are found to be more beneficial than others with relation to the positive effect upon visuospatial skill (21)(18), this may have impacted upon the performance between groups by discounting pre-existing videogaming ability in certain genres. However, our analysis shows that there was no statistical different between both two groups with regards to baseline laparoscopic skill performance indicating that the groups were comparable prior to the intervention period.

The regimen of 30 minutes of smartphone gaming for 21 days chosen for the intervention period was significantly shorter than the 2 months used in a separate study by Chalhoub et al(20). However, stringent control of compliance with the intervention was introduced through means of screen capture of gaming high scores and logs of daily time played for each participant. Previous work examining the effect of videogames on visuo-spatial competencies suggests that a total period of 4 hours is adequate to derive benefit (22). A review of the literature suggests that the positive effect of gaming on laparoscopic skills can be seen with a period of exposure as short as a single 15 minute session in a study by Plerhoples et al (23). Whilst some degree of positive effect was found in both studies, Plerhoples and Chalhoub differed in the essence of their scope. Plerhoples' intervention was an immediate and single short session of smartphone gaming prior to laparoscopic skill

assessment – it thus was unable to evaluate the effects of longer-term gaming exposure and the cognitive plasticity that comes with repeated exposure. It is possible that the quantum of improvement could have been greater in the Gaming group had the intervention period been extended.

There were gender imbalances overall in the studied population, with a more than twice the number of females than males. However, as gender was not found to influence laparoscopic skill performance in this study, and the gender ratios within each group were comparable, the bias introduced by this is limited.

5. CONCLUSION

Smartphone gaming involving 3D games requiring the use of multi-action gestures to respond to on-screen situations improve the ability of novices to acquire laparoscopic skills compared to no exposure to smartphone gaming. The most marked improvement is seen in the advanced laparoscopic skill of intra-corporeal suturing. The findings support the use of smartphone gaming to be used as an adjunct to laparoscopic training due to the convenience, portability and availability of access to most medical students and professionals.

CONSENT

All authors declare that written informed consent was obtained from the participants for publication of this study. A copy of the written consent is available for review by the Editorial Board members of this journal.

ETHICAL APPROVAL

This study was approved by the Ethics Committee of Universiti Malaysia Sarawak (Ethics Reference Number: FME/21/70)

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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