Review

The effects of video games on laparoscopic simulator skills

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Abstract

BACKGROUND: Recently, there has been a growth in studies supporting the hypothesis that video games have positive effects on basic laparoscopic skills. This review discusses all studies directly related to these effects.

DATA SOURCES: A search in the PubMed and EMBASE databases was performed using synonymous terms for video games and laparoscopy. All available articles concerning video games and their effects on skills on any laparoscopic simulator (box trainer, virtual reality, and animal models) were selected.

CONCLUSIONS: Video game experience has been related to higher baseline laparoscopic skills in different studies. There is currently, however, no standardized method to assess video game experience, making it difficult to compare these studies. Several controlled experiments have, nevertheless, shown that video games cannot only be used to improve laparoscopic basic skills in surgical novices, but are also used as a temporary warming-up before laparoscopic surgery.

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be used as a cost-effective and fun way to train basic laparoscopic skills in surgical residents. This article reviews all observational studies and controlled experiments directly related to the effects of video games on laparoscopic skills.

Methods

A search in the PubMed database was performed using the MeSH terms “video games, laparoscopy, general surgery and surgical procedures, operative” and the general terms “eye–hand coordination and psychomotor.” A complementary search combining relevant terms for video games (game, video games, gaming, games, Nintendo, and Wii) and laparoscopy (laparoscopy, surgery, eye–hand coordination, surgeon, psychomotor, and endoscopy) was carried out as well. To broaden the search, the EMBASE database was consulted, looking for the same terms in titles, abstracts, and index terms of all articles concerning human research. All available articles concerning video games and their effects on skills on any laparoscopic simulator (box trainer, virtual reality, and animal models) were selected.

Results

In total, 35 articles were found, of which 19 studies were directly related to the subject of this article. The remaining 16 articles were discarded because they were either other reviews or not directly related to the subject (eg, focused on endoscopy or general surgery). The trials that assess the effects of video games on laparoscopic skills can be divided into 2 main groups. The 1st group of articles discusses the effect of video game experience on baseline laparoscopic skills. Thirteen observational studies investigated whether gamers have better baseline skills. The 2nd group includes 7 controlled experiments, in which video games have been used as an intervention to improve laparoscopic skills. One study covers both types of trials (Table 1).

Game experience and basic laparoscopic skills

The influence of video game experience on laparoscopic simulator skills has been observed in a few studies that are specifically designed to investigate that goal. Grantcharov et al8 were the first to describe a direct, positive relationship between video game experience and laparoscopic simulator score. Subjects with previous game experience (10 of 25 novice surgeons in training) made significantly less errors on the MIST-VR simulator (Mentice Medical Simulation, Gothenburg, Sweden), even after adjusting for sex and handedness. Shane et al9 did a similar experiment; they found that students and residents who had previous game experience (11 of 26) reached pre-set proficiency criteria significantly quicker after training. This was, among others, based on a composite score including error rate. Recently, Kennedy et al10 too showed that experienced gamers had better psychomotor abilities using a ProMIS laparoscopic simulator (Haptica, Dublin, Ireland).

Four studies have incorporated video game experience as one of the many factors used to predict baseline laparoscopic skills.11–14 Van Hove et al11 followed 35 first-year surgical residents during their 1st year of training and correlated their initial laparoscopic skill level to trainee characteristics. A history of video game use correlated with significantly higher scores and better skills retention. Madan et al,12 however, were unable to find any relationship between self-reported video game experience (non-gamer, novice, expert) and a subjective score in a porcine animal model. Nomura et al13 let 43 laparoscopic novices take a short questionnaire with 9 independent variables, such a sex, confidence in driving skills, and video game experience, before testing them on the ProMIS simulator. Subjects who answered positively to the question “Do you like TV games?” were significantly faster and had a shorter left instrument path length. In an effort to predict the attainable proficiency level for first-time users of a virtual reality laparoscopic simulator, Paschold et al14 studied 279 undergraduate medical students. From a list of several expected, predictive factors such as age, sex, and handedness, frequency of playing video games (split into the terms “often,” “rarely,” or “not at all”) was the only factor able to predict the first-time score on a laparoscopic simulator test after multiple logistic regression analysis.

Besides a controlled experiment, as will be discussed in the next paragraph, Schlickum et al15 used a detailed questionnaire to assess video game experience collected on different ages and found that participants who played games between age 14 and 18 scored significantly better on the MIST-VR laparoscopic simulator. This correlates with an experiment done by Fanning et al,16 in which 15 video game experienced teenagers (15 to 19 years) performed 3 laparoscopic tasks of which 2 were significantly quicker than 15 first-year non-gaming residents in obstetrics and gynecology.

There were 2 studies in which younger children were observed.17,18 Rosenthal et al17 showed that children (aged 8 to 12) who do not play video games score lower on physical and virtual reality tasks than children who do, but this difference was not significant. Van Dongen et al18 also found that there was no significant difference between younger gamers (average 12.5 years) and non-gaming medical interns on performance on the LapSim simulator, although it turned out to be difficult to test children on a laparoscopic simulator. They did, however, find that game-experienced interns were significantly faster and more efficient than their non-gaming peers.

In only 2 observational studies, video games were actually used to objectively video game experience.19,20 Rosser et al19 tested 33 surgical residents and attending physicians on 3 different video game consoles and their own laparoscopic skills and suturing program. Both current (≥3 hours/week) and past gamers were faster and made fewer errors. When looking at demonstrated video game skill, subjects in the top tertile made fewer errors and
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AM = animal model; box = box trainer; grey = correlation; VR = virtual reality simulator; white = no relation found.
performed faster. Badurdeen et al. performed a comparable experiment. Not only did they show that participants who scored higher on the Nintendo Wii (Nintendo Co, Ltd, Kyoto, Japan) were better with a box trainer, but also showed that experienced (non-Wii) gamers scored higher on both the Wii and the box trainer (Table 2).

### Games used to improve laparoscopic skills

In 2005, Rosenberg et al. published the results of the 1st controlled experiment in which video games were used to improve laparoscopic skills. Eleven medical students were randomized into 2 groups, after performing 4 different laparoscopic tasks in a swine model. The intervention group (n = 5) played video games on an average of 6.2 hours during 2 weeks, while the control group (n = 6) did not play any video games during this period. Later, the tasks were repeated and the scores were evaluated. In contrast to the hypothesis, no correlation between video game training and changes in laparoscopic skills could be found.

Sadandanan et al. showed that one’s skill on a box trainer would directly improve after playing 10 minutes of a console version of Super Monkey Ball (SEGA Corp, Tokyo, Japan), a popular balance game using a joystick. Their study, however, lacks a control group. Plerhoples et al. used the similar game Super Monkey Ball 2 for iPhone, in which real balance is used, as a warming-up before performing a laparoscopic simulator task. Plerhoples did include a control group and stratified for previous game experience and found that the group that warmed up using the video game made significantly less errors.

More recently, a Nintendo Wii version of Super Monkey Ball, which uses the motion-sensitive Wii controller, was used by Boyle et al. to train laparoscopic skills in students. After an intake session, in which 2 physical and 1 virtual reality task was performed on a ProMIS simulator, the students (n = 11) played 3 hours of mini-games during 1 week. All 3 tasks were then performed for a 2nd time and compared with a control group (n = 11). Although practicing on the Wii was associated with a trend toward a better 2nd performance, there was no significant difference.

A more intensive training program was developed by Bokhari et al. who used Marble Mania (Kororinpa in Europe and Japan; Hudson Soft Co, Ltd, Tokyo, Japan), a similar balance game for Nintendo Wii, in combination with a custom-made Wii controller add-on that mimics a laparoscopic instrument. A group of surgical residents (n = 14) completed 50 levels of increasing difficulty directly after gaming for 2 weeks. All 3 tasks were then performed for a 2nd time and compared with a control group (n = 7). The trained residents took significantly less time, made fewer errors, and were more proficient in their hand movements.

Schlickum et al. performed 2 trials in which the effects of 2-dimensional (2D) and 3-dimensional (3D) games were evaluated. It was hypothesized that visuospatially challenging video games, such as first-person shooters

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AM = animal model; box = box trainer; FPS = first-person shooters; grey = positive effect; VR = virtual reality simulator; white = no effect shown.
better at a racing game than their colleagues. 28 This does

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Later, the participants were matched and randomized into 3 groups: (1) an FPS group (n = 11), (2) a non-FPS group (n = 11), and (3) a control group (n = 4). The gaming groups played their specific game for half an hour, 5 days a week for 5 weeks and were then retested together with the control group. The FPS group scored significantly better on the laparoscopic simulator than the group that had played a non-FPS game. Scores of the control group were not presented in the Results section. In their 2nd study, a similar experiment was performed using 3 groups: (1) a Half-Life (Valve Software Corp, Bellevue, WA) group (3D game, n = 15); (2) a Chessmaster (Ubisoft Entertainment SA, Rennes, France) group (2D game, n = 15); and (3) a control group (n = 10).15 Again, the same intensive training scheme was followed for 5 weeks. After retesting, the Half-Life and the Chessmaster groups scored significantly better on the MIST-VR simulator than the control group, in which no significant improvement was found.

Comments

There is evidence of a positive relationship between video game experience and laparoscopic simulator skills. This has also been found for endoscopy, which requires similar visuospatial abilities.15,26,27 However, it should not be forgotten that the few studies providing this evidence are observational studies, which only show a correlation between laparoscopic skills and video game experience. Correlation does not imply causation. One theory, for example, is that innate dexterous people will be attracted to video games, because higher scores will be more rewarding for them.2 Dexterous non-gamers have indeed proven to score better at a racing game than their colleagues.28 This does not render the observational studies useless because the positive effects have also been shown in controlled experiments.

Interestingly, when using video games as an intervention to improve laparoscopic simulator skills, there seem to be 2 totally different effects: a direct, warming-up effect and, on the long run, a learning effect. The warming-up effect can be seen directly after playing a balance game, with either a joystick or real balance (tilting a handheld computer), for about 10 minutes.22,23,25 The long-term learning effect seems to kick in only after an intensive training program in which video games have to be played almost each day for several weeks.15,19,20 Playing games for only a few hours during 1 or 2 weeks does not seem to have any significant effect on laparoscopic skills.21,24

Currently, there is no standard definition for “video game experience,” nor is there a validated, standard questionnaire for previous or current experience. Rosser et al19 have made the “The Amount of Video Game Experience Scale” for their own study, but did not publish their scale for further public use. Other studies use totally different measures for game experience, such as total hours of game experience,22 self-reported novice, expert or non-gamer,12 or whether one simply “likes TV games.”13 Van Dongen et al18 defined video game experience as “an average playing time of at least 10 hours/week,” but failed to collect a group that does, with gaming interns playing an average of only 1.9 hours/week. A good scale should not only account for the total hours of gameplay, but should also describe the distribution of these hours over a lifetime because children have more free time to play video games than students, interns, or surgeons. Schlickum et al15 tackled this problem by letting participants score their game experience on a 7-point Likert scale (1 corresponded to never playing, 7 corresponded to playing every day) for current experience and between ages 1 to 6, 7 to 12, and 13 to 18. Because all studies use a different definition, it is difficult to compare them on an equal level.

While most studies focus on current generation students and interns, some discuss the effect of video game experience gained on different ages.15–18 It is still hard to evaluate the effect in current day surgeons because the phenomenon of gaming developed later during their lives. It seems that younger gamers (≤12 years) do not score significantly better on laparoscopic simulators than their non-gaming peers, but experimenting with this age category seems quite challenging.17,18 When comparing experience gained during puberty, however, a lasting, positive effect can be observed.15,16,18

It should be noted as well that almost all trials have used small research groups and have observed totally different parameters. While some studies only report that gamers are faster at laparoscopic tasks, others mention a shorter path length for tools or a better cumulative score. The various simulators owned by the research groups can explain this lack in uniformity. It is advised that further research on this subject is performed using a more standardized scoring system, such as the FLS peg transfer task.29,30

Simulators have proven their usefulness in laparoscopy. However, they are expensive, mostly boring, and not rapidly available. Video games, on the other hand, are cheap, could be used for teaching, and are preferred over lectures.31,32 A competition with other peers also increases the motivation to voluntarily join skills training.33 The literature in this review has shown that video games could be part of a program for training basic laparoscopic skills in surgical novices. Senior surgeons may also benefit from video games, by using them as a warming-up before laparoscopic interventions. A video game, specifically designed to improve basic laparoscopic skills, could make virtual reality training cheaper and more fun.15,17,20,23,31 Of course, video games can never replace true simulators and real operating room experience.
There is a correlation between playing video games and basic laparoscopic skills. However, the existing evidence is too weak to definitely establish the positive effects of gaming in the development of these skills. Till now, there is no validated scale or questionnaire to assess game experience and neither do researchers use a uniform method to measure laparoscopic skills. Future trials should be more standardized and adequately powered, so stronger evidence on this subject can be acquired.

References