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# Implementation of laparoscopic virtual-reality simulation training in gynaecology: a mixed-methods design

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ABSTRACT

*Objectives:* Virtual-reality (VR) training has been demonstrated to improve laparoscopic surgical skills in the operating theatre. The incorporation of laparoscopic VR simulation into surgical training in gynaecology remains a significant educational challenge. We undertook a pilot study to assess the feasibility of the implementation of a laparoscopic VR simulation programme into a single unit.
*Study design:* An observational study with qualitative analysis of semi-structured group interviews. Trainees in gynaecology ($n = 9$) were scheduled to undertake a pre-validated structured training programme on a laparoscopic VR simulator (LapSim®) over six months. The main outcome measure was the trainees' progress through the training modules in six months. Trainees' perceptions of the feasibility and barriers to the implementation of laparoscopic VR training were assessed in focus groups after training.
*Results:* Sixty-six percent of participants completed six of ten modules. Overall, feedback from the focus groups was positive; trainees felt training improved their dexterity, hand-eye co-ordination and confidence in theatre. Negative aspects included lack of haptic feedback, and facility for laparoscopic port placement training. Time restriction emerged as the main barrier to training.
*Conclusions:* Despite positive perceptions of training, no trainee completed more than two-thirds of the modules of a self-directed laparoscopic VR training programme. Suggested improvements to the integration of future laparoscopic VR training include an additional theoretical component with a fuller understanding of benefits of VR training, and scheduled supervision. Ultimately, the success of a laparoscopic VR simulation training programme might only be improved if it is a mandatory component of the curriculum, together with dedicated time for training. Future multi-centred implementation studies of validated laparoscopic VR curricula are required.


## 1. Introduction

Laparoscopic surgery has become the standard surgical approach for an increasing number of procedures in gynaecology [1,2]. The traditional apprenticeship-tutor model of training skills in theatre, however, is currently under pressure. This is principally due to reduced working hours, greater public expectation and increased demands for competency-based education [3–5]. For hospitals, litigation costs for laparoscopic surgery are high and theatre time is expensive, placing additional pressures on the traditional education model [6–8].

Laparoscopic virtual reality (VR) simulation training in gynaecology has been shown to improve surgical skills to the level of a more experienced surgeon and reduce operating time [9–12]. It has also been shown to be cost effective [13], with lower surgical costs produced by fewer complications and cancellations, reduced litigation and theatre time [13,14].

Integration of simulation into surgical training remains a significant challenge in modern education. Despite the benefits of laparoscopic VR training, few countries have VR training integrated into their curricula, and implementation initiatives have had varying success [15,16]. Barriers to implementation are not only the lack of availability of VR simulators due to financial constraints,

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but also the variability in motivation of trainers and trainees [15–19]. Previous studies have recommended seeking and understanding trainees' opinions about simulation implementation to enhance educational programmes [20].

The primary aim of this study was to evaluate the progress of gynaecology trainees undertaking a self-directed laparoscopic VR training programme in a single unit in the UK. Our secondary aim was to assess the trainees' perceptions of the programme. Outcomes of this study will be used to improve future VR simulation training programmes.

## 2. Materials and methods

### 2.1. Study design

This was an observational study with qualitative thematic analysis of semi-structured group interviews. Ethical approval for the study was obtained prior to recruitment. The aims of the study were explained and informed written consent was obtained. Trainees were not bound to participate by their educational contracts and were free to withdraw at any stage.

### 2.2. Participants

All junior specialist trainees (years one and two; ST1/2) who were working in the unit in gynaecology in August 2010 were invited to participate by email. The sample size ($n = 10$) was pragmatically determined by the number of volunteers working in the unit during the study period (Table 1). One participant dropped out during the study as she no longer planned to pursue a career in gynaecology. The unit is a large hospital with facilities for teaching and learning. The staff includes seven consultant gynaecologists, three laparoscopic experts, 10 junior trainees (ST1-2), and 18 middle grade trainees (ST3-7).

### 2.3. Intervention

#### 2.3.1. VR Training

The VR simulator LapSim® (Gyn v 3.0.1; Surgical Science, Gothenburg, Sweden) was located in the Gynaecology Department. The participants were each given individual password-protected access to the simulator. All participants were instructed on how to use the simulator. They were shown how to use the instruments, and how to interpret the automated feedback.

Initially all participants were randomly allocated one of ten training modules. These modules, which were not part of the training programme, allowed the participants to familiarise themselves to the workings of the software. The trainees then commenced a VR validated training programme [9,11]. The programme comprised of ten modules: nine basic skills and a validated salpingectomy [9]. Participants could not progress to the next module until they had passed a previously validated the competency standard [9,11]. The participants had 24-h access to the VR simulator and were allocated six months to complete the programme. An email from the trainers (second and fifth author) offering access to one-to-one sessions to troubleshoot any problems was sent on three occasions during the study period.

#### 2.3.2. Focus groups

On completion of the study, two semi-structured focus-group interviews were undertaken. The focus groups were conducted on hospital premises by experienced qualitative researchers. The interviews followed a planned semi-structured schedule and were audio-recorded. The primary facilitator kept field notes with an observational log for each session. Participants were assured all transcripts from the interviews would be kept secure and any views expressed would remain anonymous. Interpretive thematic analysis was undertaken. Two researchers carried out the initial coding (LM, CB), and another two researchers crosschecked the results independently (HH, JA). The researchers then met as a group and the process of validation and cross-comparison continued until agreement was achieved on the main themes. Further analysis was then conducted to refine final thematic outputs with transcripts being reread several times to understand the interviews and ensure no major subjects had been overlooked or under-represented. We circulated summaries of the transcripts and analysis to a randomly selected participant from each focus group for internal validation.

### 2.4. Data collection

The VR simulator provided instant individual feedback for each module on different characteristics. This allowed trainees to consciously refine their technique at their next attempt. The simulator automatically collated data: number of attempts at each module, modules passed, and time spent on the simulator for each individual. An anonymous participant number identified individuals. Data were exported to Microsoft Excel®, Microsoft Corp., Redmond, WA.

### 2.5. Data analysis

Continuous variables were summarised by the mean and range, and categorical variables were presented as numbers and percentages. Analysis of the quantitative data was undertaken using the Statistical Package for the Social Sciences version 18 (SPSS Inc., Chicago, USA).

## 3. Results

Six (66.7%, 95% CI 29.9–92.5) of the nine participants completed six of ten modules. No participant completed all the modules. Median total time spent on the simulator was 66 min (range 20–140 min, mean 53.5 95% CI 23.0–83). A majority of VR training time (60.8%, 95% CI 57.3–64.2) was undertaken in normal working hours (09.00–17.00 h). The median number of failed attempts on the last

**Table 1**
Characteristics of participants.

| Demographic factor | |
|---|---|
| **Age** (years) [mean, range] | 26.9 (25–29) |
| **Ethnicity (%)** | |
| Caucasian | 88.9% (8/9) |
| Indian | 11.1% (1/9) |
| **Training level** | |
| *ST1* | 77.8% (7/9) |
| *ST2* | 28.6% (2/9) |
| **Gender** | |
| Female | 100.0% (9/9) |
| Male | 0.0% (0/9) |
| **Laparoscopic experience** | |
| Formal laparoscopic course | |
| *ST1* | 0.0% (0/7) |
| *ST2* | 0.0% (0/2) |
| Diagnostic laparoscopy (under direct supervision) | |
| *ST1* | 71.4% (5/7) |
| *ST2* | 100% (2/2) |
| Diagnostic laparoscopy (independent) | |
| *ST1* | 0.0% (0/7) |
| *ST2* | 0.0% (0/2) |