Preliminary Development and Evaluation of a Bovine Rectal Palpation Simulator for Training Veterinary Students

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Abstract. A computer based teaching tool has been developed using haptic technology to train veterinary students to examine the bovine reproductive tract, simulating rectal palpation. The teacher can visualise the student's actions on a screen and therefore give guidance. The properties of the virtual scene were assessed by veterinary surgeons. Evaluation of the teaching tool was conducted with a group of veterinary students. After being trained with the device, each student carried out rectal examinations and assessed the effect of haptic training. The evaluation results, although preliminary, support haptic training as a possible method for enhancing the teaching of bovine rectal palpation.

1 Introduction

Haptic technology has been used in medical research to develop interactive training tools for palpation of head and neck tumours [4] and rectal examination of the prostate [1]. A veterinary application has been developed [2] for palpation of horse ovaries.

Bovine rectal palpation is a procedure that requires considerable practice to develop the skills needed to identify structures. Additionally, when a student examines a cow the teacher is unable to observe what the student is palpating and can give only limited guidance. In the undergraduate curriculum there are difficulties associated with teaching rectal palpation. Access to cows is limited due to student numbers and animal welfare consideration [3]. Students may perform their first examination of a cow with only minimal training in this invasive technique.

There is a need to investigate ways of supplementing existing methods of training. A computer-based teaching tool has the potential to provide the student with a flexible and accessible learning environment. Furthermore, training students to develop basic skills in a risk free environment is advantageous to the welfare of the cow.

2 Requirements Analysis

A questionnaire was circulated to veterinary surgeons to gather information about the training of bovine rectal palpation, opinions regarding the basic structure of the planned teaching environment and to identify features used during pregnancy diagnosis. An informal discussion with a group of veterinary students elicited their opinions on the problems encountered while learning rectal palpation and the design of a computer based teaching tool to support the learning process.

3 Design and Implementation

A three-dimensional pelvic scene was developed and the student palpates the virtual reproductive tract using the thimble attachment of the PHANToM force feedback device. The pelvis, which defines the boundaries of exploration, was modelled as a rectangular box, with the cervix, uterus and ovaries placed on the pelvic floor.

Four separate levels were designed to support the progressive development of skills. Level 1 and Level 2 (Figure 1) are suitable for pre-clinical students to learn orientation in the three dimensional pelvic environment and to identify key anatomical structures. Levels 3 and 4 include options for a range of ovarian structures and stages of pregnancy. These levels are appropriate for more experienced students to build on existing skills and to experience a wide range of scenarios. The teacher selects a level appropriate to the student's skills and gives guidance while following the exploration.

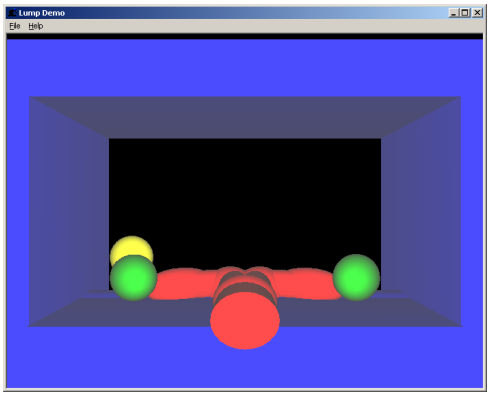

Fig. 1. Level 2: Graphic representation of a non-pregnant uterus with a corpus luteum on the left ovary.

A fibreglass model of the rear half of a cow was constructed and placed over the haptic device to create a more realistic environment. The student interacts with the PHANToM through a cuff representing the anal sphincter.

4 Evaluation

Nine veterinary surgeons assessed the haptic properties and graphic representation of all the anatomical structures and commented on interacting with the haptic device.

Evaluation of the haptic simulator as a teaching tool was conducted with seventeen veterinary students. An experienced veterinary surgeon instructed each student during the exploration of the virtual environment. After being trained with the device each student carried out rectal examinations on farms. The students commented on the effect of haptic training.

5 Results

Thirty-seven questionnaires were completed for the purpose of requirements analysis. Veterinary surgeons considered that rectal palpation is a difficult procedure to learn and still an important skill. In the initial design, the pelvis was modelled as a box and the majority considered this to be at least adequate. Visualising the student's progress on a screen was considered to be helpful. The features considered particularly useful for early pregnancy diagnosis were the size and shape of the uterine horns.

Students at the discussion group commented that initially they had difficulty feeling structures through faeces and the rectal wall and relating to the relevant anatomy. Features considered useful in an alternative computer based training environment included receiving feedback from the teacher and having time to explore without any animal welfare implications.

Experienced veterinarians rated the haptic properties of the anatomical structures in relation to shape, size and feel. The pelvic brim was well represented and considered to be a useful landmark as the veterinary surgeon can direct the student either forward or back from this point. The cervix required further development and was changed from a circular to an oval cross section, but it also felt too firm. The uterus was adequately modelled, although the size was closer to that of a heifer than an older cow. Certain ovarian structures were well represented, the anoestrus ovaries particularly, while the follicle requires further work. The eight and ten-week pregnancies were well rated, although the eight-week pregnancy needed to be slightly larger.

The graphic representation of anatomical structures was considered to be adequate, as this was for a veterinary surgeon, not a student. Other comments related to the limitations associated with the PHANToM thimble attachment, a one-finger device. This was considered to be less than ideal, although not as much of a problem as initially expected. Seven out of nine considered using one finger to explore the haptic scene was adequate and five reported perceiving feedback from the whole hand. Interaction with the haptic device through the fibreglass model of the rear half of a cow was thought to improve the realism and enhance the learning environment.
The student feedback was quite positive and is summarised in Table 1.

Table 1. Evaluation feedback from the seventeen veterinary students

After haptic training your performance rectalling cows:			
Greatly improved	Slightly improved	No change	Deteriorated
12	5	0	0
Haptic training before examining real cows would be helpful:			
Definitely	Maybe	No	
17	0	0	

6 Discussion

There are difficulties associated with learning and teaching bovine rectal palpation. A computer based teaching tool was developed to complement methods currently available during the undergraduate curriculum. The bovine rectal palpation simulator allows the teacher to give guidance and the student to develop skills while exploring the virtual pelvic and reproductive scenes. The levels within the program support the initial learning process of pre-clinical students and enhance the skills of more experienced students. The range of options allows students to experience various scenarios with more flexibility than physical models or real cows.

Evaluation of the haptic teaching tool with veterinary surgeons and students demonstrated that bovine rectal palpation can be simulated in a virtual environment. The students' feedback suggested that their performance rectalling cows improved as a result of haptic training.

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