

Preliminary Evaluation of Learning Performance of the Simplest Bovine Trans-rectal Palpation Phantom for Training Veterinary Students

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Abstract

Traditionally, animal exploitation in veterinary education in disciplines such as obstetrics is common worldwide. In addition, it is clear that veterinary schools are expected to provide sufficient opportunity for developing students' necessary skill in bovine trans-rectal palpation by graduation. However, the veterinary medical education should be refined and animal exploitation in education be superseded by using non-harmful alternatives. Thus, a phantom was developed as a potential alternative to overcome the present educational problem in Bu-Ali Sina University. The phantom was composed of a fiberglass rear-half of the cow that was designed with detailed inside structures of pelvis and abdominal cavity of cow. Two opening on the cranial and dorsal aspects of the phantom were made to provide proper guidance while an instructor followed a student's hand movement. By installing a slaughterhouse-derived cow reproductive tract inside the pelvis and a real rectum above it, an approximately real environment was provided. To find out how it can be useful in the training of students on cow trans-rectal examination, 31 veterinary theriogenologists and 110 fifth-year veterinary students were asked to fill out a developed attitude questionnaire anonymously. The results of instructors' and students' responses to the questionnaire indicated that the Phantom provided approximately a realistic physical environment and a comfortable and satisfying approach for teaching/learning cow trans-rectal examination. Accordingly, we can embed the phantom as a supplementary teaching tool in the bovine reproduction course of veterinary medical curriculum.

Keywords: Cow, Bovine trans-rectal palpation, Education, Phantom, Slaughterhouse-derived reproductive tract

Introduction

Contemporary dairy and beef farming focus on combining high production with acceptable fertility.

Therefore, the early diagnosis of reproductive disorders and early detection of pregnancy are critical points for improving a herd's production status. Thus, trans-rectal examination of genital apparatus is

considered central to bovine reproduction examination in veterinary medicine practice (Bossaert *et al.* 2009). Accordingly, knowing the trans-rectal examination is an indispensable skill for veterinarians.

In the traditional didactic program, teaching of trans-rectal palpation to veterinary students is carried out in live cows. In addition to this fact that it is an extremely expensive training method in any department of theriogenology and that the ever-growing financial burden affects the budget of veterinary medical schools, there are several reports about risk of abortion or animal death due to rectal palpation, particularly when it is carried out by novice students (Bossaert *et al.* 2009). If the financial problems are accepted even in part, animal exploitation in education should be superseded by using non-harmful alternatives because it is strongly against the animal rights.

To that end, some alternative educational methods have been considered to compensate insufficient traditional training in veterinary medical curriculum. Educational simulation has emerged at the forefront of technologies and processes when it comes to the education and training of veterinary medical students (Salazar, 2002).

Many studies have indicated that the use of simulators, compared to the traditional hands-on methods, provides comparable results (Akpan, 2001; Bernardo, 2003; Scherzer *et al.* 2010). Other researchers, nevertheless, argue against these alternatives and claim that 3D virtual reality modalities, Haptic technology, computer simulations and high quality videos are not comparable with real touch of tissues and organs (Akpan, 2001; Aziz *et al.* 2002). They claim that throughout the training,

students should be able to know how to use their hands and they should develop their touch-based skills (Older, 2004). This is due to the fact that this sense is a very important means of apprehending substantial reality and that the most tangible evidence of the actual existence in our environment is touch-based (Aziz *et al.* 2002; Older, 2004; Wolkomir, 2000).

Although developing such skills in the students of veterinary medicine is necessary, there are few animal simulators designed specifically for using in veterinary education and it may incite the further development of such technologies (Scalese and Issenberg, 2005).

Development of cow trans-rectal palpation simulators has long been considered by researchers. For example, Bovine Rectal Palpation Simulator (at the University of Glasgow, UK, 2003) and Real-time Visio-Haptic Deformable Bovine Rectal Palpation Simulator (at the Universiti Teknologi PETRONAS, Malaysia, 2010) have been developed as the teaching tools to supplement the existing training methods (Ahmad and Sulaiman, 2010; Baillie *et al.* 2003). These simulators involving a phantom haptic device have focused on basic fertility examination and diagnosis pregnancy skills, such as touching a virtual cervix, uterus and ovaries (Ahmad and Sulaiman, 2010; Baillie *et al.* 2005). Recently, the Breed'n Betsy simulation model, consisting of an artificial cow's pelvis surrounded by a metal frame, in which an artificial vulva and anal sphincter are installed, has been developed (Bossaert *et al.* 2009).

It is clear that they cannot provide the whole predictable conditions in a real reproductive system examination and a real cow should be used to learn

complete procedure (Kustritz *et al.* 2009). Furthermore, simulators are very expensive and cannot provide all anatomical variations (Aziz *et al.* 2002).

As a remedy, a Bovine Trans-rectal Palpation Phantom has been developed in Bu-Ali Sina University as the simplest and the most affordable supplementary teaching tool for training the manual bovine trans-rectal examination. Although the use of models in veterinary education was demonstrated as a method accordance with animal welfare considerations (Knight, 2008), it follows that the study aimed to determine the preliminary validation of this phantom as a proper supplementary teaching tool to embed in the bovine reproduction course of veterinary medical curriculum.

Materials and methods

Materials

The Bovine Trans-rectal Palpation Phantom was composed of a fiberglass rear-half of the cow that was designed with detailed inside structures of pelvis and abdominal cavity and was based on the anatomy of a dual-purpose Iranian-Holstein mixed breed (Fig. 1). Also, at the caudal part of its body, two openings were built as anus and vulva. In addition, three hooks were installed to secure a slaughterhouse-derived rectum in its anatomic location above the vagina. For installing a slaughterhouse-derived reproductive tract of cow, inside the pelvis and ventral to the rectum, a rigid pipe was attached proximal to the opening of vulva (Fig. 2). Cranial and dorsal parts of phantom were open to provide proper guidance while an

instructor followed a student's hand movement inside the pelvis (Fig. 3).

Purpose

The validation strategy for this phantom was aimed towards answering three basic research questions according to users' opinions:

1: Can practice with the Bovine Trans-rectal Palpation Phantom simulate performance in actual environment for teaching/learning purpose?

2: Is the learning practice made comfortable by using this phantom?

3: Is there any learning satisfaction when the phantom is used for teaching the manual trans-rectal palpation?

Data Collection Procedure

The descriptive-survey involved fifth-year veterinary students and veterinary theriogenologists. During the first stage of the study, students were theoretically taught by using just traditional materials. In the following stage, the Bovine Trans-rectal Palpation Phantom was embedded in the lecture materials. In the third stage, students performed trans-rectal palpation under close supervision on-farm situation. Finally, based on Cochran formula, 31 instructors (theriogenologists) and 110 fifth-year veterinary students were selected from the population by employing simple random sampling. All instructors and students were asked to fill out questionnaires developed and distributed among them and analyzed anonymously. They responded to

statements that assessed the reality (10 questions), comfortable learning (6 questions) and learning satisfaction (8 questions). The modal response was in the form of a Likert scale, consisting of five categories and ranging from "Very Much" (score 5) to "Very Little" (score 1) for all of the statements.

Data Analysis

Content validity of questionnaires was confirmed by 16 experts of veterinary theriogenology and educational measurement. The results of Cronbach alpha (0.86) indicated high reliability of the questionnaires. The results of Kolmogorov-Smirnov test showed that the distribution of the data was normal. Since the research adopted interval scale and the data was normal, the researcher employed one-sample t-test. To calculate the assumed mean for each variable, the number of the questions was multiplied by the mean of total responses ranging from 5 (very much) to 1 (very little). Accordingly, the assumed means calculated were 30, 30 and 24 for feeling reality, comfortable learning and learning satisfaction respectively. The calculated mean was equal to the mean of the total responses provided by the participants filling out the questionnaire. The data was submitted to SPSS (version 18) in order to calculate the t-test.

Results

The male teachers (n=31/31) and 97 students (43/97 men and 54/97 women) responded to the

questionnaire. The findings showed that there were no significant differences between men and women concerning all responses ($p < 0.001$).

According to Table 1, the values of "t" at the level of $\alpha = 0.001$ are more than "critical t values" indicating significant differences between calculated mean values and hypothetical mean values in both groups of instructors and trainees. Because the calculated mean values (in both groups) are more than the hypothetical mean value (=30), we can conclude that the phantom can create approximately realistic physical environment. Furthermore, Table 2 shows that the values of "t" at the level of $\alpha = 0.001$ are more than "critical t values" that indicate significant differences between calculated mean values and hypothetical mean values in both groups. Because the calculated mean values (based on instructors' and trainees' opinions) are more than the hypothetical mean value (=30), it can be concluded that learning of the cow trans-rectal examination using this device is very comfortable. Moreover, Table 3 reveals the learning satisfaction on the basis of users' opinions, because the values of "t" at the level of $\alpha = 0.001$ are more than "critical t values" indicating significant differences between calculated mean values and hypothetical mean values in both groups. Because the calculated mean values (based on instructors' and trainees' opinions) are more than the hypothetical mean value (=24), it can be concluded that there is a learning satisfaction when phantom is used.

Table 1. T-values for both groups' feeling of reality

Groups	frequency	Calculated mean value	Standard deviation	Hypothetical mean value	t	P value
Instructors	31	37.16	9.88	30	4.03	<0.001
Trainees	97	34.21	7.30	30	5.67	<0.001

Table 2. T-values for both groups' feeling of comfort

Groups	frequency	Calculated mean value	Standard deviation	Hypothetical mean value	t	P value
Instructors	31	22.35	3.14	30	7.73	<0.001
Trainees	97	21.97	3.15	30	12.39	<0.001

Table 3. T-values for both groups' learning satisfaction

Groups	frequency	Calculated mean value	Standard deviation	Hypothetical mean value	t	P value
Instructors	31	33.32	4.30	24	8.18	<0.001
Trainees	97	34.21	3.18	24	14.44	<0.001



Figure 1: The Bovine Trans-Rectal Palpation Phantom has been designed with detailed inside structures of pelvis and was based on the anatomy of a dual-purpose Iranian-Holstein mixed breed.



Figure 2: For installing a slaughterhouse-derived reproductive tract of cow, inside the pelvis and ventral to the rectum, a rigid pipe was attached proximal to the opening of vulva.



Figure 3: Cranial and dorsal parts of phantom are open to provide proper guidance while instructor follows the student's hand movement inside the pelvis.

Discussion

The manual trans-rectal palpation is a common veterinary practice applied to reproduction programs management because accessibility of reproductive structure from rectum is an easy, cost-effective, accurate and efficient method. Thus, it should be acquired by veterinary students, especially if they expect a professional career in bovine reproduction (Simões, 2012). A traditional method for the purpose of training students involves using live animals in slaughterhouses (Lopes and Rocha, 2006). It is a traumatic and stressful situation for

animals; however, in the slaughterhouses, minimized stress for animals should be provided just before they are dead. Some partial solutions for the student training purposes were studied, like the use of the 3D animations (Scherzer *et al.* 2010) or computer assisted learning without living cows. In response to the need for finding the ways of supplementing existing methods for training veterinary students to perform bovine trans-rectal palpation with animal welfare considerations, a Bovine Trans-rectal Palpation Phantom has been developed as a potential solution.

Probably, using the Bovine Trans-rectal Palpation Phantom, like other simulators, can provide a standardized experience for all trainees without showing unpredictable behaviors such as fatigue.

Moreover, it can be readily available at any time and place without the limitation in the number of examinations allowed. Due to the fact that the simulation represents a safe environment and there are no bad consequences when the trainees make mistakes, they can learn from their mistakes and correct them in simulation environment. Another issue that is closely related to safety is animal welfare considerations that may raise some ethical questions about the exploitation of a real patient as an educational resource while the simulator does not have the same ethical and welfare limitations.

Although cadaver is mostly applicable in the teaching of anatomy, in the traditional bovine reproductive teaching, live cows are used (Aziz *et al.* 2002; Lopes and Rocha, 2006), because the understanding of anatomy of live organs and anatomical variations are very important components (Zucconi *et al.* 2002). However, most of simulators cannot create environment just like real-life (Aziz *et al.* 2002; Older, 2004). For instance, the users' comments (trainees and teachers) of the Bovine Rectal Palpation Simulator at the University of Glasgow indicated that the

subjects have not felt a full reality of the rectal environment because of the absence of feces and peristaltic contractions. Another limitation is related to trainees' single finger contact with haptic device because detailed examination of ovaries and membrane slip requires the use of all fingers (Baillie *et al.* 2005). Thus, these limitations reduce the fidelity of this simulator.

To compensate this deficiency, the Bovine Trans-rectal Palpation Phantom was equipped with a slaughterhouse-derived real bovine reproductive organ. Accordingly, there is no limitation to palpate the whole of reproductive tract by all fingers that provide high-fidelity three-dimensional interaction for examiner. The results of Table 1 show that instructors and trainees felt a realistic environment when they used the phantom, although there were some comments claiming that it was better if there was a broad ligament and free border of broad ligament could be found. Furthermore, while instructors can provide the students with the sessions for any states of reproduction cycle and gestation status, the Bovine Rectal Palpation Simulator at the University of Glasgow and the Real-time Visio-Haptic Bovine Rectal Palpation Simulator at the Universiti Teknologi PETRONAS can only conduct basic skills in the trans-rectal palpation independently of the complete procedure of fertility examinations, diagnosis

pregnancy and some anatomical variations (Ahmad and Sulaiman, 2010; Baillie *et al.* 2003).

According to the users' comments (trainees and teachers) of the phantom in the present research and other studies, the cow trans-rectal palpation is difficult to learn and perform by novice veterinary students and requires repetitive practice to get more experience in the identification of structures palpated (Baillie *et al.* 2005; Penny, 2002). Thus, during the teaching trans-rectal palpation with a real cow, the teacher should provide the students guidance as they perform the procedure (Simões, 2012). However, providing effective guidance can be difficult because the students' hand movement is not visible and they cannot describe the palpated structures carefully; therefore, the teaching method can be both limited and variable by using live cow (Baillie *et al.* 2005). According to the instructors and students, the teacher is able to provide more effective guidance and feedback on their performance during the training by this device via following the student's hand movement. It was confirmed on users' opinions.

Although some comments of students and instructors who have used the Bovine Trans-rectal Palpation Phantom stressed the appropriacy of the device for learning trans-rectal palpation (Table 3), they mentioned that it was not sufficient by itself. This

limitation is not unique to our study but true for other devices in this field too (Bossaert *et al.* 2009). We should consider the potentiality of this device to supplement the existing teaching methods.

Since this device will enable students to make more effective use of animals as a learning resource, bovine trans-rectal palpation course should be comprised of several stages (Knight, 2007). At first, students learn the procedure theoretically. Then, they progress to simulated procedure by the Bovine Trans-rectal Palpation Phantom. Finally, students perform trans-rectal palpation under close supervision on-farm situation for practical concerns. According to the comments written by the instructors and students, this phantom illustrated some additional benefits including time and cost savings, increased student confidence and the saving of substantial numbers of animal lives who might be injured throughout veterinary courses (Simões, 2012).

It is expected to embed the supplementary teaching tools in veterinary curriculum and emphasize the use of these devices to develop student's understands of animal welfare science and animal welfare issues, not only during their education but throughout their entire professional career.

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