Ability of a bovine transrectal palpation objective structured clinical examination to predict veterinary students' pregnancy diagnosis accuracy

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Abstract

Bovine pregnancy diagnosis (PD) by transrectal palpation (TRP) is one of the most frequently performed procedures in bovine practice, and an important competency for veterinary graduates. It is currently not known if pre-existing TRP skills on non-pregnant cows can be used to predict students' future PD accuracy. The study objective was to evaluate if TRP objective structured clinical examination (OSCE) scores can predict students' future PD accuracy.

Fourth year (of a six-year programme) veterinary students (n=128) received TRP and PD training on Breed'n Betsy (BB) simulators and live cows. Students' TRP skills were assessed using a live cow TRP OSCE after completion of the fourth year training. The same students received additional TRP (BB and live cows) and PD (BB) training sessions in the first semester of their fifth year. PD accuracy was assessed after the additional TRP and PD training, five months after the TRP OSCE assessment and measured as sensitivity and specificity (the ability to correctly identify the presence and absence of pregnancy, respectively). Each student palpated six cows transrectally to diagnose pregnancy status and stage for the PD assessment. The TRP OSCE results were analysed as predictors for students' PD accuracy.

Students with 'competent palpation skills' on the TRP OSCE had higher PD specificity. The individual OSCE components that were predictive of higher PD accuracy were students' ability to estimate ovarian size, identify uterine position and exclude intrauterine fluid. It was concluded that a TRP OSCE has the ability to predict students' future PD accuracy.

Introduction

Bovine pregnancy diagnosis (PD) by transrectal palpation (TRP) is widely used in veterinary practice and is of economic importance.[1–4] It is also one of the most frequently performed procedures in bovine practice,[5] and therefore an important competency for veterinary graduates.[6] Bovine TRP and PD training is challenging since it requires extensive exposure to TRP in live cows to ensure competency.[7 8] However, limited resources, increasing student numbers, availability of teaching animals and welfare issues reduce training opportunities on live animals in general,[9] and thus influence PD training for veterinary students. Furthermore, it seems difficult for students to get additional bovine PD and TRP exposure outside the veterinary course.[10]

Several studies have evaluated the use of simulators and live cows in an effort to improve bovine TRP training.[7 8 10–15] The effectiveness of simulators such as the Breed'n Betsy (BB; Brad Pickford, Australia, http:// www.breednbetsy.com.au/) and the Haptic Cow (Virtalis, Cheshire, UK, https:// www.virtalis. com/haptic-cow/) to teach TRP and PD skills has been explored.[7 10–15] The use of a TRP simulator is superior to theoretical instruction only,[11 14] but live cow training

in conjunction with simulator training is advised to optimise learning outcomes.[10 11 14]

French *et al* have investigated different methods for TRP training on live cattle.[8] This study concluded that having students identify specific reproductive landmarks such as the cervix and uterine horns with quantitative size measurements and choosing cows that are easy to handle have a positive impact on student training.[8] Reported overall PD accuracy (pregnancy status and stage) of students is lower than what is considered acceptable accuracy for veterinarians.[10 16–19] Student specificity (correctly identify non-pregnant cows) was lower than sensitivity (correctly identify pregnant cows) and additional student training on non-pregnant cows could be a strategy to improve the necessary palpation skills.[10] However, it is not known if pre-existing TRP skills on non-pregnant cows can be used to predict future PD accuracy.

Objective structured clinical examinations (OSCE) are used to test clinical skills.[20–25] A wide range of clinical skills can be tested under simulated examination conditions evaluating the candidate's practical competence. However, practical competence is not the same as clinical performance.[25] Since OSCEs are conducted under simulated examination conditions, they do not provide valid information on the candidate's ability to perform the skill in real-life situations.[25] For example, the performance level of Dutch general practitioners was lower than their competence level based on OSCE assessments.[26]

Bovine PD via TRP is the practical application of TRP skills that students acquire via TRP training. The objective of this study was to determine if OSCE scores on bovine TRPs (competence) can be used as predictors for students' future bovine PD accuracy (performance). It was hypothesised that palpation competency level based on OSCE scores is predictive of students' subsequent PD accuracy. Another aim of the study was to examine if the TRP OSCE is a valid and reliable assessment for TRP skills of veterinary students.

Materials and methods
Student TRP and PD training
The fourth year veterinary curriculum of the University of Pretoria's six-year programme includes a one-year module on veterinary reproduction of all domestic species.[27] Bovine, small stock, small animal and equine reproduction are taught separately throughout the year and one examination at the end of the year assesses knowledge and skills for all species. The bovine part of the veterinary reproduction module covers aspects of male and female theriogenology, of which TRP and PD is one part. The 2015 fourth year TRP and PD practical training consisted of three sessions. The first TRP training session included three components: inspection of abattoir-obtained female reproductive organs, palpation of non-pregnant BB models and

palpation of non-pregnant live cows with facilitator guidance. The abattoir-obtained reproductive organs included non-pregnant uteri as well as a variety of pregnant uteri of various pregnancy stages. The variety of abattoir reproductive organs was fairly similar for all student groups. The first TRP training session was presented either before or just after the theoretical lectures on PD. The second and third practical TRP training sessions followed two to three months after the theory component of PD. The second TRP training session consisted of bovine PD via TRP on BB models. The BB simulators were set up using the seven different uteri models to allow for palpation of weekly pregnancy stages from 6 to 11 weeks, and four to five months of gestation.[10] The third TRP training session consisted of bovine PD via TRP on live cows (one week after the PD training on BB models). Training focused on pregnancy status determination (pregnant or not pregnant) and estimating stage of pregnancy. During the palpation training, students were encouraged to measure the width of their fingers and hand and practise estimating sizes of structures that were palpated. Students performed an average of five non-pregnant TRPs on live cows and BBs and an average of 16 pregnant TRPs on live cows and BBs during the training module. No cow was palpated more than three times during any of the training sessions.

Reproduction module and TRP assessment
Students had to pass an examination at the end of the reproduction module consisting of theory assessment via computer-based testing and practical skills assessment in an OSCE examination consisting of two OSCE stations (figure 1). Students knew which OSCE stations they might be subjected to and that all students would be assessed at the bovine TRP OSCE station. Students had access to the OSCE marking sheets before the examination. Examination time was restricted to 10 minutes per OSCE station. For all students, 'Station one' was bovine TRP on a live cow where each student palpated one live cow and wrote down his or her findings on an OSCE marking sheet (figure 2). The OSCE marking sheet was handed to the student before the palpation. No cow was palpated more than three times. The TRP findings on cows used during the OSCE examination were predetermined by two specialist veterinary examiners experienced in bovine TRP. None of the cows used on the day of the OSCE examination was pregnant or showed any reproductive abnormalities such as intrauterine fluid accumulation. Fifteen marks for the TRP OSCE station were allocated for correctly inserting the hand into the rectum; identifying uterine position and tone, location and estimation of the diameter of the cervix, symmetry of the uterine horns, ovarian size, ovarian structures (corpus luteum and follicle for left and right ovaries), pregnancy (yes/no) and, if yes, staging of the pregnancy (figure 2). Scores were assigned to the
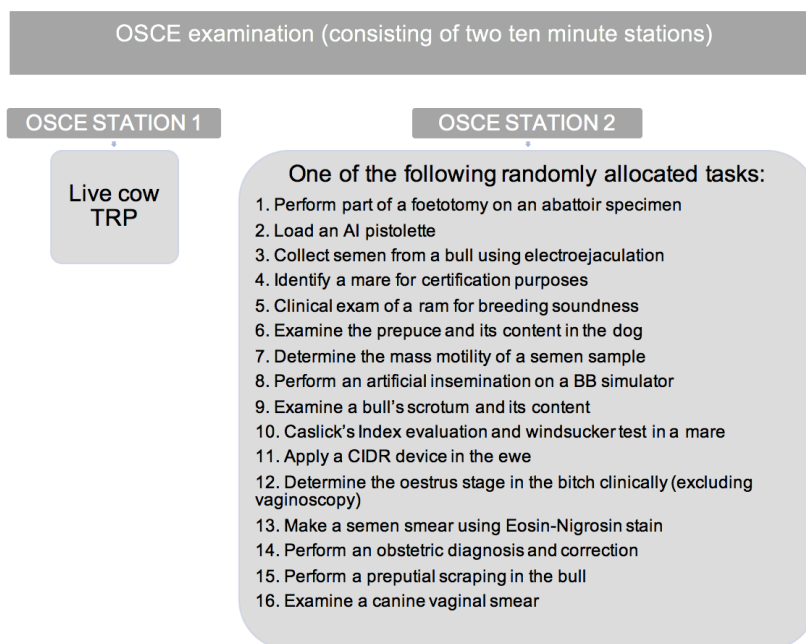
Figure 1 Reproduction module OSCE set-up for 128 fourth year students in November 2015. BB, Breed'n Betsy; OSCE, objective structured clinical examination; TRP, transrectal palpation; AI, artificial insemination; CIDR, controlled internal drug release.

OSCE marking sheet as follows: one mark was scored for each finding of the student who agreed with that of the examiners, and in the case of reproductive organ and ovarian structure sizes, students were assigned the score if their finding was within 1 cm of the examiners' findings.

The nine scores that evaluated palpation skills (size and position of the cervix; size, tone and symmetry of uterine horns; size and presence of pertinent structures on the ovaries) were ordinally transformed: no palpation skills (0−1/9), deficient palpation skills (2 - 3/9), some palpation skills (4 - 5/9), good palpation skills (6 - 7/9) and competent in palpation (8 - 9/9) (table 1). This was

given as feedback to the students by the assessors on ClickUP (the Blackboard Learning Management Tool of the University of Pretoria) after completion of the examination.

Study design and participants

The same veterinary students (n=128) received additional supervised bovine TRP training during their fifth year, four months after the TRP OSCE examination (figure 3). The additional bovine TRP training consisted of three training sessions. Training session 1 consisted of palpation of non-pregnant BB models. Training session 2 involved non-pregnant live cow palpations.

Figure 2 Objective structured clinical examination (OSCE) marking sheet for the bovine transrectal palpation (TRP) station filled in by 128 fourth year veterinary students in November 2015. Students recorded their TRP findings by ticking the correct option on the OSCE marking sheet and writing down their findings where applicable. CL, corpus luteum; F, follicle.

Table 1 Categorisation of palpation skills for student feedback purposes. To determine the palpation skills level only the points of the objective structured clinical examination (OSCE) sheet were considered that actually measured students' ability to palpate. Maximum possible score was 9

Scores*	Palpation skill categorisation
0–1	No palpation skills
2–3	Deficient palpation skills
4–5	Some palpation skills
6–7	Good palpation skills
8–9	Competent in palpation

*Scores included to determine palpation skill categorisation:
1. Did the student correctly identify the position of the uterus (intrapelvic/intra-abdominal/partially intra-abdominal)?
2. Did the student correctly indicate the tone of the uterine horns (high/moderate/low)?
3. Did the student estimate the diameter of the cervix within 1 cm of the actual measure (as determined by two experienced veterinarians)?
4. Did the student correctly identify the presence or absence of asymmetry between the uterine horns?
5. Did the student correctly identify the length of both ovaries within 1 cm of the actual measure (as determined by two experienced veterinarians)?
6. Did the student correctly identify the presence or absence of a palpable corpus luteum on the left ovary?
7. Did the student correctly identify the presence or absence of a palpable corpus luteum on the right ovary?
8. Did the student correctly identify the presence or absence of a follicle >9 mm on the left ovary?
9. Did the student correctly identify the presence or absence of a follicle >9 mm on the right ovary?

No cow was palpated more than three times during the additional training. Training session 3 entailed bovine PD via TRP on BB models. The BB simulators were set up using the seven different uteri models to allow for palpation of weekly pregnancy stages from 6 to 11 weeks, and four to five months of gestation.[10]

All students visited a commercial Nguni beef cattle herd three weeks after training where their accuracy to correctly diagnose pregnancy status and stage by TRP was assessed. Each student was allowed 12 minutes to palpate a total of six cows transrectally of which the pregnancy status and stage was predetermined by a specialist veterinarian with more than 10 years of experience (a second specialist was available to confirm findings in case of doubt on pregnancy status or stage). Individual cows were palpated by a maximum of three students (figure 4). Students were blinded to each other's diagnoses. Cows were not formally randomised but taken into the crush in a convenient manner out of a group of available cows. Each cow was only used and palpated on one of the three assessment days.

Data analysis

Data per palpation performed were transferred from individual data capture sheets into a computer spreadsheet. Categorical data were described as frequencies, proportions and 95% CIs. Student's overall accuracy of PD was estimated as the proportion of correct diagnoses (pregnant or not pregnant, and correct staging of pregnancy where applicable according to the experienced veterinarian). Sensitivity was defined as the proportion of cows determined to be pregnant by the specialist veterinarian that were correctly identified by the student. Specificity was defined as the proportion of non-pregnant cows as determined by the specialist veterinarian correctly identified by the student. Sensitivity and specificity were estimated using a generalised linear model assuming a binomial error distribution and included random effects terms for students (each student examined multiple cows) and individual cows (the same cow was examined by up to three students). The effects of student's practical assessment scores on estimates of sensitivity and specificity were evaluated using univariate logistic regression. OSCE reliability was assessed by estimating Cronbach's alpha. Commercial software was used for all statistical analyses (IBM SPSS Statistics V.24, International Business Machines) and results were interpreted at the 5 per cent level of significance.

Results

The study population consisted of 128 fifth year veterinary students of which 96 students were female and 32 were male (75 and 25 per cent, respectively).

All 128 students had passed the Veterinary Reproduction module during their fourth year of study (2015). Based on the bovine TRP OSCE station results from November 2015, eighteen students (14.1 per cent) had no palpation skills; 26 students (20.3 per cent) had deficient palpation skills; 35 students (27.3 per cent) had some palpation skills; 35 students (27.3 per cent) had good palpation skills; and 14 students (10.9 per cent) had competent palpation skills (figure 5).

On the day of the practical PD assessment five months after the bovine TRP OSCE examination, 374/771 (49 per cent) student palpations were performed on pregnant
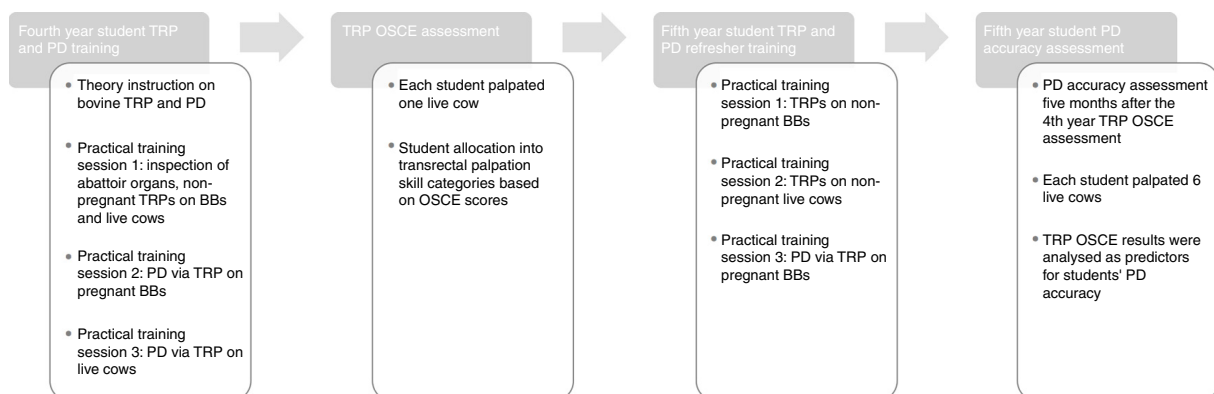

Figure 3 Schematic display of the fourth and fifth year TRP and PD training and assessment for 128 veterinary students. BB, Breed'n Betsy; OSCE, objective structured clinical examination; PD, pregnancy diagnosis; TRP, transrectal palpation.
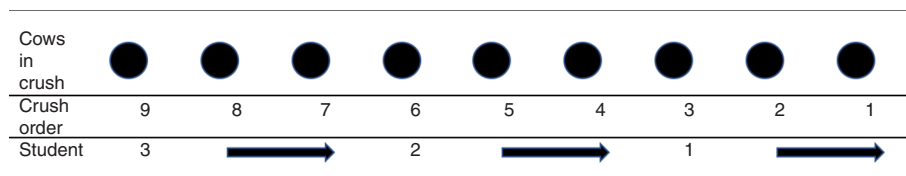
Figure 4 Schematic display of cow allocation to students. Nine cows were taken into the examination crush at the same time. The specialist veterinarian wrote down cow crush order, individual cows' identification and which cows were allocated to which student on a spreadsheet. Three students were allocated to palpate at the same time. Student 1 started at cow 3 to palpate cows 3, 2, 1, 9, 8 and 7. Student 2 started at cow 6 to palpate cows 6 to 1. Student 3 started at cow 9 to palpate cows 9 to 4. Each student noted crush order of palpated cows, individual cows' identifications and their PD findings on a data collection sheet. This data collection sheet was handed to the specialist veterinarian by the student on completion of the TRPs. Each cow was palpated by two students and subsequently by the specialist veterinarian. New cows were then taken into the crush for the next students.

cows, of which 262 were on cows less than six months (70 per cent) pregnant and 112 were on cows at least six months (30 per cent) pregnant. The remaining 397 student palpations were performed on non-pregnant cows. One hundred and twenty-five students palpated six cows in the 12 minutes' time limit. One student did not finish on time and only palpated five cows. Two students only examined non-pregnant cows initially and were subsequently assigned two pregnant cow palpations. This occurred because the order that cows entered the crush was haphazard without consideration of pregnancy status.

Compared with the diagnoses provided by the experienced veterinarian, the mean overall student accuracy of PD was 61% (95% CI 55% to 65%) for pregnancy status alone and 31% (95% CI 27% to 36%) for pregnancy status with correct stage. The mean sensitivity (to correctly identify pregnant cows) was 79% (95% CI 73% to 83%). The mean specificity (to correctly identify non-pregnant cows) was 42% (95% CI 35% to 49%). The student's ability to correctly estimate ovary dimensions during the previous OSCE was positively correlated to PD sensitivity (table 2). The student's ability to correctly identify uterine position, absence of intrauterine fluid and a student classification into the category 'competent palpation skills' at the time of the OSCE was positively associated with the ability to correctly identify non-pregnant cows (PD specificity) at the subsequent practical PD assessment (table 3).

Cronbach's alpha for the 15 items within the OSCE station was 0.78.

Discussion

The main finding of this study is that specific OSCE scores on bovine TRPs (competence) are predictors for students' future bovine PD accuracy (performance). This seems to be more applicable for student specificity (to correctly identify non-pregnant cows) than for sensitivity (to correctly identify pregnant cows) as 'competent palpation skills' were shown to be positively correlated to student PD specificity but not sensitivity. The only individual OSCE component predicting higher student PD sensitivity was the ability to estimate ovary dimensions. This finding is in agreement with the fact that asking students to give quantitative measurements of reproductive organs during bovine TRPs was found to have a positive effect on student TRP training.[8] In order to accurately estimate ovarian size, students must be able to find the ovaries by following the uterine horns, fixing them and feel around them to give a size estimate. This skill is more advanced than simply locating the cervix and uterus. Therefore, students who are able to do that should be more successful at identifying pregnant cows as well. The ability to locate the cervix or uterus can be mastered by more students, but this is not necessarily linked to the ability to recognise a pregnant cow. The ability to correctly identify uterine
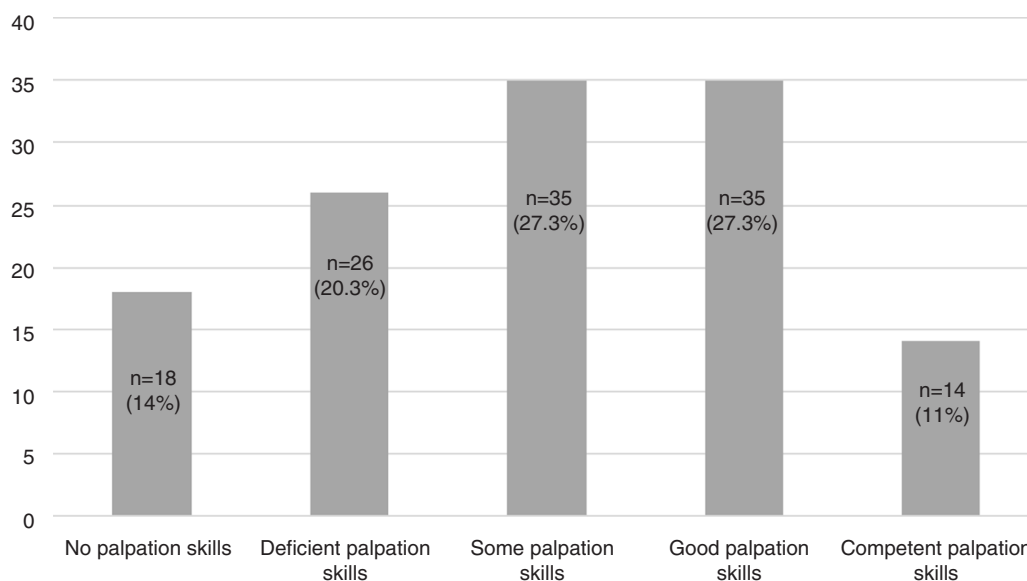

Figure 5 Number of students allocated to the individual categories of palpation skills based on the bovine transrectal palpation (TRP) objective structured clinical examination (OSCE) outcome.

Table 2 Univariate associations between student TRP OSCE assessment scores and pregnancy diagnosis sensitivity for 128 veterinary students in South Africa

Variable	Parameter estimate (β)	OR (95% CI)	P value
Hand	−0.476	0.62 (0.12 to 3.14)	0.564
Cervix position	0.058	1.06 (0.53 to 2.12)	0.869
Uterus position	−0.353	0.70 (0.41 to 1.20)	0.194
Uterine tone	0.331	1.39 (0.81 to 2.39)	0.228
Cervix diameter	−0.433	0.65 (0.37 to 1.14)	0.133
Symmetry of uterine horns	−0.183	0.83 (0.49 to 1.43)	0.505
Uterus diameter	−0.166	0.85 (0.49 to 1.45)	0.546
Intrauterine fluid	−0.013	0.99 (0.56 to 1.75)	0.965
Ovary dimensions	0.669	1.95 (1.10 to 3.48)	0.023
Corpus luteum left	0.441	1.56 (0.90 to 2.69)	0.113
Corpus luteum right	0.137	1.15 (0.67 to 1.97)	0.618
Follicle left	0.217	1.24 (0.72 to 2.13)	0.430
Follicle right	−0.042	0.96 (0.56 to 1.64)	0.877
Total*	−0.006	0.99 (0.92 to 1.07)	0.874
Palpation skills†	0.031	1.03 (0.87 to 1.22)	0.715
Competent palpation skills‡	0.183	1.20 (0.47 to 3.04)	0.699

*Sum of the 15 individual assessment components and modelled as a continuous predictor.
†Ordinal scale skill left assessed by lecturer and analysed as a continuous predictor.
‡The highest ordinal category compared with all other lower categories.
OSCE, objective structured clinical examination; TRP, transrectal palpation.

position, absence of intrauterine fluid and a student classification into the category 'competent palpation skills' was positively correlated to the ability to correctly identify non-pregnant cows. The ability to correctly identify uterine position as intrapelvic or intra-abdominal is a necessary skill to identify a pregnancy and the stage thereof and indirectly linked to the ability to make the diagnosis of non-pregnancy. The same holds true for the more advanced rectal palpation skill to correctly identify absence of fluid in the uterus. This skill is necessary to identify early pregnancies, and therefore indirectly necessary to exclude

Table 3 Univariate associations between student TRP OSCE assessment scores and pregnancy diagnosis specificity for 128 veterinary students in South Africa

Variable	Parameter estimate (β)	OR (95% CI)	P value
Hand	0.600	1.82 (0.31 to 10.8)	0.507
Cervix position	−0.045	0.96 (0.46 to 1.99)	0.904
Uterus position	0.678	1.97 (1.12 to 3.47)	0.019
Uterine tone	0.335	1.40 (0.79 to 2.47)	0.247
Cervix diameter	0.492	1.64 (0.89 to 3.02)	0.114
Symmetry of uterine horns	0.162	1.18 (0.67 to 2.08)	0.576
Uterus diameter	0.360	1.43 (0.81 to 2.53)	0.215
Intrauterine fluid	0.793	2.21 (1.23 to 3.98)	0.008
Ovary dimensions	0.304	1.36 (0.76 to 2.42)	0.303
Corpus luteum left	0.305	1.36 (0.77 to 2.39)	0.291
Corpus luteum right	−0.267	0.77 (0.44 to 1.35)	0.355
Follicle left	0.527	1.69 (0.96 to 3.00)	0.072
Follicle right	0.482	1.62 (0.92 to 2.86)	0.095
Total*	0.077	1.08 (1.00 to 1.17)	0.054
Palpation skills†	0.155	1.17 (0.98 to 1.39)	0.077
Competent palpation skills‡	1.109	3.03 (1.26 to 7.29)	0.013

*Sum of the 15 individual assessment components and modelled as a continuous predictor.
†Ordinal scale skill left assessed by lecturer and analysed as a continuous predictor.
‡The highest ordinal category compared with all other lower categories.
OSCE, objective structured clinical examination; TRP, transrectal palpation.

pregnancy and confirm a cow to be non-pregnant. Since no cows were pregnant or had uterine pathologies such as intrauterine fluid accumulations on the day of the OSCE examination, it can be assumed that 'guess work' influenced the students' decisions when they indicated that there was fluid in the uterus. If they said there is no fluid in the uterus, it either meant that they can palpate the absence of fluid, or that they guessed correctly. It is not surprising that students categorised as 'competent' in TRP had a higher PD specificity as compared with students in all other categories. It is more difficult for students to correctly identify non-pregnant cows than pregnant cows as shown by the low PD specificity in this study and as reported previously.[10] Therefore, students with 'competent palpation skills' would be expected to have a higher PD specificity. The fact that no more individual OSCE components were predictive of sensitivity or specificity could be due to the fact that the majority of students (n=79, 62 per cent) had insufficient palpation skills (figure 5). If a higher percentage of students had sufficient palpation skills (categorised as students with good or competent palpation skills) then more individual OSCE components might have been identified. The effect of guessing on the students' side may have been reduced if more students were competent at TRP. This assumes that students would fill in OSCE marking sheets with guesses if in fact they did not palpate the structure or are unsure of their findings. The 'microscopic approach' to validity[28] could be applied to evaluate whether or not individual OSCE items are appropriate and sample the domain of interest (palpation skills in this case).[28 29] This approach evaluates validity on the fact that when item scores (individual OSCE items in this case) are valid, the total test scores (categorisation into the different palpation skill levels) should also be valid. The fact that student categorisation into 'competent palpation skills' was linked to higher PD specificity provides evidence for the OSCE validity. The reliability of an assessment is an estimation of correlation of scores on the given examination (TRP OSCE in this case) with scores on a hypothetical alternative examination or test.[30] Or in other words, reliability of an assessment is high if students who failed or passed in the evaluated assessment would be expected to also pass or fail an alternative assessment for the same skill. Alpha values across items estimate consistency of behaviour within a station and are computed using correlations between items.[30] Such an estimate would consider, for example, if students who were able to estimate cervical size were also able to estimate ovarian size correctly. A large-scale OSCE reliability meta-analysis of reported Cronbach's alpha values showed an overall mean alpha value within stations across items of 0.78 (95% CI 0.73 to 0.82).[30] The Cronbach's alpha for the 15 items within the TRP OSCE determined in this study was 0.78 which indicates reasonable[30] to very good reliability.[20]
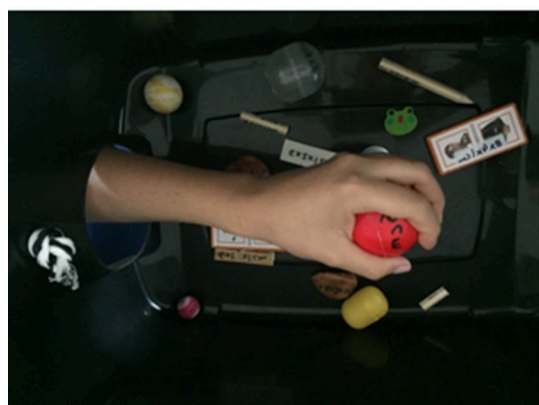
The findings of this study suggest that the student's exposure within practical sessions of the fourth year reproduction module is insufficient to ensure palpation

Figure 6 'Mini Cow Palpation Box'. (A) Modified plastic box with hand entrance holes. (B) Three-dimensional objects of varying sizes inside the box. All objects are labelled with the correct length, width and height measurements in centimetres. (C) Students using the palpation box. (D) Student instruction/information sheet on the palpation box.

competency. The fact that only 49 students (38 per cent) had either good (n=35, 27 per cent) or competent (n=14, 11 per cent) palpation skills on the day of the OSCE examination, while the majority of students (n=79, 62 per cent) had insufficient palpation skills, confirms the need for extensive exposure to TRP in live cows to ensure competency.[7 8 10] It also confirms the need to investigate into alternative bovine TRP training to improve the training outcome and provide the TRP and PD competency required of new graduates.[6]

Students' overall PD accuracy (pregnancy status alone) and PD accuracy including pregnancy status and stage was lower than what is considered acceptable accuracy for veterinarians,[16–19] and is in agreement with previous findings.[10] Overall PD accuracy for experienced large animal practitioners has been reported as high as 99.7 per cent for TRPs performed from day 35 of pregnancy, with a sensitivity of 100 per cent and a specificity of 99.4 per cent.[18] While students at this stage in their studies are not expected to perform at these accuracy levels, the reported 31 per cent overall accuracy (including pregnancy state and stage) is very low compared with the reported values of large animal practitioners. The additional palpation sessions (TRPs on non-pregnant and pregnant BBs

and non-pregnant live cows) offered to the students as 'refresher' training during their fifth year were not sufficient to ensure acceptable palpation skills. This is in accordance with previous studies,[7 10] and confirms that additional TRP exposure is essential.

Standard criteria are necessary to determine whether an assessment measures what it is supposed to measure.[28] The validity of an assessment is demonstrated by low correlations between scores of methods measuring different traits with high correlations present between methods measuring similar traits.[28] If it is assumed that measuring palpation accuracy via a TRP OSCE and testing students' PD accuracy are two methods that measure a similar trait (TRP skill), the outcome of this study provides supporting evidence for OSCE validity because the low PD accuracy is consistent with the low percentage of students with 'good or competent palpation skills'. The fact that the majority of students were not competent in TRP is an explanation of the low overall PD accuracy, sensitivity and, especially, specificity. This is further supported by the fact that student categorisation into 'competent palpation skills' was associated with higher PD specificity. An approach to improve PD training could therefore be to introduce the TRP OSCE as a formative assessment for ongoing feedback throughout the reproduction module and to make it compulsory for students to pass the TRP OSCE with 'good or competent palpation skills' before advancing to PD training on live cows. An additional approach to improve TRP competency could be implementation of focused access to live cow palpations during later stages of the curriculum. This could involve additional TRP and PD training for students intending to follow a career in food animal practice.

Furthermore, implementation of an additional teaching tool like the 'palpation box' as described by French *et al* is recommended.[8] This is based on the result of this study that the ability to estimate ovarian size was positively correlated to PD sensitivity. Such a tool might also help advance the fine motor skills necessary to accurately estimate the size of the cervix and uterine horns and to identify ovarian structures.[8] A locally manufactured 'Mini Cow Palpation Box' (figure 6) has been added to TRP training sessions at our institution. It uses three-dimensional objects varying in size from 2 to 8 cm. All objects are labelled with the correct length, width and height measurements in centimetres. The objects are placed in a plastic box with hand entrance holes to ensure palpation and size estimation of objects without visualisation.

Conclusions

A well-structured TRP OSCE has the ability to predict students' future PD accuracy. This is more applicable for specificity than sensitivity and the categorisation of students into having 'competent palpation skills' is associated with higher PD specificity. Individual OSCE components that have been identified with higher PD accuracy are students' ability to estimate ovarian size,

correctly identify uterine position and exclude intrauterine fluid. Student training should focus on these items in combination with additional palpation exposure to improve overall student PD accuracy. Furthermore, including a TRP OSCE in practical training sessions for formative feedback aiming at student improvement before advancing to PD training on live cows is recommended.

References

1 Alexander BM, Johnson MS, Guardia RO, *et al*. Embryonic loss from 30 to 60 days post breeding and the effect of palpation per rectum on pregnancy. *Theriogenology* 1995;43:551–6.
2 Romano JE, Thompson JA, Kraemer DC, *et al*. Early pregnancy diagnosis by palpation per rectum: influence on embryo/fetal viability in dairy cattle. *Theriogenology* 2007;67:486–93.
3 Romano JE, Thompson JA, Kraemer DC, *et al*. Effects of early pregnancy diagnosis by palpation per rectum on pregnancy loss in dairy cattle. *J Am Vet Med Assoc* 2011;239:668–73.
4 Romano JE, Fahning ML. Effects of early pregnancy diagnosis by per rectal palpation of the amniotic sac on pregnancy loss in dairy cattle. *J Am Vet Med Assoc* 2013;243:1462–7.
5 Morin DE, Constable PD, Troutt HF, *et al*. Individual animal medicine and animal production skills expected of entry-level veterinarians in bovine practice. *J Am Vet Med Assoc* 2002;221:959–68.
6 Luby CD, McIntyre K, Jelinski MD. Skills required of dairy veterinarians in western Canada: a survey of practicing veterinarians. *Can Vet J* 2013;54:267–70.
7 Bossaert P, Leterme L, Caluwaerts T, *et al*. Teaching transrectal palpation of the internal genital organs in cattle. *J Vet Med Educ* 2009;36:451–60.
8 French HM, Dascanio JJ, Gilbert GE, *et al*. Bovine Reproductive Palpation Training: Does the Cow Make a Difference? *J Vet Med Educ* 2018;45:219–23.
9 BAILLIE S. Utilisation of simulators in veterinary training. *Cattle Practice* 2007;15:224–8.
10 Annandale A, Annandale CH, Fosgate GT, *et al*. Training Method and Other Factors Affecting Student Accuracy in Bovine Pregnancy Diagnosis. *J Vet Med Educ* 2018;45:224–31.
11 Baillie S, Crossan A, Brewster S, *et al*. Validation of a bovine rectal palpation simulator for training veterinary students. *Stud Health Technol Inform* 2005;111:33–6.
12 Baillie S, Mellor DJ, Brewster SA, *et al*. Integrating a bovine rectal palpation simulator into an undergraduate veterinary curriculum. *J Vet Med Educ* 2005;32:79–85.
13 Baillie S, Crossan A, Brewster SA, *et al*. Evaluating an automated haptic simulator designed for veterinary students to learn bovine rectal palpation. *Simul Healthc* 2010;5:261–6.
14 Giese H, Gundelach Y, Dilly M. Simulationsbasiertes Training der transrektalen gynäkologischen Untersuchung beim Rind. Hamburg: Düsseldorf: German Medical Science GMS Publishing House, 2014.
15 Giese H, Gundelach Y, Geuenich K, *et al*. Effects of training methods for rectal palpation in cattle on student's performance and self-evaluation. Proceedings of the AMEE conference. Glasgow, UK, 2015.
16 Warnick LD, Mohammed HO, White ME, *et al*. The relationship of the interval from breeding to uterine palpation for pregnancy diagnosis with calving outcomes in holstein cows. *Theriogenology* 1995;44:811–25.
17 Oltenacu PA, Ferguson JD, Lednor AJ. Economic evaluation of pregnancy diagnosis in dairy cattle: a decision analysis approach. *J Dairy Sci* 1990;73:2826–31.
18 Romano JE, Fahning ML. Accuracy of per rectum palpation for pregnancy diagnosis in cattle. Proceedings of the XXVIII World Buiatrics Congress. Cairns, Australia, 2014.
19 Alonso-Alanusa L, Galina-Hidalgo C, Romero-Zuniga JJ, *et al*. Usefulness of rectal palpation and transrectal ultrasonography in the diagnosis of gestation of the Zebu cattle in the humid tropical in Costa Rica Utilidad de la palpacion rectal y la ecografia transrectal en el diagnostico de gestacion del ganado cebu en el tropico humedo de Costa Rica. : Facultad de Ciencias Veterinarias, Universidad del Zulia, 2012:22: 9–16.
20 Hecker K, Read EK, Vallevand A, *et al*. Assessment of first-year veterinary students' clinical skills using objective structured clinical examinations. *J Vet Med Educ* 2010;37:395–402.
21 Hodges B. Validity and the OSCE. *Med Teach* 2003;25:250–4.
22 Hodges BD. The objective structured clinical examination: three decades of development. *J Vet Med Educ* 2006;33:571–7.

23 Bark H, Shahar R. The use of the Objective Structured Clinical Examination (OSCE) in small-animal internal medicine and surgery. *J Vet Med Educ* 2006;33:588–92.

24 May SA, Head SD. Assessment of technical skills: best practices. *J Vet Med Educ* 2010;37:258–65.

25 Davis MH, Ponnamperuma GG, McAleer S, *et al*. The Objective Structured Clinical Examination (OSCE) as a determinant of veterinary clinical skills. *J Vet Med Educ* 2006;33:578–87.

26 Rethans JJ, Sturmans F, Drop R, *et al*. Assessment of the performance of general practitioners by the use of standardized (simulated) patients. *Br J Gen Pract* 1991;41:97.

27 Irons PC, Holm DE, Annandale CH. Curricular renewal at the southern tip of africa: the 2016 veterinary curriculum at the University of Pretoria. *J Vet Med Educ* 2017;44:440–9.

28 Van Der Vleuten CP. The assessment of professional competence: developments, research and practical implications. *Adv Health Sci Educ Theory Pract* 1996;1:41–67.

29 Van der Vleuten CP, Norman GR, De Graaff E. Pitfalls in the pursuit of objectivity: issues of reliability. *Med Educ* 1991;25:110–8.

30 Brannick MT, Erol-Korkmaz HT, Prewett M. A systematic review of the reliability of objective structured clinical examination scores. *Med Educ* 2011;45:1181–9.

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