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Transabdominal ultrasonographic determination of pregnancy and fetal viability in mares

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Abstract

The study was designed to evaluate the efficiency of transabdominal ultrasonographic approach for pregnancy diagnosis and monitoring the viability of fetus in mares as an alternative approach to the transrectal ultrasonography to minimize the opportunity of misdiagnosis and prevent the deleterious effect of transrectal invasive. Forty-five mares were scanned by transrectal and transabdominal ultrasonography. Results showed that 26 mares were pregnant and 19 mares were non-pregnant. The accuracy, sensitivity, specificity, the positive and negative predictive values of both approaches were 100%. Transabdominal approach required less time in comparison to transrectal ultrasonography to reach the final decision for non-pregnant mares 5.26±0.27 vs. 8.11±0.31 min, mares at second trimester 4.36±0.49 vs. 5.57±0.29 min and third trimester 4.12±0.51 vs. 5.86±0.26 min, respectively. Both methods recorded no significant correlation between the scanning time and the gestational age. The positive predictive values for determining fetal viability were 26.9% for transrectal and 80.8% for transabdominal ultrasonography. A significant variance was reported between the positive predictive values obtained by transrectal and transabdominal ultrasonography. In conclusion, the transabdominal is an effective, practical, and often essential approach of ultrasonographic for determination of pregnancy and fetal viability in mares, especially at the second and third trimesters of pregnancy. We recommended transabdominal ultrasonographic scanner as the first examination for mares presented for pregnancy diagnosis, if this approach does not accurately diagnose, the mares can be scanned transrectaly. So, we can minimize the stress and hazard of the transrectal examination.

Introduction

Determination and monitoring of pregnancy are essential for better reproductive management in the mares. After natural or artificial insemination, the mares must be examined to confirm the pregnancy. Some factors lead to fetal loss at different periods of gestation. Therefore, monitoring the pregnancy along the gestation period is required (1).

Ultrasonography is the favored method for pregnancy diagnosis in mares. There are two approaches for this technique; transrectal and transabdominal. Transrectal ultrasonography is the most widely used approach for pregnancy determination in mares, especially for early determination of pregnancy (2). It gave a possible for early pregnancy diagnosis and monitor the embryo's viability and development (3).

At the beginning of the second trimester of gestation and foreword until parturition, the users of the transrectal ultrasonography is reduced due to the depth of abdominal cavity and gravid uterine horn go down, in these cases, pregnancy diagnosis and determination of fetal viability

cannot be recognised (4). Also, transrectal or gynecological examinations of mares seem to act as stressors and may increase cortisol secretion (5). Furthermore, the risk of rectal tears can occur during the transrectal examination (6).

Several studies have been conducted to apply the ultrasonographic technique to determine pregnancy in mares. Most of the studies adopted the transrectal approach of the ultrasonographic scanning (7-12), while limited studies have adopted the transabdominal approach of the ultrasonographic scanning to evaluate pregnancy in mares (4,13-16).

The present study was designed to evaluate the efficiency of transabdominal ultrasonographic approach for pregnancy diagnosis and monitoring the viability of fetus in mares as an alternative approach to the transrectal ultrasonography to minimize the opportunity of misdiagnosis and prevent the deleterious effect of transrectal invasive.

Materials and methods

Animals

Forty-five mares (aged between three to ten years) were included in the present study. Twenty-six mares were pregnant, and nineteen mares were non-pregnant. According to the date of insemination that gave by mare's owners, the pregnant mares were at different ages of gestation, ranging between 120 and 270 days. Seventeen mares were in the 2nd trimester (120-210 days), and nine mares were in 3rd trimester (more than 210 days) of pregnancy.

Ultrasound examination

Initially, the mares were examined using transrectal ultrasonography to ensure the pregnancy status of mares. Subsequently, a transabdominal approach of ultrasonography was applied to detect the pregnancy status of mares and to monitor the viability of fetus. The mares were scanned in a standing position using a B-mode ultrasonographic device (Medison, SA600V). The transrectal ultrasonographic examination was performed using a 7.5 MHz linear transrectal probe (17). The transabdominal examination was done according to the method that described by Murase *et al.* (16) with some modification (the examination was done without clipping or shaving). After putting the gel, the mares were scanned using the 3.5 MHz sector transducer on the ventral abdominal wall. The examination area that depended in this study was situated on the ventral abdomen wall, near the udder ventrally, and the area between the stifle fold and abdominal wall dorsally, as was previously applied in cow and buffalo (18,19). The mares were regarded pregnant if observation of an anechogenic areas of the uterus that fluid-filled (Figure 1), whereas the fetal viability was determined depending on the monitoring and observing of the fetal movement and their heartbeat (Figure 1 and 2) (15).
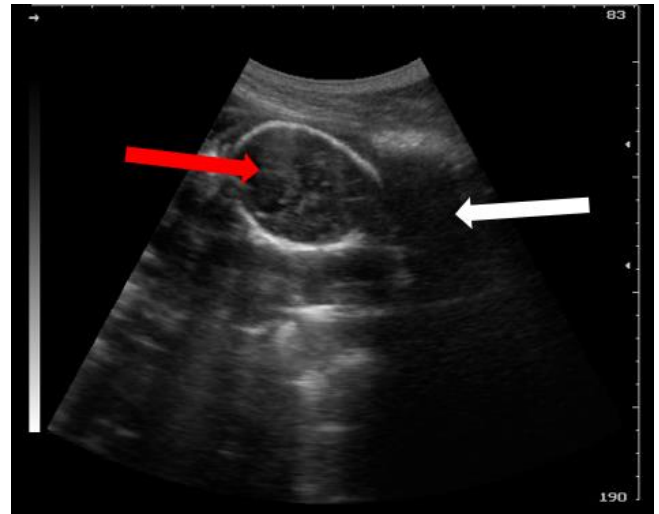

Figure 1: Ultrasonographic image of the mare at the sixth month of gestation which was scanned transabdominally, white arrow: the fluid-filled uterus that appear as an anechogenic areas, red arrow: head of the fetus.
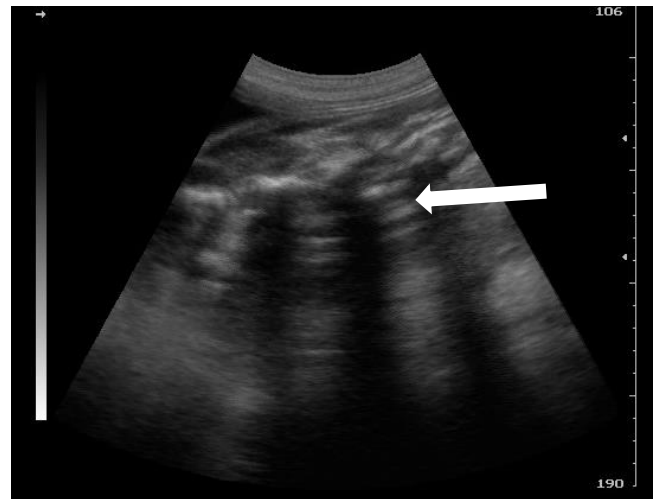

Figure 2: Ultrasonographic image of the mare at the sixth month of gestation which was scanned transabdominally, white arrow: ribs of the fetus.

The time required to access the final diagnosis has been recorded in transrectal and transabdominal ultrasonography. For the transrectal ultrasonography, the time was calculated starting from inserting the hand to the rectum to evacuate it and reaching the final decision. While for the transabdominal ultrasonography, the time was calculated starting from putting the gel on the abdominal wall and ending up reaching the final decision.

Calculation of the parameters

The following equations were used for calculation of the accuracy, sensitivity, specificity, positive predictive value, and negative predictive value for the results of the two ultrasonographic approaches:

Accuracy = (a+c) / (a+b+c+d)*100
Sensitivity = a / (a+d)*100
Specificity = c / (c+b)*100
Positive predictive value = a / (a+b)*100
Negative predictive value = c / (c+d)*100

a = number of mares were true positive diagnosed, b = number of mares were false positive diagnosed, c = number of mares were true negative diagnosed, d = number of mare were false negative diagnosed (20).

Statistical analysis

According to the distribution of the data Chi-square and Fisher Exact test were used to compare the information of accuracy, sensitivity, specificity, positive predictive value, and negative predictive value of the two ultrasonographic approaches. The information of time required for determination of pregnancy were presented as mean $\pm$ SE, and the T-test was applied to compare the information.

Pearson correlation coefficients was used to estimate the relationship between the time and gestation period. The statistical analyses were conducted by SigmaStat (Jandel scientific software V3.1). P<0.05 was considered statistically significant.

Results

Table 1 summarized the results of the mares that scanned by transrectal and transabdominal approaches of ultrasonography. Out of forty-five mares, nineteen mares were non-pregnant, and the other twenty-six mares were pregnant.

Scanning of the pregnant mares by transrectal ultrasonography resulted in twenty-six mares were diagnosed true positive, and there was no mare were diagnosed false-positive. The non-pregnant mares (19 mares) were diagnosed true negative, while no mares were diagnosed false-negative. The values of the accuracy, sensitivity, specificity, positive predictive, and negative predictive of the transrectal and transabdominal approach of the ultrasonographic scanner were 100%.

Table 1: Results of transrectal and transabdominal approaches of the ultrasonographic scanner for determination of pregnancy in mares

Diagnosis	No. of mares	Ultrasonographic examination	
		Transrectal	Transabdominal
Pregnant	26	26[a]/0[b]	26[a]/0[b]
Non-pregnant	19	19[c]/0[d]	19[c]/0[d]
Accuracy		100%	100%
Sensitivity		100%	100%
Specificity		100%	100%
Positive predictive value		100%	100%
Negative predictive value		100%	100%

[a] number of mares were true positive diagnosed, [b] number of mares were false positive diagnosed,
[c] number of mares were true negative diagnosed, [d] number of mare were false negative diagnosed.

Table 2 presented the information of the time required to reach the final decision of pregnancy diagnosis in mares that scanned by transrectal and transabdominal approaches of the ultrasonography. The mares have no pregnancy which were scanned by transabdominal approach were diagnosed faster (P<0.001) in comparison to those which were scanned by transrectal approach (5.26 $\pm$ 0.27 vs. 8.11 $\pm$ 0.31 min). At the second trimester of pregnancy, transabdominal approach of ultrasonographic scanner needed less time (P<0.05) than that needed for the transrectal approach to reach the final decision (4.36 $\pm$ 0.49 vs. 5.57 $\pm$ 0.29 min). Also, in the third trimester, transrectal ultrasonography required more time (P<0.01) than transabdominal ultrasonography to diagnose the pregnant mares (5.86 $\pm$ 0.2630 vs. 4.12 $\pm$ 0.51 min). The correlation coefficient between the gestation age and the

time needed for pregnancy determination was more significant in mares that examined transrectaly than those that examined transabdominaly in the second trimester (r= 0.378 vs. r= 0.16) and third trimester (r= 0.27 vs. r= 0.21), despite that in both methods of ultrasonography and both trimesters of gestation, there was no significant correlation between the gestation age and the time needed for determination of pregnancy in mares.

Table 3 presented the positive predictive values of the determination of fetal viability in mares examined by transrectal and transabdominal ultrasonography. The positive predictive values of fetal viability obtained at the 2nd and 3rd trimesters of pregnancy by transrectal approach of ultrasonographic scanner were 29.4 and 22.2% and by transabdominal ultrasonography were 88.2 and 66.7%,

respectively. The overall positive predictive values for determining fetal viability obtained by transrectal and transabdominal ultrasonography were 26.9 and 80.8%,

respectively. A significant variance (P<0.01) was reported between the positive predictive values obtained by transrectal and transabdominal ultrasonography.

Table 2: The information of time needed for transrectal and transabdominal approaches of ultrasonographic scanner to reach the final diagnosis of pregnancy in mares

Pregnancy status	Time needed for pregnancy determination (min)	
	Transrectal ultrasonography	Transabdominal ultrasonography
Non-pregnant	8.11 ± 0.31	5.26 ± 0.27 ***
2nd trimester of pregnancy	5.57 ± 0.29	4.36 ± 0.49 *
3rd trimester of pregnancy	5.86 ± 0.30	4.12 ± 0.51 **

Significant differences at *P<0.05, **P<0.01 and *** P<0.001.

Table 3: The positive predictive values (%) of the determination of fetal viability in mares that examined by transrectal and transabdominal ultrasonography

Pregnancy period	No. of pregnant mares	Determination of fetal viability				Positive predictive value (%)	
		Tranrectal		Transabdominal		Tranrectal	Transabdominal
		+Ve	-Ve	+Ve	-Ve		
2nd trimester	17	5	12	15	2	29.4 [a,A]	88.2 [a,B]
3rd trimester	9	2	7	6	3	22.2 [a,A]	66.7 [a,A]
Total	26	7	19	21	5	26.9 [A]	80.8 [B]

[a] there is no significant difference between the rows, [A,B] there are significant (P<0.05) differences between the two columns.

Discussion

Transrectal ultrasonographic have been commonly used for determination of pregnancy in mares (21). The current study was designed to evaluate an alternative approach of ultrasonography for monitoring pregnancy and fetal viability in mares. Our experience and working at the University Veterinary Clinic have recorded numerous difficulties in scanning mares for pregnancy diagnosis and determining fetal vitality, especially when the mares have a pregnancy of more than 100 days. These difficulties include; the necessity to evacuate the rectum before the examination, the mares tend to recumbent during the rectal examination, which exposes the examiner to harm, the transrectal examination makes the mares nervous. Furthermore, the examiner must be careful because the mare's rectum is very sensitive and is highly susceptible to injury or tear. Pregnancy diagnosis in mares is sometimes difficult because of the large body size and depth of the abdominal cavity, especially in mares at the 2nd trimester (5-6 months) of pregnancy (21). Therefore, our study was designed to evaluate the transabdominal approach of ultrasonographic scanner for determination of pregnancy and monitoring of the fetal viability in mares.

The current study showed that the transabdominal approach of the ultrasonographic scanner is a practical and an accurate approach for determination of in mares, especially for the mares that in the 2nd and 3rd trimesters of pregnancy. The accurate results of our study were founded

due to the location of the gravid uterine horn at this pregnancy period. The uterine horn is enlarged significantly and becoming heavy and drooping in the lower abdominal cavity (22), and it is becoming closure over the site of scanner that applicate in this study. Similar findings were recorded in previous studies, which were adopted the transabdominal ultrasonography for monitoring the fetal and placenta of mares at the late period of gestation (4,23,24).

Both transabdominal and transrectal ultrasonography gave equal accuracy, sensitivity, and specificity values at the 2nd and 3rd trimesters of pregnancy in mares. However, the difference was in the time that required to reach the final diagnosis of pregnancy. Transabdominal ultrasonography was easier and faster than the transrectal approach. We have obtaining these results due to the gravid uterus is becoming closer to the ventral abdominal wall by progress the gestation (4). By this approach, the distance between the pregnant uterus and the ultrasonographic probe is very small, so we get faster results. The time required for the transabdominal ultrasonography in this study was less than the time recorded by Murase et al. (16), who found that the duration of ultrasonographic scanning ranges between 15 and 30 min (depending on fetal position, presentation, posture, and gestational period). The ultrasonographic examination of the mares without clipping and shaving may explain the variation in time required for ultrasonographic scanning between the two studies.

In comparison to the transrectal approach, the transabdominal ultrasonography provided fetal viability monitoring because this approach allowed to screen the movement of the fetus and other viability signs, especially the fetal heartbeat. The positive predictive values of the determination of fetal viability at the second and third trimesters of gestation, obtained by the transabdominal approach of ultrasonography, were higher than the values recorded by the transrectal approach. The lower positive predictive values of the transrectal ultrasonography at the second and third trimesters were obtained because the fetus at this period was located so far in the abdominal cavity and did not appear in the ultrasonographic image (4).

The transabdominal ultrasonographic approach that applied in the present study for determination of pregnancy in mares has advantages over the transrectal approach, these include; it is non-invasive approach, avoiding the possible rectal damage, limiting of mare's restriction that is necessary during the examination, scanning of mares in less time, and safer for examiners.

Conclusion

Transabdominal is an effective, practical, and often essential approach of ultrasonographic scanner for determination of pregnancy and estimation of the fetal viability in mares, especially for the mares at the 2nd and 3rd trimesters of pregnancy. We recommended transabdominal ultrasonography as the first examination for mares presented for pregnancy diagnosis, if this approach does not accurately diagnose, the mares can be scanned transrectaly. So, we can minimize the stress and hazard of the transrectal examination.

Acknowledgments

Conflict of interest

The authors declare no conflict of interest.

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فحص الحمل وحيوية الجنين باستخدام تقنية الامواج فوق الصوتية عبر جدار البطن في الأفراس

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الخلاصة

أجريت هذه الدراسة لتقييم كفاءة تقنية الفحص بالأمواج فوق الصوتية عبر جدار البطن لتشخيص الحمل وحيوية الجنين في الأفراس، كطريقة بديلة لتقنية الفحص بالأمواج فوق الصوتية عبر المستقيم، وذلك لتقليل احتمالية التشخيص الخاطئ ولتجنب الأذى الناجم عن الدخول للمستقيم. تضمنت هذه الدراسة خمسة واربعون فرس. فحصت الافراس باستخدام تقنية الفحص بالأمواج فوق الصوتية عبر المستقيم وعبر جدار البطن. بينت النتائج أن ٢٦ فرس كانت حامل و ١٩ فرس غير حامل، وأن الدقة، والحساسية، والخصوصية، والقيمة التنبؤية الإيجابية لكلا طريقتي الفحص كانت ١٠٠ ٪. الفحص عبر جدار البطن تطلب وقتا" أقل مقارنة مع الفحص عبر المستقيم للوصول الى التشخيص النهائي في الافراس غير الحوامل ٥,٢٦±٠,٢٧ مقابل ٨,١١±٠,٣١ دقيقة، الافراس في الثلث الثاني من الحمل ٤,٣٦±٠,٤٩ مقابل ٥,٥٧±٠,٢٩ دقيقة، وفي الثلث الثالث من الحمل ٤,١٢±٠,٥١ مقابل ٥,٨٦±٠,٢٦ دقيقة، على التوالي. في كلتا الطريقتين، لم يسجل ارتباط معنوي بين الوقت اللازم للفحص وعمر الحمل. وكانت القيم التنبؤية الإيجابية الإجمالية لتحديد حيوية الجنين ٢٦,٩% للفحص عبر المستقيم و ٨٠,٨% للفحص عبر جدار البطن. وتم تسجيل فرق معنوي بين القيم التنبؤية الإيجابية التي تم الحصول عليها من خلال الفحص عبر المستقيم وعبر جدار البطن. استنتج من الدراسة الحالية أن تقنية الامواج فوق الصوتية عبر جدار البطن لفحص الحمل وحيوية الجنين هي طريقة فعالة وعملية وأساسية في كثير من الأحيان ولا سيما في الثلثين الثاني والثالث من الحمل عند الافراس. نوصي بفحص الافراس أولا بطريقة الفحص عبر جدار البطن، وفي حال عدم التوصل الى التشخيص الدقيق، يمكن بعدها فحص الافراس عبر المستقيم، وبذلك يمكننا التقليل من الإجهاد والأذى الناجم عن الفحص عبر المستقيم.