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Assessment of awareness of ultrasound artifacts among Saudi interns and radiologic technologists in Al Madinah hospitals

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ABSTRACT

Aim: The study aims to identify the knowledge of ultrasound artifacts among internship students and radiographers and compare the knowledge according to their discipline, institute and educational level. *Material and method:* A cross-sectional survey study included 82 participants in the radiography field-the data was obtained from Al Madinah general hospitals from October 2020 to January 2022. A questionnaire was designed and surveyed the target population (radiographers and interns). The data were analysed using the SPSS program. Chi-square and ANOVA statistical tests were used to analyse the data. *Results:* The total mean knowledge score was 0.73, considered good knowledge of identifying US artifacts. There was no different significance in mean knowledge scores between private and governmental institutions (P-values > 0.05). The participants who have radiographic fellowship have a high knowledge score (100%) and there was a different significance among the groups (p-value < 0.001). Participants with diplomas have a low mean knowledge score (29%). The mean knowledge of radiographic technologists was significantly higher than the interns (p-value = 0.018). The participants who specialized in sonography had a mean score of knowledge of 0.77±23, which was higher than those of other disciplines. *Conclusions:* The study concluded that US artifacts' overall knowledge score was good. There was a significant difference between internship students and radiographic technologists regarding the awareness of US artifacts. Participants from public institutions and hospitals had a higher average knowledge score.

Keywords: US image artifacts, radiographic technologists, internship students.

1. INTRODUCTION

Ultrasound (US) imaging technology uses high-frequency waves to define tissue characteristics and organ and diagnose various diseases. Diagnostic ultrasound applications are dependent on the detection and receiving of echoes reflected from interfaces of tissues inside the body (Carovac et al., 2011). These responses provide the information from the tissue to generate high-resolution, gray-scale images of the body and display information related to blood flow. The US is an important imaging modality and a versatile medical imaging tool (Klibanov and Hossack, 2015). The US is an effective imaging method widely used in various medical fields. Its advantages are cheap, safe, available and easily manipulated (Haar, 2011).

One of the advantages of US is that it a real-time as it evaluates ventricular contractions, respiratory movements, arterial pulsations and phasic changes in venous blood flow, muscle/tendon/joint movements or the effects of provocative stresses on ligaments or tendons can all be easily spotted by experienced operators (Hoskins et al., 2019).

Artifacts are routinely seen at the clinical US; some artifacts are unwanted, while others provide valuable information about the composition and structure of the underlying tissue (Baad et al., 2017). Numerous artifacts can be explained as departures from the presumptions used to create the image (Nasir, 2018). The concept of the artifact is often used in radiological imaging to identify any image that does not correctly describe the anatomical structures found within the assessed subject (Nagarajappa et al., 2015). Artifacts may have the potential to intervene in the interpretation of images (Spaide et al., 2015).

For accurate image analysis, troubleshooting and utilization of this modality's full potential, radiologists must be able to understand the basic physics of ultrasonography, spot frequent US artifacts and offer recommendations for changing the imaging technique. Furthermore, Studying the US artifacts is necessary for better image quality.

We chose to study the awareness of US artifacts in this study since there is a need to evaluate the knowledge of internship students and Radiographers about US artifacts, they meet in their daily practice of ultrasound examinations. It is imperative to be aware of US artifacts as they may affect or degrade the image quality. Identifying these artifacts is very important for improving the image quality and describing some diseases which cause artifacts. Therefore, it is crucial to assess the level of knowledge of radiographic technologists and internship students regarding the US image artifacts that will ensure the delivery of training courses, fill the gap between theory and practice and improve graduate skills. For these reasons, the study aims to assess the awareness of these artifacts among Interns and Radiographers.

2. MATERIALS AND METHODS

Study design and population

This study is a cross-sectional descriptive study that deals with questioning participants to respond to the awareness of US artifacts. The study was conducted in Al-Madinah governmental hospitals from the 10th of October 2020 to January 2022. The study participants were radiographic technologists and internship students. There was no difference in age and gender. The study variables were categorized into dependent and independent variables. The dependent variables were all the questions and responses about the knowledge and identification of the US artifacts. The independent variables were demographic characteristics such as age, gender, type of participants as interns and radiographers, employment status, period of experience, institution and the participants' specialty.

The data collection and sample size

A total of 82 participants were chosen using the non-probability sampling method—the sample size was composed of 23 internship students and 59 radiographers. A questionnaire was designed to collect the data from radiographic technologists and internship students from private and public colleges and hospitals. The survey instrument consisted of a self-administered demographic characteristics questionnaire. It was designed after full revising literature review and was piloted to detect ambiguity or difficulties during the gathering the data. The Cronbach's alpha for the questionnaire was estimated and it was 0.152.

The questionnaire was composed of 10 questions related to identifying the benefit of US artifacts and their demographic characteristics. The questions related to US images with artifacts were chosen based on the most known artifacts that faced the interns and radiographers during their routine work. Google form was used to write the questionnaire and test the participants used. We utilized the Twitter and WhatsApp programs to publish the questionnaire in the Medina area. They were asked and their responses were collected. Then the data was exported from the Google-drive to excel and the SPSS program. The scoring range was determined by taking an average of all responses in each category. The validity of the questionnaire was checked before the survey. The survey was sent to 105 individuals to participate in the study; 82 participants responded to the online survey (22% is the response rate).

Statistical analysis

The data were analyzed and interpreted using Statistical Package for the "Social Sciences (SPSS, Inc., Chicago, IL, USA)" program. Chi-square, analysis of variance (ANOVA) and independent student-t-test statistical tests were applied to analyze the qualitative and quantitative data. A p-value less than 0.05 were considered significant.

3. RESULTS

The socio-demographic data are presented in Table 1. A total of 82 participants were selected to satisfy the study; the mean age was 35.3 years, 73.5 % males and 26.5% females (Table1). A total of 59 radiographic technologists and 23 internship students have responded to the questionnaire. They have been classified according to their institution and employment status. The participants of governmental institutes were higher than in private ones (72% vs. 28%). The assessment of the whole questions with their knowledge scores was 73%, reflecting good knowledge of US artifacts.

Table 1 Distribution of demographic variables of the study

Variables	Frequency	Percent %
Gender		
Males	60	73
Females	22	27
Current Employment		
Radiographic technologist	59	72.0
Interns	23	28.0
Place of employment		
Private	23	28.0
Governmental	59	72.0
Educational level		
Diploma	2	2.4
Bachelor	52	63.4
Master's degree	2	2.4
Fellowship	19	23.2
Ph.D. degree	7	8.5
Current discipline		
Ultrasonography	18	22.0
CT scanning	7	8.5
MRI	6	7.3
Nuclear medicine	15	18.3
Radiography	33	40.2
Other	3	3.7

Table 2 summarizes the correct and incorrect responses of the participants regarding the identification, source and usefulness of US artifacts. 91 % of the participants were well-oriented about the source of acoustic shadowing artifacts and 82.9% on identifying the source of reverberation artifacts (Table 2). The participants showed average responses on identifying contact artifacts, acoustic shadowing and reverberation artifacts (54.9% 52.4% and 62.2%) respectively.

Table 2 Correct and incorrect responses of the participants regarding the identification and benefits of US artifacts

Question	Correct responses Freq. (%)	Incorrect responses Freq. (%)
Q1: Are there some US artifacts useful for diagnosis	66 (80.5%)	16 (19.5%)
Q2: Do US artifacts removed by the operator or using filters as used in CT	59 (72.0%)	23 (28.0%)
Q3: What is the source of acoustic shadowing artifacts	75 (91.5%)	7 (8.5%)

Q4: What is the source reverberation artifacts	68 (82.9%)	14 (17.1%)
Q5: Identification of contact artifact on image 1.	45 (54.9%)	37 (45.1%)
Q6: Identification of acoustic shadowing on image 2.	43 (52.4%)	39 (47.6%)
Q7: Identification of reverberation artifact on image 3.	51 (62.2%)	31 (37.8%)

The comparison of mean knowledge according to the current discipline or work of the participants was summarized in Table 3. It was found that participants in nuclear medicine image responded with a higher score of knowledge (.93±19) than in the other disciplines. The participants who specialized in sonography had a mean score of knowledge of 77±23. Participants specialized in MRI have a low frequency mean knowledge (.50±28).

Table 3 Comparison of knowledge score of ultrasound artifacts according to participants' discipline or job

Current discipline or work	Mean of score knowledge ± SD	Frequency
Ultrasonography	.77±23	18
CT scanning	.69±25	7
MRI	.50±28	6
Nuclear medicine	.93±19	15
Radiography	.60±24	33
Other	.95±82	3
Total	.71±27	82
P-value < 0.001		

Table 4 summarizes the mean knowledge score of radiographic technologists and interns according to their graduation and place of current employment. The radiographic technologists showed a higher significant score of knowledge of US artifacts than interns (.76 vs. .60, p-value = 0.018). The mean of governmental institutes was higher than those of private ones (p-value=0.024).

Table 4 Mean knowledge score of radiographic technologists and interns according to graduation of the participants and place of current employment

Characteristics	Mean knowledge ±SD	P-value
Current professional status		
Radiographic technologist	.76	.018
Interns	.60	
Institution		
Governmental	.75	0.024
Private	.60	
Hospitals		
Governmental	. 73	0.25
Private	. 66	

The participant's responses to the identification of acoustic shadowing showed significant differences according to private and governmental hospitals (p-value < 0.001) (Figure 1). The radiographic technologists responded correctly to the identification of contact artifacts more significantly than the interns (p-value= 0.005) (Figure 2), where there was no different significance regarding the correct response on the identification of the reverberation artifacts (p-value < .05) (Figure 3). There was no significant difference regarding the correct answer on the title of the acoustic shadowing artifacts (p-value < .05) (Figure 4).

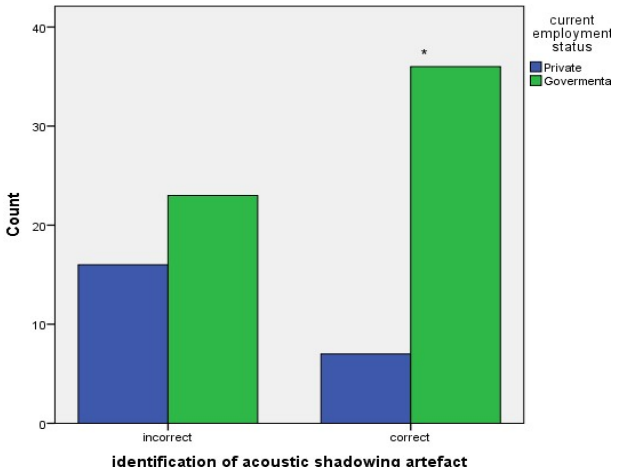

Figure 1 Identification of acoustic shadowing as responded by private and governmental participants

*Significance < 0.05

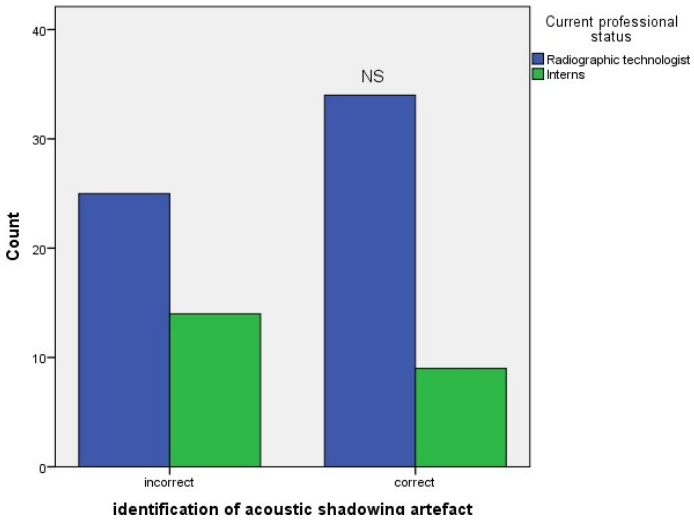

Figure 2 Identification of contact artifact as responded by interns and radiographic technologists

*significance < 0.05

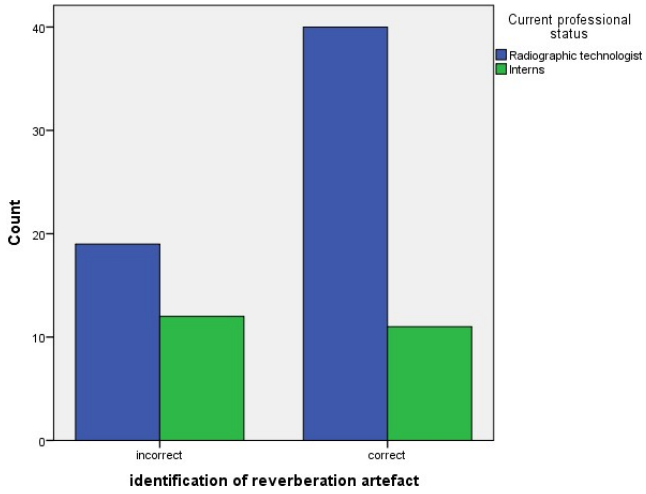

Figure 3 Identification of reverberation artifacts as responded by interns and radiographic technologists

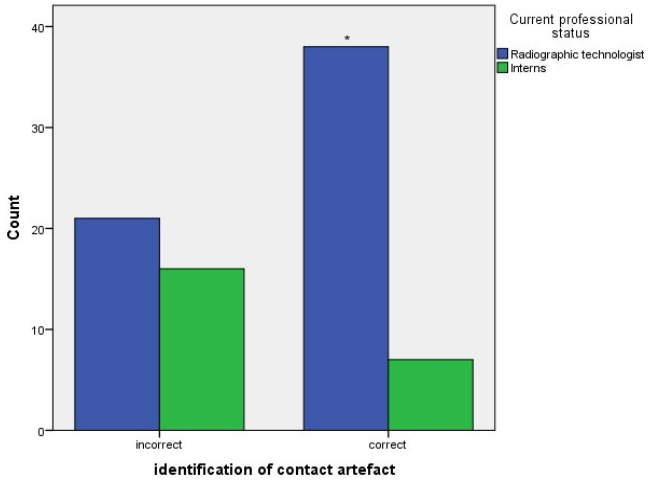

Figure 4 Identification of contact artifact as responded by interns and radiographic technologists

*significance < 0.05

4. DISCUSSION

This study showed that the participants have a good knowledge of US artifacts. Knowledge of US artifacts is an integral part of performing sonographic procedures and identifying abnormalities that characterize sonographic appearance. Applying US artifacts' knowledge will help diagnose diseases with different sonographic appearances. Investigating any knowledge deficiencies will support the educational institute and hospitals' design of appropriate continuing education and building programs for the graduates and radiographers.

The study demonstrated that the participants responded correctly regarding the knowledge of the source of acoustic shadowing artifacts and reverberation artifacts. The majority of the responders have correctly identified the artifacts. In contrast, the participants, knowledge of contact artifacts and acoustic shadowing artifacts was poor. Identifying the correct US artifacts is essential for image-quality improvement and optimal patient care (Richard et al., 2013).

With a rudimentary understanding of the physical parameters of the ultrasonic beam, sound propagation in materials and image processing assumptions, US artifacts can be understood. Problems in the US beam characteristics, the presence of multiple and various echo routes, velocity inaccuracies and attenuation errors all contribute to US artifacts. In clinical practice, reverberation, ring-down, comet tail, acoustic shadowing and contact artifacts are familiar. These artifacts must be recognized since they may provide information about composition of tissue and help in diagnosis. The capacity to identify and repair correctable sonographic artifacts is essential for improving image quality and providing the best possible patient care (Feldman et al., 2009).

The present study revealed that the knowledge level of US artifacts among radiographers and internship students was significantly different. It was found that Radiographic technologists have significantly more knowledge than the interns and participants of governmental students were significantly more knowledgeable than the private ones. The increased awareness among the radiographers might be attributed to the longer duration of experiences than the interns. In general, the radiographers' attitudes toward research and utilization of research evidence have become more positive (Abrantes et al., 2020; Ahonen and Liikanen, 2010; Ooi et al., 2012; Vikestad et al., 2017).

The participants were asked about contact artifacts, acoustic shadowing and reverberation. These artifacts are highly correlated with a variety of reasons; including velocity mistakes, multiple echo routes, attenuation errors and faults that are inherent to the US beam's properties (Pinto et al., 2013). The responses of the participants to the identification of contact artifacts according to their qualifications showed significant differences among the participants (p-value < 0.001). The radiographic technologists responded correctly to identifying contact artifacts more significantly than the interns (p-value= 0.005). There was insignificant difference regarding the correct response in identifying the reverberation artifact (p-value=0.094). There was insignificant difference regarding the proper response to determining the acoustic shadowing artifact (p-value=0.13). The insignificant result of acoustic shadowing is attributed to the artifact's characteristic shadow. Acoustic shadowing, described above, is the most commonly encountered artifact. It can hinder diagnosis by hiding some deep structures, such as shadows that extend all the way to the ribs. On the other hand, acoustic shadowing can aid in recognizing a solid structure such as stones and identifying the position of intravascular catheter (Anvari et al., 2015; Bakhru and Schweickert, 2013; Harrison et al., 2021; Heng and Widmer, 2010; Quien and Saric, 2018).

US artifacts should be considered in the examinations since they degrade the image quality. For accurate US interpretation, troubleshooting and use of the full potential of this imaging modality, a radiologist or sonographer must be able to recognize frequent US artifacts and make recommendations for changing the imaging technique.

Limitations

The major limitation of this study is the insufficient response to the questionnaire. Secondly, some radiographers were busy and did not respond to the survey. Consequently, some hospitals were missed from the survey.

5. CONCLUSION

The study concluded that knowledge about US artifacts was good. A significant difference existed between internship students and radiographic technologists regarding the total knowledge scores of identification US image artifacts. Knowledge-based practice and continuous periodical training are essential to filling the US image quality knowledge gap. It is recommended that the radiographic technologists and internship students participate in periodic training to strengthen knowledge about the importance of identifying US image artifacts. Further studies are recommended with a large sample size.

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Ethics approval and consent to participate

The Research Ethics Committee of faculty of applied medical sciences at Taibah University approved the study (Approval Project No. 2020 /77/ 306 / DRD on 28/10/2020). Oral informed consent was obtained before the study. There was no identifying information about individual subjects.

Authors' contributions

Moawia Gameraddin: Put the concept and made the analysis reviewed the manuscript and gave final approval of the manuscript. Ali Abdullah Alqarni: Data collection and preparation; Bandr Jumayan Aljabri: Shared in writing the discussion and gathered references; Fares Rabah Alradaddi: Data collection and design; Abdulrahman Alrhili: Edited the manuscript and shared in writing the introduction and methodology; Awadia Gareeballah: Editing and analysis; Muna Ahmed M Ali: Reviewed and final editing the manuscript.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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