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Bacterial contamination of ultrasound probes and coupling gels in a university hospital in Turkey

Hakan Kıran[1], Murat Aral[2], Gürkan Kıran[1], Salih Serin[1], Deniz Cemgil Arıkan[1], Uğurkan Erkayıran[1], Hasan Çetin Ekerbiçer[3]

[1]Department of Obstetrics and Gynecology, Sütçü İmam University School of Medicine, Kahramanmaraş, Turkey
[2]Department of Microbiology, Sütçü İmam University School of Medicine, Kahramanmaraş, Turkey
[3]Department of Public Health, Sütçü İmam University School of Medicine, Kahramanmaraş, Turkey

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ABSTRACT

Objectives: Nosocomial outbreaks of infection originating from ultrasound probes and contaminated coupling gels have been reported. It was reported that the ultrasound probe, if cultured after routine scanning of intact skin, may become colonized with skin flora.

Methods: Culture swabs from 22 probes of the 9 ultrasound machines and from the gels in the 10 gel folders were taken. All swabs taken from probe head, probe holder and the coupling gel in the folder at the beginning of the day were cultured. After fifth scanning and after wiping off the gel with a dry, nonsterile paper towel, cultures were again obtained from probe head and probe holder.

Results: A total of 98 culture results were included of which 42.8% were positive for bacterial growth. The rate of bacterial contamination from probes at morning before the start of examination and after scanning were 34.1% and 56.8%, respectively and this difference was statistically significant ($p = 0.023$).

Conclusions: We think that using nonsterile, dry, soft and absorbent paper towel after each procedure, could be inadequate for disinfection of probe head. Especially, good hand hygiene could decrease the rate of growth of bacterial colony at probe handle.

Keywords: Bacterial contamination, ultrasound, coupling gel, nosocomial infections

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A nosocomial infection which means "hospital acquired infection" can be defined as: an infection acquired in hospital by a patient who was admitted for a reason other than that infection [1]. Nosocomial infections are hospital-acquired infections that occur 48 hrs after the admission of the patients to the hospital [2]. They occur worldwide and affect both developed and resource-poor countries. A prevalence survey conducted under the auspices of WHO in 55 hospitals of 14 countries showed an average of 8.7% of hospital patients had nosocomial infections [3].

The hospital environment plays a crucial role in the transmission of organisms associated with nosocomial infections [4]. Nosocomial infections have become an increasingly recognised problem and medical devices can be one of the vehicles for the spread of these infections. Medical equipments including bronchoscopes, gastrointestinal endoscopes, stethoscopes

Address for correspondence: *Uğurkan Erkayıran, MD., Sütçü İmam University School of Medicine, Department of Obstetrics and Gynecology, Kahramanmaraş,Turkey*
E-mail: byugrerk@hotmail.com

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and electronic thermometer have all been previously implicated in the transmission of nosocomial infections [5-7].

Ultrasonography is a most widely-used diagnostic imaging technique. Staff and patients have been implicated as vectors for the transmission of pathogenic organisms. Ultrasound (US) probes are used by doctors and nurses to assess for clinical evaluation of patients. US probes are reusable instruments, which can act as a reservoir for bacterial pathogens. Nosocomial outbreaks of infection originating from US probes and contaminated coupling gels have been reported [8-10]. The prevalence of US probe contamination after contact with patients' skin during scanning has been found to be as high as 95% with frequent isolation of pathogens such as Staphylococcus aureus [11-13]. It was reported that the ultrasound probe, if cultured after routine scanning of intact skin, may become colonized with skin flora in up to 33% of cases [14].

Unclean US probes can potentially transmit pathogens. The prevention of transmission of microorganisms among patients is of great importance, particularly in vulnerable patients who are susceptible to nosocomial infections resulting in increased morbidity, mortality and costs [15]. In this study, the US probes are routinely cleaned after each procedure simply by wiping them until they are visibly clean with a dry, nonsterile, soft, absorbent paper towel. Our purpose was to investigate if this simple cleaning procedure provided adequate probe decontamination to prevent the spread of infection between patients. We studied the potential role for the US probe or coupling gel to serve as a appliance of cross-contamination.

METHODS

A total of 98 culture swabs from 22 probes of the 9 US machines and from the gels in the 10 gel folders were taken by a single investigator. All swabs taken from probe head, probe holder and the coupling gel in the folder at the beginning of the day were cultured. After fifth scanning and after wiping off the gel with a dry, nonsterile paper towel, cultures were again obtained from probe head and probe holder. All samples were tested in a microbiology laboratory. The probes were always used with conducting gel. The US probes used in this study included Hitachi EUB-420, Toshiba Aplio XU, General Electric Vivid 7 Pro, DWL Multidop. X, Aloka Prosound SSD 3500, General Electric Logiq P5, Hitachi EUB 525 and Aloka Prosound 4000. The departments which the study was performed were; radiology, gynecology and obstetry, general surgery, endocrinology, orthopedia, urology, pediatry, neurology and gastroenterology. US coupling gel was first applied to the skin, after which the US probe was placed directly into the skin. Practitioners often did not decontaminate their hands pre- or post-procedure. The US probes are routinely cleaned after each procedure, simply by wiping them until they are visibly clean with a dry, non-sterile, soft, absorbent paper towel. After the final procedure of the day, probes were cleaned with a liquid cleaning solution such as Zefiran, alcohol, hydrogen peroxide, ammonium chloride, non-alcoholic wet tissue or dry towel to remove all traces of coupling gel, which could support the overnight growth of bacteria for any clinic. Patients underwent transvaginal sonography with probes that had been coated with gel and then covered with a latex condom. After the condoms were removed, the probe was wiped with a dry tissue. Condom defects were not detected after the scans by inspection. US probes and gels were chosen randomly and swabs were taken with sterile bouillon-soaked swabs (at least twice; one before clinic opening time, one on the following fifth US scanning), then swabs were cultured in Stuart's transport medium and taken to the laboratory within 3-6 hours. The samples were cultured on blood agar, Sabouraud dextrose agar (SDA) and eozin methylene blue (EMB) agar and incubated in blood and EMB agar at 37°C for 24 hours, or in SDA at 30°C for a week. Conventional microbiological methods were used for identification of the growing microorganisms and for definition of their colony characteristics, such as morphology, Gram stain, catalase, coagulase, oxydase tests and bacitracin and optochin sensitivity tests were done.

Statistical Analysis

All data were expressed as frequency and percentages. Statistic evaluation was performed using Mc Nemar test, and SPSS Ver 15.0. A p value less than 5% ($p < 0.05$) was considered to be statistically significant.

RESULTS

A total of 98 culture results were included of which 42.8% were positive for bacterial growth. The rate of bacterial contamination from probes at morning before the start of examination and after scanning of 5th patient were 34.1% and 56.8%, respectively and this difference was statistically significant ($p = 0.023$). The rates of bacterial contamination at probe head and probe handle were compared at morning before the start of examination and after scanning of 5th patient. The growth of bacterial colony was present in 9 out of 22 probe heads (41%) before the start of examination and in 13 out of 22 probe heads (59.1%) after scanning, the difference was not significant ($p = 0.388$). The growth of bacterial colony was present in 6 out of 22 probe handles (27.2%) before the start of examination and in 12 out of 22 probe handles (54.5%) after scanning and this difference was statistically significant ($p = 0.039$) (Table 1).

Percent positive bacteriological cultures from US probes before and after scanning shown in Figure 1. The growth of bacterial colony was seen in 2 of the gel examples taken from 10 gel folders. The majority of organisms which are found in normal skin and environmental flora were isolated from different parts of the US probes and gels. Of the 98 cultures, 42 (42.8%) were positive; 39 were positive for methicillin-sensitive Staphylococcus aureus (MSSA), 1 was positive for MSSA + Alpha-hemolytic Streptococcus, 1 was positive for MSSA + group A beta-hemolytic streptococcus, and 1 was positive for MSSA + kocuria kristinae. The gels were contaminated with MSSA. At the end of the day all the clinics were using different methods for the disinfection of the probes. No growth of bacterial colony has been detected at the examples taken before the start of examination from the probes that were cleaned with only alcohol after the end of the examinations.

The cleaning methods used at the end of the day and the rate of growth of bacterial colony at these samples are shown in Table 2.

DISCUSSION

Ultrasound probes and transmission gels come into direct contact with the skin of patients and can transmit bacteria between them, which can cause nosocomial infections. US probes may serve as a vector for cross infection particularly in vulnerable patients such as neonates, patients with unhealed wounds, burns and those with haematological malignancies or renal diseases. Thus, detecting bacterial transmission through US equipments is an important factor in the control of infection in hospitals. Nosocomial infections are most commonly caused by

Table1. The results of bacteriological cultures from ultrasound probes before and after scanning

Sampling site	Bacteriological culture	Before scanning (n = 22)	After scanning (n = 22)	*p* value
Probe head	Positive	9	13	0.388
	Negative	13	9	
Probe handle	Positive	6	12	**0.039**
	Negative	16	10	

Table 2. Association with cleaning methods of probes used for routine ultrasonography after the last scan of the day and bacterial contamination. Probes were swabbed before the first examination.

Cleaning methods (n = 44)	Number of swabs (n = 15)	Bacterial contamination	Percentage (%)
Hydrogen peroxide	4	1	25
Alcohol	4	-	0
Benzalkonium chloride	16	4	25
Ammonium chloride	16	7	43.7
Wet tissue	2	1	50
Dry towel	2	2	100

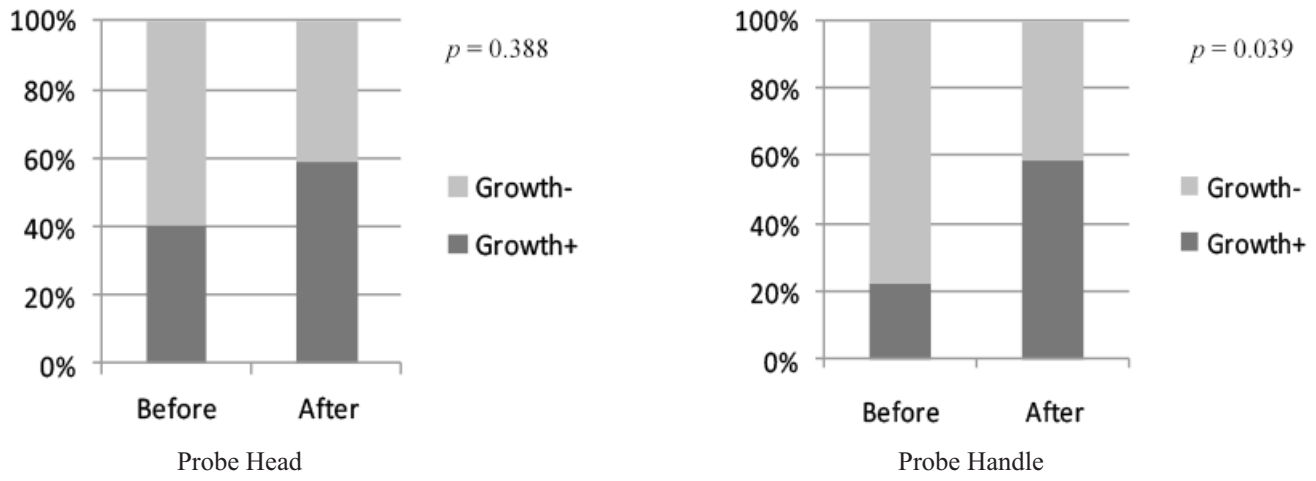

Figure 1. Percent positive bacteriological cultures from ultrasound probes before and after scanning are shown.

MSSA [16]. Other organisms such as *Escherichia coli, Enterococcus spp., Staphylococcus epidermidis, Streptococcus spp., Pseudomonas spp.* and *Candida spp*. are also common in surgical patients [17]. In our study, the prevalence of US probes and gels contamination has been found to be as high as 42.8% with frequent isolation of MSSA.

Sykes *et al*. [18] determined the extent of contamination of US equipment including probe, probe holder, keyboard and gel. The results revealed that 64.5% of the samples were contaminated with environmental organisms, 7.7% with potential pathogens and 27.8% were no growth [18]. Nosocomial outbreaks of infection originating from US probes and contaminated coupling gels have been reported in a French hospital [8]. Ohara *et al*. [19] evaluated whether US instruments are important in the spread of nosocomial staphylococcal infections. Following genomic typing by pulsed-field gel electrophoresis, it was apparent that US procedures transferred colonizing staphylococci from a patient's skin to the US instruments. *Staphylococcus aureus* survived in the transmission medium for longer than in water. Furthermore, *S. aureus* was more resistant to the ultrasonic medium than *Pseudomonas aeruginosa*, also a significant cause of hospital-acquired infections. To prevent staphylococcal transmission by US equipment, they recommend disinfection of the probe and removal of the medium after each examination [19]. In the other study, aerobic cultures were obtained from each patient's periumbilical and suprapubic areas before the transabdominal scan and from the transducer head before and after wiping off the gel with a dry cloth. Of the abdominal skin cultures, 175 (92%) were positive; 35 (18%) were positive for serious organisms, and 140 (74%) were positive for organisms of low virulence. Sixty percent of the transducer head cultures from women with abdominal skin pathogens were positive before the gel was wiped off. None of the cultures from the transducer head were positive after removal of the gel. They concluded that many women carry potentially virulent pathogens on the abdominal skin and that transmission of these organisms to the transducer head commonly occurs [20]. In our study, the rate of bacterial contamination from probe heads was 59.1% after removal of the gel. In the US department decontamination of US transducers is an important issue because of the risks of cross infection from dirty probes. Also, coupling gels can potentially transmit pathogens. Muradali *et al*. [21] concluded that as the coupling gel can support bacterial growth, the inadequately wiped US probe could potentially become contaminated with bacteria and serve as a vector of nosocomial infection. Similarly, this finding is supported by a previous report of the growth of bacteria several days after the intentional inoculation of microorganisms into bottles of US coupling gel [14]. Another study has incriminated the US gel as a potential source of infection [10]. In our study, the growth of bacterial colony was seen in 2 of the gel examples taken from 10 gel folders.

The prevention of transmission of micro-organisms among patients is of great importance, particularly in

vulnerable patients who are susceptible to nosocomial infections, resulting in increased morbidity, mortality and costs [15]. The literature on US probe cleaning and minimising the risks of cross infection agrees that cleaning and sterilising is essential [22]. Aylirffe *et al*. [23] summarized the infection control guidelines in hospitals, which needs to be tailored in sonographical practice and there are no clear international guidelines regarding the cleaning methods of the US probes.

Several methods have been used for US probe disinfection, including single-paper and double-paper wiping and disinfection with alcohol, antiseptic solutions or ultraviolet C technology (UVC). Conflicting results have been obtained concerning the respective efficacy of these cleaning methods under routine conditions [21, 24, 26]. Some authors have considered that simple wiping of the probe with a paper towel is enough to avoid cross-contamination, whereas others found that bacteria were still present after dry-wiping and considered this method inadequate [21, 24, 25]. Muradali *et al*. [21] suggested that simply wiping the probe with a dry towel appears to be sufficient to remove the gel and to decontaminate the probe. The additional use of an antiseptic solution after each routine scanning procedure does not offer any additional benefit [21]. Tarzmani *et al*. [27] found that the probes that were cleaned by cloth soaked in alcohol, showed the growth of bacterial colony to be zero. In their study, in the probes cleaned by non-sterile cloth, the bacterial count was 48.38%, 22.6%, 9.7% for the *Staphylococcus epidermidis, Staphylococcus aureus* and *Pseudomas aeruginosa*, respectively. They concluded that cleaning the probe and US gel as a device of bacterial growth is time saving and cost effective. They recommend disinfection of probes using alcohol in patients prone to infection [27]. Similarly, in our study, no growth of bacterial colony has been detected at the examples taken before the start of examination from the probes that were cleaned with only alcohol after the end of scanning. On the other hand, routine alcohol wiping is not recommended because of possible degradation of the rubber seal and shortening of the working life of the probe [25, 28].

Recently, Kac *et al*. [26] shown that US probes may carry nosocomial pathogens unless properly cleaned after each patient. Treatment of carefully dry-wiped probes in a UVC-chamber significantly reduced bacterial load. UVC disinfection of US probes may reduce cross-transmission of pathogenic bacteria [26]. Bello *et al*. [13] concluded that single paper wipe is adequate for outpatients, but for inpatients, especially those with high risk of cross infection, double paper wipe is preferred with probe thoroughly wiped until visibly clean. The use of dry wipe is effective for abdominal scanning, whereas alcohol wipes are recommended for the axillar and the inguinal regions [25]. Mirza *et al*. [29] determined the effectiveness of three different methods of US probe cleaning for the prevention of nosocomial infections. Culture was sent before and after using three different techniques of cleaning US probe, which included sterilized paper towel, 0.9% saline and swipe over with standard bath soap applied on patients respectively. The overall reduction in pathogenic bacterial count after performing each cleaning method was 45%, 76% and 98% for paper cleaning, normal saline and soap cleaning method respectively. They concluded that, soap cleaning technique is the most effective method for reducing bacterial count acquired due to patients body contact with the US probes [29].

CONCLUSION

The US equipments may be a potential vector for nosocomial infection in staff and patients. In this study, the bacterial contamination was still present in 59.1% of probe heads after dry-wiping. In this context, we think that using nonsterile, dry, soft and absorbent paper towel after each procedure, could be inadequate for disinfection of probe head. Concerning probe handle; the rate of bacterial contamination after scanning was significantly higher than the rate obtained from the samples before the start of the examination ($p = 0.039$). Especially, good hand hygiene could decrease the rate of growth of bacterial colony at probe handle.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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