http://dx.doi.org/10.14400/JDPM.2013.11.12.665

자기공명영상검사장비의 세균오염도 측정 및 소독에 관한 연구

정성운, 임청환, 유인규
한서대학교 보건의료학과

A Study on the Measurement of Bacterial Contamination of MRI Examination Equipment and Disinfection Conditions

Seung-Woon Jeung, Chung-Hwan Lim, In-Gyu You
Dept. of Health Care, Hanseo University*

요 약 영상의학과에는 다양한 질병을 가진 환자들이 검사를 받는 곳으로 병원감염의 교차 오염이 될 가능성이 큰 부서이다. 특히 자기공명영상(MRI)검사는 다른 검사에 비해 검사시간이 오래 걸려 교차오염에 더욱더 노출이 될 수 있다. 이에 본 연구는 MRI검사장비의 소독실태를 파악하고, 환자와 접촉이 가장 많은 Head coil, 환자 고정용 Block, 밀폐된 공간인 Bore에서의 세균분포도를 파악 하였다. MRI 검사장비의 소독실태는 MRI실 근무자 150명을 대상으로 설문을 실시하였으며, 세균분포의 파악은 10 곳의 의료기관에서 측정하였다. MRI 장비의 세균 분포도결과 Staphylococcus, 등의 다양한 세균들이 발견되었다. MRI실 소독실태 파악결과 Head coil, Block, Bore의 소독은 잘 시행되는 것으로 나타났으며, 소독의 시기는 아침에 1회 소독을 가장 많이 시행 하는 것으로 나타났다. 또한 감염관리자에 따른 소독의 유,무 와 소독의 시기에서는 MRI실 검사자가 감염관리 할 때 잘 시행되는 것으로 나타났다. 환자를 검사한 후 교차오염을 방지하기 위하여 바로 적절한 소독제로 소독을 실시하여 교차오염을 방지하여야 할 것이다.

주제어 : MRI, 감염, Head coil, Bore, Block

Abstract In radiology department, where patients with a variety of diseases receive their tests, there is a large possibility of cross contamination of nosocomial infection. Magnetic resonance imaging (MRI) tests take particularly more time than other tests do, which increases the possibility of being exposed to cross contamination. Therefore, this research examines the status of MRI equipment sterilization and investigates the bacterial distribution on head coils, which have the most frequent contact with patients, patient fixation blocks, and bores, which are confined spaces. The status of MRI equipment disinfection was examined by a survey targeting 150 employees, and the distribution of bacteria was measured in ten medical facilities. The result of bacterial distribution tests on MRI equipment showed various bacteria, including Staphylococcus, Acinetobacter, Sphingomona, Pantoea agglomeranss, Micrococcus, Bacillus, Saprophyticus, Brevundimona, and Myroidesspecies. The result of examining the stat us of MRI room disinfection showed that the disinfections of the head coil, block, and bore were implemented well, and the largest proportion was carried out once a day in the morning. The time and implementation of disinfection by the disinfection manager showed that they were implemented well when the manager was the MRI room examiner. The disinfection after examining a patient using an appropriate disinfectant is mandatory to prevent cross contamination.

Key Words : MRI, Contamination, Head coil, Bore, Block

* 이 논문은 2013년도 한서대학교 교비 학술연구 지원사업에 의하여 연구되었음.
Received 1 December 2013, Revised 20 December 2013
Accepted 20 December 2013
Corresponding Author: Chung-Hwan Lim(Dept. of Health Care, Hanseo University)
Email: lch116@hanseo.ac.kr

ISSN: 1738-1916

1. Introduction

The development of medical technology, public, awareness and interest in maintaining health have resulted in increased medical examinations in general, which has allowed for the early detection of diseases, making treatments and maintaining health easier. However, the increased visits to medical facilities has caused more frequent occurrence of nosocomial infection [1][16]. There are two types of nosoco mial infections: endogenous and exogenous. Endogenous infections are due to bacteria from either organ transplants or the patients themselves, and they are hard to prevent. Exogenous infections refer to the indirect spread of external viruses through contact, food, solution or medical equipment for treatment. Exogenous infection can be prevented by medical caution staff and the improvement of hospital environments [2]. Radiology department have a high chance of frequent cross contamination and contact contamination, through exogenous infection, form staff, patients, and equip ment for examination and examination aids [12]. However, radiologists working in radiology have been indifferent to the risk of nosocomial infection [3][14]. Magnetic resonance ima ging(MRI) is relatively time consuming among the nume rous tests performed in the department of radiology, and it is performed in a confined space called a Bore. MRI equip ment is expensive, and most medical institutions except ad vanced hospitals and general hospitals are equipped with on ly one, so it must be shared often by infectious patients and outpatients. When patients with a weak immune system are exposed to bacteria for a long time through unsterilized test equipment for MRI, the risk of contamination can become m uch more serious [4]. The damage of infection and extended periods of hospitalization due to contamination impose finan cial damage on patients [13]. The disinfection of equipment and their cycles, however, is not being monitored very well in medical installations. Therefore, this research aims to dete rmine the status of MRI equipment sterilization to about warn the risk of infection and to measure the bacterial distri bution on head coils, which have the most frequent contact with patients in MRI tests, patient fixation blocks, and bores. The results can be used to find ways of preventing infections.

2. Object and Method of Study

2.1 Subject of Study

One hundred and fifty radiologists were asked to fill out a structured survey to investigate the status and awar eness of infection control for equipment in MRI room, Information was collected by visiting medical institutions and through mail.140 out of 150 questionnaires were col lcted, and 120, excluding those with insufficient or inade quate answers, were used in the analysis. The bacterial measurement on head coils, which has the most frequent contact with patients in MRI tests, patient fixation blocks, and bores, were taken form ten medical institutions.

Five advanced hospitals or college hospitals, three gen eral hospitals or semi-general hospitals, and two clinics w ere selected, and by location, three advanced hospitals or college hospitals and one general hospital were in urban areas, and two advanced hospitals or college hospitals, tw o general hospitals or semi-general hospitals, and one clinic were selected for the bacterial measurement.

2.2 Method of Study

2.2.1 Investigation Method

The questionnaire used in this research as an inves tigation method has four different sections. The first is four questions about the general status of exam iners, the second is four questions asking whether they disinfect head coils, blocks, and bores the third is four questions on when and how often they are disinfected,

and the fourth is about the infection control in MRI rooms. A total of 16 questions composed the survey questionnaire, of which the reliability was confirmed with Cronbach's Alpha value of .699.

2.2.2 Bacterial Measurement

The tools used in this research included disinfected transport media (Transport Medium Swabs, Micromedia, Korea) for measuring bacteria on equipment, medical gloves (Dreamtex Glove, TG Medical, Korea) to prevent contam ination from the hands of researchers, and medical masks (Dental masks 81001, Yuhan-Kimberly, Korea) to prevent air contamination. Additionally, a blood agar plate (BAP: Blood agar plate, Hanil KOMED, Korea) was used for germiculture and Mc Conkey agar (Mc Conkey agar, Hanil KOMED, Korea) was used to investigate types of enterobacteria.

2.2.3 Specimen Collection

Specimens were collected from head coils, patient fixation blocks, and bores, in ten medical institutions by wiping the upper, middle, and lower part with a disinfected transport medium swab. The collected transport medium swabs were sealed and bar-coded to prevent specimen mixing.

2.2.4 Germiculture

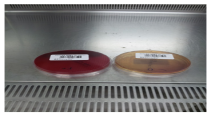
The tips of transport medium swabs were put into dishes that contained nutrient medium (10 cc) individu ally, which were then stored in a 37℃ incubator for 24 hours, and 1cc of nutrient medium from each dish was moved to a blood agar plate(BAP) for bacterial growth and cultured for 48 hours in a 37℃ incubator. Ger miculture was carried out with MAC medium as well to determine the existence of internal bacteria.

2.2.5 Statistics

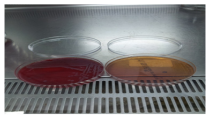
Data analysis was done with the statistical program

[Fig 1] BAP Bacter Inatoin

[Fig 2] BAP Streking



[Fig 3] In the Incubator



[Fig 4] Bacter Detected

SPSS (Ver. 12.0 for Windows). A frequency analysis was carried out to determine the general status of surveys, and a cross analysis was done to identify the type of disinfection depending on the infection control manager of the MRI test room. Over 95% ($p<0.05$) confidence in the results of each analysis was determined to be statistically significant. Cronbach's Alpha value for the reliability of the survey questionnaire was .699.

3. Results

3.1 Results of Equipment Sterilization Conditions

In the frequency analysis on disinfection status to determine whether bores, head coils, and blocks, are being disinfected, 67 people (55.8%) said that they regularly disinfected their bores, 48 people (40.0%) said they did not, and 5 people (4.2%) were the rest. In the case of coil disinfection, 81 people (67.5%) said they practiced it, 36 people (30.0%) said they did not, and 3 people (2.5%) were the rest. In the case of blo ck disinfection, 70 people (59.2%) said they practiced it, 46 people said they did not, and 4 people (3.3%) were the rest. The most common answers among the rest said that they practiced it in the case that foreign substances are found, before regular inspection, and after examining infected patients (table 3).

〈Table 1〉 Bore, Head coil, Block Whether or not is Disinfected

Question	Subdivide	Frequency (N)	Percent(%)
Bore	Yes	67	55.8
	No	48	40.0
	Others	5	4.2
Head coil	Yes	81	67.5
	No	36	30.0
	Others	3	2.5
Block	Yes	70	59.2
	No	46	37.5
	Others	4	3.3
Total		120	100

3.2 General Information on Research Subjects

General information about research subjects was collected. The most common type of MRI magnetic field was form superconducting magnets, which were used by 112 people (93.3%) and the most common age of equ ipment was 3 to 4 years, which was used by 30 people (25.0%). The most common type of disinfectant was alco hol, used by 71 people (59.2%), and the most common work shift was three staff members with two shifts each, which was experienced by 42 people (35.0%, Table 1).

〈Table 2〉 General Information on Research Subjects

Question	Subdivide	Frequency(N)	Percent (%)
Magnetic Field Type	Permanent magnet	4	3.3
	Superconducting magnet	112	93.3
	Electromagnetic	4	3.3
Age of Equipment,	1 to 2 years	19	15.8
	3 to 4 years	30	25.0
	5 to 6 years	18	15.0
	7 to 8 years	26	21.7
	9 to 10 years	23	19.2
	Over 10 years	4	3.3
Type of Disinfectant in Use	High cross-liquid	19	15.8
	Alcohol	71	59.2
	Water	12	10.0
	others	18	15.0
Work Shift in MRI Room	1 staff on duty	20	16.7
	2 staffs on duty	29	24.2
	3 staffs 2 shifts	42	35.0
	4 staffs 2 shifts	2	1.7
	4 staffs 3 shifts	14	11.7
	others	13	10.8

3.3 Results of the Condition for Equipment Sterilization Time

The results of questions on disinfection cycle showed that 36 people (30%) practiced it once a day every morning 29 people (24.2%) did not practice it and 49 people (40.8%) did not practice it regularly. In the case of head coils, 35 people (29.2%) practiced it once a day every morning, and 17 people (14.2%) did not. In the case of block, 29 people (24.2%) practiced it once a day every morning, and 28 people (23.3%) did not. The most common answers among the rest said that they practiced it in the case that foreign substances are found, before regular inspection and after examining infected patients (table 4).

〈Table 3〉 Bore, Head coil, Block Sterilization Time

Question	Subdivide	Frequency (N)	Percent (%)
Bore	Sterilizing in the Morning	36	30
	Morning and Evening,	5	4.2
	Patient is Changed	1	0.8
	No Sterilization	29	24.2
	Others	49	40.8
Head Coil	Sterilizing in the Morning	35	29.2
	Morning and Evening,	6	5.0
	Morning, at Noon and Evening	1	0.8
	Patient is Changed	8	6.7
	No Sterilization	17	14.2
	Others	53	44.2
Block	Sterilizing in the Morning	29	24.2
	Morning and Evening,	2	1.7
	Morning, at Noon and Evening	2	1.7
	Patient is Changed	28	23.3
	No Sterilization	28	23.3
	Others	47	39.2
total		120	100

3.4 The Disinfection Status of Bore, Head coil, and Block by Infection Control Manager

Cross analysis was performed to determine the disinfection status by an infection control man ager. In the case of the head coil, the most com mon answer was that disinfection is performed when the MRI room examiner is in charge, which was from 46 people (38.3%). 28 people (23.3%) said that they did it when the infection control manager was in charge, 6 people (5.0%) said when the department of radiology staff was in charge, and one said when the general staff was in charge, which was statistically significant with the p value of 0.036(p<.05). In the case of the block, 46 people (38.3%) said that disinfection is performed when the MRI room examiner is in charge, 29 people (24.2%) said they did it when infection control manager is in charge, and 6 people (5%) said they did when department of radiology staff was in charge, which was statistically significant with the p value of 0.046 (p<.05). In the case of the bore, 42 people (35%) said that disinfection is performed when the MRI room examiner is in charge, 19 people (15.8%) said when the infection control manager is in charge, and 1 people (0.8%) said they did when department of radiology staff was in charge, which was statistically significant with the p value of 0.043(p<.05) (Table 2).

〈Table 4〉 The Disinfection Status of Bore, Head coil, and Block by Infection Control Manager

		infection control					
		Infection control manager in hospital	MRI examiner is in charge	Department of radiology staff is in charge	Staff from another department is in charge	Infection control is not practiced	p-value
Head Coil	Yes	28 (23.3)	46 (38.3)	6 (5.0)	1(0.8)	0(0)	0.00
	No	11 (9.2)	17 (14.2)	4 (3.3)	0(0)	4(3.3)	
	Others	0(0)	2(1.7)	0(0)	0(0)	1(0.8)	
	Total	39 (32.5)	65 (54.2)	10 (8.3)	1(0.8)	5(4.2)	
Block	Yes	29 (24.2)	35 (29.2)	6 (5.0)	1(0.8)	0(0)	0.00
	No	10 (8.3)	27 (22.5)	4 (3.3)	0(0)	4(3.3)	
	Others	0(0)	3(2.5)	0(0)	0(0)	1(0.8)	
	Total	39 (32.5)	65 (54.2)	10 (8.3)	1(0.8)	5(4.2)	
Bore	Yes	19 (15.8)	42 (35.0)	5 (4.2)	1(0.8)	0(0)	0.00
	No	20 (16.7)	19 (15.8)	5 (4.2)	0(0)	4(3.3)	
	Others	0(0)	4(3.3)	0(0)	0(0)	1(0.8)	
	Total	39 (32.5)	65 (54.2)	10 (8.3)	1(0.8)	5(4.2)	

3.5 Bacterial Distribution in Medical Institutions

The results of identifying bacteria from ten medical institutions were as follows. Bacteria were found in head coils from 7 institutions, blocks from 2, and bores from 8 (Table 5).

〈Table 5〉 Detected bacteria Bore, Head coil, Block

HOSP	Head coil	Bore	Block
A	M.C luteus. B.S	N.G	S,S
B	S.C pidermidis B.S	Pseudomonaslut eola	S.C xylosus Brevundimona sp
D	Pantoea sp	N.G	S,S
C	A.V S,S	N.G	S.C haemolyticus S.P
E	S.C cohnii ss urealyticus B.S	N.G	S,S B.S
F	A.B S.C hominis	N.G	A.B
G	N.G	N.G	N.G
H	N.G	N.G	S.P
I	N.G	N.G	M.S A,blowffii
J	S.C capitis ss	Pantoea agglomeranss	N.G

N.G: No Growth, S,S: Staphylococcus saprophyticus
S.C:S taphyl ococcus, A.B:Acineto bacter lowffii
M.C:Micrococcus, M.S:Myroides species A,blowffii
S.P: Sphingomonas(Pseudo) paucimobiis, B.S:Bacillus spp
A.V:Aerococcus viridians

4. Discussion and Conclusion

Medical institutions, unlike regular companies, are whe re patients with various diseases are tested, and the refo re, they must be more cautious about nosocomial infection [15]. The department of radiology in particular does not separate ward patients, outpatients and infectious patients for screening, causing higher risk of contact infec tion and cross contamination. MRI test is particularly time consuming, and cross contamination would be critical to patients with a weak immune system. The practice of appropriate disinfection is the most basic and important way prevent such cross contamination. Effective disinfection of the medical equipment used by a patient requires involves disinfectants that achieve a decided level of sterilization and disinfection. Seok-Hwan Bae (2008) reported that 100% of the bacteria were eliminated on equipment disinfected with 70% alcohol [5]. The investigation of disinfectant in this research showed that 71 people (59.2%) used alcohol and 19 people (15.8%) used high cross solution, showing that most medical institutions were using an appropriate disinfectant. Meanwhile, 55.8% for the head coil, 67.5% for the block, and 59.2% for the bore said that they practiced disinfection 40.0% for the head coil, 30.0% for the block, and 37.5% for the bore said they did not, which was high. The most common answers among the rest said that they practiced it in the case that foreign substances are found, before a regular inspection and after examining infected patients, which can be considered as an absence of regular disinfection. The most common answer for disinfection cycles was once a day every morning, which was about 30%, followed by when foreign substances are found, before regular inspections and after examining infected patients. This shows the same result as in the questions asking if disinfection is being practiced. Sang-Hyeon Han (2008) reported that awareness of nosocomial infection control by radiologists was lower than that by nurses, clinical pathologists, and radiologists in the department of nuclear medicine, and that their rate of disinfection practice as well was lower than that of nurses, clinical pathologists and radiologists in the depar tment of nuclear medicine [6]. This corresponds to this research on disinfection, which supports the importance of implementing education about disinfection.

Various efforts for nosocomial infection control are currently being made, such as having infection control in the assessment and evaluation of hospital certification, and recruiting professional nurses and establishing infection control department by medical institutions [3]. However, the average number of infection control manager is 1.8, each of which is in charge of 467 beds, which is far less than a sufficient number of professionals to practice infection control in all hospitals throughout the year at the same level [7]. This research investigated the disinfection status by infection control managers 37.2% answered that disinfection was practiced when the MRI examiner was in charge, and 21.1% answered that designated infection control manager practiced it, which was statistically significant ($p<.05$). This research determined that infection control by staff that has a thorough understanding of each departments was the most systematic and effective.

The measurement and analysis of bacterial distribution in ten medical institutions in this research showed 7 medical institutions with an infectious head coil, 2 for the block and 8 for the bore. 70% of the head coils, which has direct contact with patients, and 80% of the were found to be infectious. The found bacteria included Gram(+) Cocci Bacillus, the cause of head coil anthrax diphtheria, and Aerococcu, which is Gram(-) Bacilli that resides in soil or water and separates from people or animals [17]. Staphylococcus which occurs in the skin or mucous membranes was also found. Most of the strains were nonpathogenic, but Staphylococcus saprophyticus strains were determined to be

pathogenic, which can cause urinary tract infection. The reason that these nonpathogenic strains should not be overlooked is because although they are not very pathogenic, they can infect patients who have a weak immune system or underlying diseases, which can be critical [10][11]. The rest of the nonpathogenic stra ins found include Pseudomon asluteola, urealyticus, Myroides species, Sphingomonas(Pseudo) paucimo biis, and Pantoea agglomeranss.

This investigation showed that the disinfection of MRI test equipment is generally good. However, the investigation of bacterial distribution found infectious equipment from many medical institutions, which should serve as a warning about the importance of regular disinfection using designated disinfectants to prevent cross contamination. The department of radiology should assign radiologists as infection control manager to imple ment infection prevention that is appropriate for each test.

Acknowledgments

This work was supported by Research Foundation from Hanseo University in 2013. The authors are grateful to staffs in the University for financial support.

References

[1] Young-Keum Kim, Seung-Kil Lee, Chang-Bok Kim “A study on the ba cterial contamination level of radiogr aphic room” The Journal of Kwang ju health college, vol. 29, pp. 201, 2004.

[2] Jung-sub Shin, Cheol-woo Park, Bye ong-kyou Jeon, “Analysis on infection control of general Hospital Radiology”, Journal of the Korean Society of Rad iology, vol. 6, no 5, pp. 335-337, 2012

[3] Seun -Gkyu Shin, Hyo- Yeung Lee, “The Pathology of Infection in the Department of Radiology”,Korean Society of Radiological Science, vol. 35, no. 3, pp. 211-212, 2012.

[4] Dae-Cheol Kweon, Peom Park, “Disinfection effect of file cassettes by ultraviolet irradiation” Korea Asso, Radiat prot, vol. 26, no. 4, pp. 425, 2001.

[5] Seok-Hwan Bae, Moo-Sik Lee, Cha ng-Seon Lim, Gha-Jung Kim “A Study on the Measurement of the Pollution Le vel of Bacteria and Disinfection of Table and IP Cassette” Kon yang University, Kon yang University Hospital, vol. 31, no. 3, pp. 233~235, 2008.

[6] Sang- Hyun Han “Correlation between Recognition and Performance of Radi ologist on Management of Nosocomial Infection” Kon yang University, pp. 25, 2008.

[7] Korean Society for Nosocomial Infection Control, “Institution′s Infection Control” pp.5~17, 2011.

[8] Kyen-Sup Lee, Diagnostic Nosocomial Microbiology, Go-ryeo Medicine, pp. 294~341, 1999.

[9] Yeun-Sup Jeung, Latest Diagnostic Microbiology, Seo-heung Publishing, pp.294~300, 2009.

[10] Kyung-Wan Lee, “Establishment of antibiotic-resistace management for clinical patients, Ministry of Food and Drug Safety Report”, pp.3~10, 2005.

[11] Seon-Chil Kim, “Bacteriological Monitoring of Radiol ogy Room Apparatus in the Department of Radiol ogical Technology and Contamination on Hands of Radiological Technologists” korea Society of Radio logical Science, vol. 31, no. 4, p.333, 2008.

[12] W.A Rutala, D.J.Weber, “Disinfection and Steril ization in Health Care Facilities: What Clinicians need to Kn ow” Clin. Infect dis, vol. 39, pp. 702-709. 2004.

[13] Hospital Infection Management Guidelines”, pp.3~4, 2005

[14] Jae-Seung Lee, Kyu-Hwan Jeong, Gy oung-Hee Kim, In-Chul Im, Dae-Cheol Kweon, Eun-Hoe Goo, Kyung-Rae Do ng, Woon-Kwan Chung “Radiology Dep artment Infection Control Accord ing to Radiography Frequency and Disinfection Period” Journal of the Korean Society of Radiol ogy, vol. 5,

no. 2. pp.74-75. 2011.
[15] Ha-Neul Park, “Levels of Knowledge and Practice on the Prevention of Nosocomial Infection of Radiolog ical Technologist” Department of Public Health Gra duate School Chonnam National Unive rsity, pp3-4, 2009.
[16] Jin-Dong Yeo, Byeong-Kyu Jeon, “A Study on Radiologists′ Awareness and Performance Of Hospital Infection Prev ention” Journal of the Korean Society of Radiology, vol. 6, no. 5, pp.322-323, 2012.
[17] Kyung-Hee Park, “Nosocomial Infection Rates and Risk Factors in Intensive Care Units of a University Hospital” Dep. of Public Health, Graduate School of Public Health, Chosun University, pp.17-20. 2007.

정 성 운(Jeung, Seung Woon)

・2012년 2월 : 한서대학교 방사선학 석사
・2013년2월 ~ 현재 : 한서대학교 보건의료학과 박사과정 중
・관심분야 : 보건의료, 보건교육
・E-Mail : Joungshun@naver.com

임 청 환(Lim, Chung Hwan)

・1997년 8월 : 단국대학교 보건행정학과(보건학 석사)
・2005년 2월 : 경원대학교 의료경영학과(보건학 박사)
・2001년 3월 ~ 현재 : 한서대학교 방사선학과, 보건의료학과 교수
<관심분야> : 방사선학, 보건의료학
・E-Mail : LCH116@hanseo.ac.kr

유 인 규(Jeung, Seung Woon)

・2012년 2월 : 한서대학교 방사선학 석사
・2012년2월 ~ 현재 : 한서대학교 보건의료학과 박사과정 중
・관심분야 : 보건의료, 보건정책
・E-Mail : semicoma72@daum.net