Volume: 28, Issue: 1, January 2017 pp: 27-30 ORIGINAL ARTICLE / ORJİNAL MAKALE

CAN THE AIRBORNE CONTAMINATION OF SURGICAL INSTRUMENTS BE RESPONSIBLE FOR SURGICAL SITE INFECTION?

CERRAHİ ENSTRÜMANLARIN HAVA KAYNAKLI KONTAMİNASYONU CERRAHİ ALAN ENFEKSİYONUNDAN SORUMLU OLABİLİR Mİ?

Aydin GERİLMEZ[1],
Ali Erhan KAYALAR[1],
Mehmet Reşit ONEN[1],
Evren YUVRUK[1],
Sait NADERİ[2]

[1]*Department of Neurosurgery, Health Sciences University, Umraniye Training and Research Hospital, Ümraniye, Istanbul, Turkey.*

[2]*Prof. of Neurosurgery, Department of Neurosurgery, Health Sciences University, Umraniye Training and Research Hospital, Ümraniye, Istanbul, Turkey.*

SUMMARY

Back-round data: Surgical site infections, which are the primary of nosocomial infections, continue to be an issue as they result in increased rates of morbidity, healthcare costs and patient dissatisfaction The aim of this study was to reveal the role of airborne particle contamination of surgical instruments in surgical site infection.

Material-Method: In this prospective study, an evaluation was made of a total of 25 simple and complex spinal surgery cases performed over a one month period. In order to demonstrate that there were no contaminants in the surgical set preoperatively, 2 instruments were randomly selected and culture samples were taken from a 1 cm^2 surface area of each. The instruments were not used in surgery and one was covered to remain sterile while the other was exposed to airborne particles on the nurse's desk. At the end of the operation, culture samples were taken from all instruments.

Results: The samples taken preoperatively from the airborne particle exposed and sterile covered instruments showed no bacterial growth postoperatively. No surgical site infections developed in any of the patients.

Conclusion: When appropriate precautions are taken, it is possible to avoid contamination of surgical instruments with airborne particles. Therefore, great attention must be given to appropriate behavior regarding contamination in the operating room, activity must be kept to a minimum, and doors must be controlled.

Key words: Spinal infections, contamination, spinal surgery, transmitted with air.

Level of evidence: Prospective clinical study, Level II.

ÖZET

Giriş: Cerrahi alan enfeksiyonları, morbidite oranlarını ve sağlık harcamalarını, hasta memnuniyetsizliği arttırarak sorun teşkil etmeye devam etmekte ve birçok klinikte hastane enfeksiyonları arasında ilk sıradaki yerini korumaktadır. Bu çalışmanın amacı cerrahi aletlerin hava kaynaklı partiküllerle kontaminasyonun cerrahi alan enfeksiyonu oluşumundaki rolünün ortaya konmasıdır.

Materyal-Metot: Bu prospektif araştırmada bir aylık zaman diliminde gerçekleştirilen toplam 25 basit ve karmaşık spinal cerrahi olgu üzerinde çalışılmıştır. Cerrahi setten rasgele seçilerek çıkarılan 2 adet aletten kontamine olmadıklarını göstermek amacıyla operasyon öncesi dönemde alet yüzeyinin 1 cm^2 'lik bölümüne sürülerek kültür örnekleri alındı. Aletler cerrahi girişimde kullanılmaksızın birinin üzeri arınık bir şekilde örtülerek muhafaza edildi. Diğeri ise üzeri açık bir şekilde hemşire masasında hava kaynaklı parçacık maruziyetine bırakıldı. Operasyon bitiminde tüm aletlerden tekrar kültür örnekleri alındı.

Bulgular: Preoperatif alınan kültürlerde, hava kaynaklı parçacık maruziyetine bırakılan ve üzeri örtülen aletlerden postoperatif dönemde alınan kültürlerin hiçbirinde üreme olmamıştır. Hiçbir hastada cerrahi alan enfeksiyonu gelişmemiştir.

Sonuç: Operasyon odasında kontaminasyon açısından uygun davranış, minimize edilmiş aktivite, operasyon odası kapı kontrolü gibi gerekli önlemler alındığında cerrahi aletlerin hava kaynaklı partiküllerle kontamine olmayabileceği görülmüştür.

Anahtar Sözcükler: Omurga enfeksiyonları, kontaminasyon, spinal cerrahi, hava kaynaklı

Kanıt Düzeyi: Prospektif klinik çalışma, Düzey II

Address: Op. Dr. Aydın GERİLMEZ, T.C. S.B.U. Umraniye Egitim Arastirma Hastanesi, Elmalikent Mahallesi, Adem Yavuz Cad., No:1, Umraniye, Istanbul, Turkey.
E-mail: aydingerilmez@hotmail.com
Phone: +90 216 632 18 18
Gsm: +90 533 513 21 50
Received: 8th Septenber, 2016.
Accepted: 12th December, 2016.

INTRODUCTION

Surgical site infections (SSI) develop within 30-90 days after surgery and are believed to be related to the surgical incisions or perioperative organ or cavity intervention [4]. These infections, which are the primary of nosocomial infections, continue to be an issue as they result in increased rates of morbidity, healthcare costs and patient dissatisfaction [4,6].

The incidence of SSI is related to contamination of the site (Altemeier classification), the general health status of the patient (ASA classification), and the duration of the operation, and is assessed using the National Nosocomial Infection Surveillance Risk Index (NNIS). This rate has been reported to be 1 % lower in a low-risk patient group and 15 % higher in a high-risk patient group [3].

Contaminating pathogens may be endogenous or exogenous. The source of endogenous pathogens is the skin of the patient. The sources of exogenous pathogens are airborne particles, the hands or other exposed skin areas of the surgical team, mucous membranes, surgical instruments, materials and irrigation solutions [14,17].

In the vast majority of cases, the source held mainly responsible is airborne particles. The direct contamination rate from the patient's skin is only 2 % [18]. In contamination with airborne particles, 30 % is by direct inoculation and 70 % by transfer to the wound through the surgeon's hands or instruments [13].

In clean surgical injuries, microorganisms carrying airborne particles are found to be mostly responsible for surgical site contamination. The source of these airborne particles are usually the skin residues that are spilled from the operating room staff [14,17].

A person leaves 104 skin residues around while walking, and 10 % of these residues carry bacteria [5]. The size of the bacteria-bearing particles is 4-60 micrometers [10-11]. The maximum number of acceptable colonies to reduce postoperative surgical site infection is 103 cfu/mm3. Therefore, perioperative contamination control has become a necessary measure to prevent surgical site infection [12].

Air contamination can be reduced by removing contaminants from the air using an effective ventilation system, limiting the number and activity of people in the operating room, using appropriate clothing and controlling the doors [9,19]. Thus, the use of laminar air flow ventilation systems is recommended in implantation surgeries [7].

However, laminar air flow ventilation systems are expensive and subsequent installation in an operating room is complicated.

The role of airborne particles in the formation of surgical site infection, the contamination of the wound site with these particles, and the postoperative contaminations of surgical instruments have been shown in previous studies. However, there has been little research into whether or not these particles contaminate surgical instruments. The aim of this study was to reveal the role of airborne particle contamination of surgical instruments in surgical site infection.

MATERIALS AND METHODS

In this prospective study, an evaluation was made of a total of 25 simple and 47 complex spinal surgery cases performed over a one month period. The operations comprised 13 microdiscectomies for lumbar disc hernia, three microdiscectomies and cage implantation for cervical disc hernia, five decompression and instrumentation operations for spinal stenosis and instability, two tumor excisions for spinal tumor, and two decompression and instrumentation operations for unstable spinal fracture diagnosis. All operations were performed by the same surgeon in the same operating room with the use of intraoperative x-ray. No blood product was used in any patient. The average duration of the operations was 2.2±-0.5 hours.

Operating Room

The study was performed in a 120 m3 operating room equipped with a standard ventilation system. The average temperature was 19°C±0,5°C, and average humidity was 48.2 % ± 0.8 %.

Surgical Team

The surgical team consisted of a main surgeon, an assistant and a nurse, together with an anesthesiologist, an anesthesia technician and a circulating nurse. The maximum number of people in the operating room during the entire operation was six.

The entire surgical team used sterile, wool-free clothing, facial masks, caps and sterile gloves. The anesthesiologist and technician wore operating scrubs, face masks, caps and disposable gloves. The number of people in the operating room and their activities were minimized, and the operating room door was kept under control during the operation.

Collection of Samples

In order to demonstrate that there were no contaminants in the surgical set preoperatively, two instruments were randomly selected and culture samples were taken from a 1 cm2 surface area of each. The instruments were not used in surgery and one was covered to remain sterile while the other was exposed to airborne particles on the nurse's desk. At the end of the operation, culture samples were taken from all instruments.

Samples were taken by using Stuart transport swab and mediums and sent to the laboratory for calculation of the bacterial load in colony forming units per square centimeter

(cfu/cm2) by cultivation in sheep blood agar and eosin methylene blue agar. The samples were incubated for 48 hours at 37 ° C. 82

RESULTS

The samples taken preoperatively from the airborne particle exposed and sterile covered instruments showed no bacterial growth postoperatively. No surgical site infections developed in any of the patients.

DISCUSSION

Surgical site contaminations in clean surgical wounds are mostly caused by microorganisms in airborne particles. Previous studies about surgical instrument contamination have focused more on the contamination of used instruments. The rate of biological load per instrument has been shown to be closely related to the surgical field in which the instrument is used. Chu-Nancy et al. found the biological load levels after clinical use to be 0 and 4415.

In the current study, the biological load levels were <1000 on 88% of the instruments [(2)]. Gordon Smith et al. showed that microbial contamination on used dental handpieces varies from 42 to 250 cfu/mL16. Percin et al. showed that the bacterial load on used instruments varied between 10 and 102 cfu/cm2. The most contaminant instruments were reported to be those used in reconstructive surgery operations, which was thought to be related to the number of pseudomanas in burn wounds being 106 cfu/g per tissue. No contamination was detected in biopsy instruments, which was associated with the short duration of the intervention. Three instruments used in neurosurgical operations showed only 10 cfu/cm2 bacterial load [(15)].

In many studies on contaminants leading to surgical field infection, airborne particles in the operating room have been found to be responsible. The amount of these particles in the wound and instrumentation areas has been determined. The use of a mobile laminar air flow (LAF) has been suggested to reduce the number of particles.

In a study of airborne contamination, Sossai et al. compared the standard ventilation status with the addition of a LAF unit. Bacterial air contamination in the wound area was determined to be 23.5 cfu/m3 with standard ventilation and 3.5 cfu/m3 with the LAF unit addition. In the instrument desk area, the contamination was found to be almost the same (28.6 cfu/m3, 30.8 cfu/m3). With the addition of the LAF unit, the particle number of 0.5 lm was reduced from 970,533 particles/m3 to 17,361 particles/m3 [(17)].

Amaral et al. studied bacterial contamination on the plastic covered instrument desk and compared the plastic covers sterilized with ethylene oxide and plastic covers also disinfected with 70% alcohol and 1% iodine solutions in clean surgical procedures.

Positive test rates on desk surfaces with the ethylene oxide sterilized plastic covers were 2.9 % before and 45.7 % after surgery. Although bacterial growth in preoperative cultures was not expected, it was detected. No statistically significant difference was determined between ethylene oxide sterilization and disinfection with all protection procedures in respect of colony numbers before and after surgery. Micrococci were identified as the main contaminants in both groups, followed by Staphylococcus aureus. It was claimed that these bacteria were the main microorganisms in the air of the operating room. Only one case resulted in surgical site infection1.

Litrico et al. evaluated cases where disposable instrument sets were used and screws and rods were kept in their sterile packages until the beginning of the implantation, and reported that the infection rate was lower compared to cases where reusable instrument sets were used and this finding was attributed to the reduced exposure time to airborne bacteria [(8)].

Yin et al. demonstrated that the speed of air contamination of air exposed surgical instruments was 1.18 times faster than that of covered surgical instruments by taking samples for cultures at 30, 60 and 90 minutes. It has been suggested that this study provided laboratory evidence of the infection in the operating room [(21)].

In the current study, there was no growth in the preoperative cultures from surgical instruments as expected. Neither was there any growth in the postoperative cultures obtained from the instruments exposed to airborne particles. According to the calculations in this period, the number of particles were determined as 750.456 particles/m3, which is consistent with the literature. It has been observed that surgical instruments may not be contaminated with airborne particles when appropriate precautions are taken, such as appropriate behavior regarding contamination in the operating room, minimized activity, and door control.

A limitation of this study could be said to be that the amount of bacterial contamination (cfu/m3) and particle numbers (particle/m3) in the operating room and on the instrument desk were not calculated.

When appropriate precautions are taken, it is possible to avoid contamination of surgical instruments with airborne particles. Therefore, great attention must be given to appropriate behavior regarding contamination in the operating room, activity must be kept to a minimum, and doors must be controlled.

REFERENCES

1. Amaral AM, Diogo Filho A, Sousa MM, Barbosa PA, Gontijo Filho PP. The importance of protecting surgical instrument tables from intraoperative contamination in clean surgeries. *Rev Lat Am Enfermagem* 2013; 21 (1): 426-432.
2. Chu NS, Chan-Myers H, Ghazanfari N, Antonoplos P. Levels of naturally occurring microorganisms on surgical instruments after clinical use and after washing. *Am J Infect Control* 1999; 27: 315–319.
3. Debarge R, Nicolle MC, Pinaroli A, Ait Si Selmi T, Neyret P. Surgical site infection after total knee arthroplasty: a monocenter analysis of 923 first-intention implantations. *Rev Chir Orthop Reparatrice Appar Moteur* 2007; 93: 582-587.
4. Fernandes AT, Ribeiro N Filho, Oliveira AC. Infecções do Sítio Cirúrgico. In: Oliveira AC (Eds). Infecções Hospitalares Epidemiologia, Prevenção e Controle. *Medsi Rio de Janeiro* 2005; pp: 732.
5. Hambraeus A. Aerobiology in the operating room-a review. *J Hosp Infect* 1988; 11: 68-76.
6. Jenks PJ, Laurent M, McQuarry S, Watkins R. Clinical and economic burden of surgical site infection (SSI) and predicted financial consequences of elimination of SSI from an English hospital. *J Hosp Infect* 2014; 86: 24-33.
7. Lidwell OM, Lowbury EJL, White W, Blowers R, Stanley SJ, Lowe D. The effect of ultraclean air in operating rooms on deep sepsis in the joint after hip or knee replacement: a randomized study. *Br Med J* 1982; 285: 10-14.
8. Litrico S, Recanati G, Gennari A, Maillot C, Saffarini M, Le Huec JC. Single-use instrumentation in posterior lumbar fusion could decrease incidence of surgical site infection: a prospective bi-centric study. *Eur J Orthop Surg Traumatol* 2016; 26 (1): 21-26.
9. Memarzadeh F, Manning A. Comparison of operating room ventilation systems in the protection of the surgical site. *ASHRAE Trans* 2002; 2: 3-15.
10. Noble W, Lidwell O, Kingston D. The size distribution of airborne particles carrying micro-organisms. *J Hyg* 1963; 61: 385-391.
11. Noble WC. Dispersal of skin microorganisms. *Br J Dermatol* 1975; 93: 477–485.
12. Nobre LF, Galvão CM, Graziano KU, Corniani F. Avaliação de indicadores do controle da contaminação da sala de operação: um estudo piloto. *Medicina* 2001; 34(2): 183-193.
13. Pasquarella C, Pitzurra O, Herren T, Poletti L, Savino A. Lack of influence of body exhaust gowns on aerobic bacterial surface counts in a mixed-ventilation operating theatre. A study of 62 hip arthroplasties. *J Hosp Infect* 2003; 54: 2-9.
14. Pasquarella C, Sansebastiano GE, Ferretti S, Saccani E, Fanti M, Moscato U, Giannetti G, Fornia S, Cortellini P, Vitali P, Signorelli C. A mobile laminar air flow unit to reduce air bacterial contamination at surgical area in a conventionally ventilated operating theatre. *J Hosp Infect* 2007; 66: 313-319.
15. Percin D, Sav H, Hormet-Oz HT, Karauz M. The relationship between holding time and the bacterial load on surgical instruments. *Indian J Surg* 2015 ;77 (1): 16-18.
16. Smith G, Smith A, Ramage G. Assessment of biofouling of dental hand pieces after use. Presented at *the 10th World Congress of Sterilization*, Crete, Greece, 2009.
17. Sossai D, Dagnino G, Sanguineti F, Franchin F. Mobile laminar air flow screen for additional operating room ventilation: reduction of intraoperative bacterial contamination during total knee arthroplasty. *J Orthop Traumatol* 2011; 12 (4): 207-211.
18. Talon D, Schoenleber T, Bertrand X, Vichard P. Performances of different types of airflow system in operating theatre. *Ann Chir* 2006; 131: 316-321.
19. Tammelin A, Ljungqvist B, Reinmüller B. Comparison of three distinct surgical clothing systems for protection from air-borne bacteria: a prospective observational study. *Patient Saf Surg* 2012; 6: 23.
20. Whyte W, Hodgson R, Tinkler J. The importance of airborne bacterial contamination of wounds. *J Hosp Infect* 1982; 3: 123-135.
21. Yin SH, Xu SH, Bo YC. Study of surgical instruments contamination by bacteria from air during the operation. *Zhonghua Hu Li Za Zhi* 1996; 31 (12): 690-691.