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■ Original Article

The rate and risk factors of nasal Staphylococcus aureus carriage in hemodialysis patients

Hemodiyaliz hastalarında Staphylococcus aureus nazal taşıyıcılığı oranları ve risk faktörleri

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ABSTRACT

Aim: The aim of the present study was to determine the rates of nasal Staphylococcus aureus (*S. aureus*) and methicillin resistant Staphylococcus aureus (MRSA) carriage in hemodialysis patients and to evaluate the risk factors associated with the carriage.

Material and Methods: A total of 118 patients, 61 female (mean age: 54.20 ± 15.9 years) and 57 men (mean age: 60.33 ± 15.8 years), who underwent hemodialysis were included in the present study. The patients were divided into three groups according to nasal culture results as; grup-1 MRSA nasal carriers, grup-2 methicillin sensitive Staphylococcus aureus (MSSA) nasal carriers and grup-3 cases having no *S. aureus* in nasal cultures. The relationship between nasal MRSA carriage and comorbid diseases (hypertension, diabetes mellitus, pulmonary diseases, and gastrointestinal system disorders), duration of dialysis, hospital admissions in last year, use of antibiotics in the last six months, whether one of the family members working in the hospital as a staff, catheter infection in last year, smoking habits, and serum albumin levels were investigated. The nasal swabs obtained from the patients were inoculated onto mannitol salt agar and Chromogenic MRSA agar (BBL Chromagar MRSA II), respectively, and the isolates were identified using conventional bacteriological methods. Methicillin resistance in the isolated strains was confirmed by the ceftioxin disc diffusion method. The variables that yielded a significant relationship with MRSA carriage in univariate analysis were further analyzed by multivariate logistic regression analysis to determine independent risk factors. A P value ≤ 0.05 was considered statistically significant.

Results: Among the patients, 13 (11%) were nasal carriers of MRSA and 5 (4.2%) were nasal carriers of MSSA. The rate of nasal carriage of MRSA was significantly higher in females and in patients who had sustained catheter infection in the last one year (for females, P = 0.027; for patients with a history of catheter infection, P = 0.037). In the multivariate logistic regression analysis, gender and the history of catheter infection in the last one year appeared as independent risk factors for nasal carriage of MRSA.

Conclusion: Since the history of catheter infection was determined as an independent risk factor for the nasal carriage of MRSA, the researchers consider that the eradication of MRSA carriage might prevent catheter infections that can be caused by this agent.

Keywords: Hemodialysis patients, methicillin - resistant Staphylococcus aureus, nasal carriage, risk factors

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ÖZ

Amaç: Bu çalışmada, kronik böbrek yetmezliği nedeniyle ayaktan hemodiyaliz tedavisi alan hastalarda Staphylococcus aureus (S. aureus) ve MRSA nazal taşıyıcılık oranlarının ve taşıyıcılıkla ilişkili risk faktörlerinin belirlenmesi amaçlandı.

Gereç ve Yöntemler: Kırıkkale ilindeki diyaliz merkezlerinde düzenli hemodiyaliz tedavisi gören 61 kadın (yaş ortalaması: 54,20 ± 15,9), 57 erkek (yaş ortalaması: 60,33 ± 15,8) olmak üzere toplam 118 hasta dahil edildi. Hastalar burun kültürü sonuçlarına göre grup-1 MRSA nazal taşıyıcısı olanlar, grup-2 metisiline duyarlı S.aureus (MSSA) nazal taşıyıcısı olanlar ve grup-3 S.aureus burun taşıyıcısı olmayanlar olmak üzere 3 gruba ayrıldı. Hastalarda eşlik eden hastalıklar (hypertension, diabetes mellitus, akciğer hastalıkları, gastrointestinal sistem hastalığı), diyaliz süresi, son bir yılda hastanede yatış, son 6 ayda antibiyotik kullanımı, ailede hastane personeli varlığı, son bir yılda kateter enfeksiyonu geçirme, sigara alışkanlığı, serum albümin düzeyi ile MRSA burun taşıyıcılığı arasındaki ilişki araştırıldı. Hastalardan alınan burun sürüntü örnekleri sırasıyla; mannitol salt agar ve kromojenik MRSA agar besiyerlerine (BBL Chromagar MRSA II) ekildi, izolatlar konvansiyonel bakteriyolojik yöntemlerle tanımlandı. İzole edilen suşlarda metisilin direnci sefoksitin disk difüzyon yöntemiyle doğrulandı. Verilerin analizi SPSS for Windows 15 paket programında yapıldı. MRSA taşıyıcılığı için tek değişkenli analiz sonucunda anlamlı çıkan değişkenler çok değişkenli lojistik regresyon analizi yöntemiyle değerlendirilerek bağımsız risk faktörleri belirlendi. P ≤ 0,05 değeri için sonuçlar istatistiksel olarak anlamlı kabul edildi.

Bulgular: Hastaların 13'ünde (%11) MRSA burun taşıyıcılığı, 5'inde (%4,2) ise metisiline duyarlı Staphylococcus aureus (MSSA) nazal taşıyıcılığı saptandı. Kadın cinsiyette ve son 1 yılda kateter enfeksiyonu geçirme öyküsü olanlarda MRSA burun taşıyıcılığı oranı istatistiksel olarak anlamlı oranda yüksekti (kadın cinsiyet için P = 0,027, kateter enfeksiyonu geçirme öyküsü için P = 0,037). Çok değişkenli lojistik regresyon analizinde cinsiyet ve son bir yılda kateter enfeksiyonu geçirme öyküsü MRSA burun taşıyıcılığı için bağımsız risk faktörleri olarak belirlendi.

Sonuçlar: Sonuç olarak hemodiyaliz hastalarında MRSA burun taşıyıcılığı için kateter enfeksiyonu geçirme öyküsü bağımsız risk faktörü olarak belirlendiğinden, bu hastalarda MRSA taşıyıcılığının taşıyıcılığın eradikasyonunun bu etkene bağlı olarak gelişebilecek kateter enfeksiyonlarının önlenmesine katkı sağlayacağı görüşündeyiz.

Anahtar kelimeler: Hemodiyaliz hastaları, Metisiline dirençli Staphylococcus aureus, nazal taşıyıcılık, risk faktörleri

Introduction

Many studies have suggested a relationship between nasal carriage of Staphylococcus aureus (S. aureus) and the infections caused by this agent in patients undergoing hemodialysis. The studies have reported higher rates of bacteremia and catheter-related infections in nasal carriers of S. aureus compared to non-carriers [1-4].

Methicillin-resistant Staphylococcus aureus (MRSA) infections have an important place among staphylococcal infections. Many studies have reported an association between nasal MRSA carriage and MRSA infections. The established risk factors for MRSA include hospital stay, use of broad-spectrum antibiotics, surgical intervention, staying in nursery home, and presence of a family member working in the hospital [5,6]. S. aureus is particularly resistant to methicillin. The catheter infections related to MRSA, catheter-related bacteremia and sepsis are important causes of mortality in patients undergoing hemodialysis [7-10]. The compromised immune system in hemodialysis patients, frequent invasive interventions that disrupt skin integrity, frequent hospitalizations, use of antibiotics, frequent and close contact with the hospital staff, and disruption of the normal skin flora contribute to high rates of infections [7,10,11].

The nasal carriage plays an important role in development of infections in patients undergoing hemodialysis [1,2,12,13]. Therefore, detection of nasal carriage in hemodialysis patients and eradication of the infection with proper treatment in nasal carriers are essential to prevent further infections. The aim of the present study was to determine the rate of nasal carriage of MRSA in patients undergoing hemodialysis and to determine the risk factors associated with nasal carriage.

Materials and Methods

A total of 118 patients, 61 female (mean age: 54.2 ± 15.9 years) and 57 men (mean age: 60.3 ± 15.8 years), who underwent hemodialysis between September and December 2013, were included in the present multicenter study.

Hemodialysis patients divided into three groups according to their nasal culture results as group-1: Hemodialysis patients with nasal carriers of MRSA, group-2: Hemodialysis patients with nasal carriers of MSSA, group-3: Hemodialysis patients without nasal carriers of S.aureus (i.e, patients with normal nasal flora)

The patients provided written informed consent and the study was approved by Ethics Committee. The relationship between nasal MRSA carriage and comorbid diseases (hypertension, diabetes mellitus, pulmonary diseases, gastrointestinal system

disorders), duration of dialysis, hospital admissions in the last one year, use of antibiotics in the last six months, the presence of a family member working in the hospital as a staff, catheter infection in the last one year, smoking habit and serum albumin levels were evaluated. The nasal swabs obtained from the patients were inoculated onto mannitol salt agar (Oxoid, UK) and Chromogenic MRSA agar (BBL Chromagar MRSA II, France). Methicillin resistance in the isolated strains was confirmed by ceftaxime disc diffusion method.

Statistical Analysis

The data were analyzed using SPSS 15.0 for Windows software package. The descriptive statistics included mean \pm standard deviation for variables with normal distribution and median (max-min) for variables without normal distribution. Nominal values were indicated as the number of cases (%). The significance of difference between the groups (group- 1, group-2, and group-3) in terms of mean values was tested with Student's t test and Mann-Whitney U test was used to evaluate the significance of difference between median values. The significance of difference between more than two groups in terms of mean values was tested with ANOVA variance analysis and Kruskal-Wallis test was used to evaluate significance of

difference between median values. The nominal values were evaluated using Pearson's Chi-square test or Fischer's exact test. The variables that yielded significant relationship with MRSA carriage in univariate analysis were further analyzed by multivariate logistic regression analysis to determine independent risk factors. A P value \leq 0.05 was considered statistically significant.

Results

Of the total 118 patients, 13 (11%) were nasal carriers of MRSA and 5 (4.2%) were nasal carriers of methicillin sensitive Staphylococcus aureus (MSSA). When compared to the group-1, group-2 and group-3, the rate of nasal carriage for MRSA was significantly higher in females and in patients who sustained catheter infection in the last one year (for females, P = 0.027; for patients with a history of catheter infection, P = 0.037).

In multivariate logistic regression analysis, gender and the history of catheter infection in the last one year appeared as independent risk factors for nasal carriage of MRSA. The demographic features of the patients and the risk factors that could be associated with MRSA nasal carriage are presented in Table 1. The results of multivariate logistic regression analysis are presented in Table 2.

Table 1. The demographic features of the patients and the risk factors that could be associated with MRSA nasal carriage. (n=118 HD patients)

Variables		Group-1 MRSA (n=13)	Group-2 MSSA (n=5)	Group-3 Normal nasal flora (n=100)	P
Gender	Males (n,%)	45 (45%)	4 (80%)	12 (92.3%)	0.002*
	Females (n,%)	55 (55%)	1 (20%)	1 (7.7%)	
Age	Median(min-max)	60 (20 - 85)	70 (49 - 72)	61 (27 - 72)	0.424
Diabetes	(n, %)	41(41%)	2 (40%)	6 (46.2 %)	0.919
Hypertension	(n, %)	48 (48%)	2 (40%)	8 (61.5%)	0.612
Duration of Dialysis	1-10 years	73	4	11	
	10-20 years	13	1	0	
	>20 years	2	0	0	
Catheter infection in the last year	(n,%)	3 (3.4%)	0 (0%)	3 (27.3%)	0.025*
Hospitalization in the last year	(n,%)	34 (38.6%)	0 (0%)	6 (54.5%)	0.106
Use of antibiotics in the last six months	(n,%)	47 (47%)	3 (60%)	10 (76.9%)	0.126
Family member working in the hospital	(n,%)	14 (15.9%)	0 (0%)	0 (0%)	0.439
Smoking	(n,%)	12 (12%)	0 (0%)	2 (15.4%)	0.823
Place of residence	Rural (n,%)	29 (29%)	2 (40%)	2 (15.4%)	0.544
	Urban (n,%)	71 (71%)	3 (60%)	11 (84.6%)	
Pulmonary disease	(n,%)	13 (13%)	0 (0%)	1 (7.7%)	1.000
GIS disorder	(n,%)	18 (18%)	1 (20%)	3 (23.1%)	0.877
Serum albumin level	mean \pm SD	3.91 \pm 0.33	3.09 \pm 0.14	3.77 \pm 0.21	0.413

Abbreviations; MRSA: Methiciline resistant staphylococcus aureus, n: number of patients, SD: standard deviation, GIS: gastrointestinal system, *: significant

Table 2. Results of multivariate logistics regression analysis

	P value	Odds ratio (95% CI)
Gender	0.027*	10.997 (1.32 – 91.69)
Catheter infection in last year	0.037*	7.294 (1.12 – 47.20)

Abbreviation; CI: Confidence interval, *: significant

Discussion

The prevalence of *S. aureus* and MRSA infections is higher in hemodialysis patients compared to normal population. The reason for this higher prevalence is associated with higher rate of nasal carriage among these patients compared to normal population. The studies conducted in Turkey have reported a nasal carriage rate of MRSA ranging between 9.4% and 27.2% in patients undergoing hemodialysis. The studies in the other countries have reported a nasal carriage rate ranging from 2.4% to 21.7% [3,4,7,14-16].

The nasal carriage rate for *S. aureus* in patients undergoing hemodialysis in Turkey was reported to be 67% by Şencan et al [16], 33% by Kurutepe et al [17], and 32.3% by Çelik et al [15]. The nasal carriage rate for MRSA in patients undergoing hemodialysis in Turkey was reported to be 3.9% by Çelik et al [15], 40.4% by Şencan et al [16], 11% by Kurutepe et al [17] and 1.8% by Mutlu et al [18]. The study by Lu et al [3] reported 22% nasal carriage rate for *S. aureus* and 2.4% nasal carriage rate for MRSA, and the study by Lederer et al [4] reported 53% nasal carriage rate for *S. aureus* and 12% nasal carriage rate for MRSA in patients undergoing hemodialysis.

In the present study, the rate of nasal carriage for MRSA was 11% in patients undergoing hemodialysis. The rate of nasal carriage reported in the present study is similar to that reported in the other studies conducted in Turkey or in other countries. Köseoğlu et al [7] studied 466 patients residing in the province of Denizli who underwent hemodialysis, and they isolated *S. aureus* from 204 patients (43.8 %), 34 (16.7 %) of which harbored methicillin-resistant strains. They reported 7.3 % (34/466) nasal carriage rate for MRSA. In multivariate analysis in their study, hospitalization in the last one year and presence of chronic obstructive pulmonary disease were identified as independent risk factors for nasal carriage of MRSA. MRSA nasal carriage rate reported in their study is close to that reported in the current study.

Wang et al [11] studied 541 patients undergoing hemodialysis, and they reported nasal carriage of MRSA in 32 patients (5.9 %) and nasal carriage of MSSA in 89 (16.5%) patients. Congestive heart failures, staying in the nursery home and nutrition via nasogastric tube in the last three months were identified as the risk factors for nasal carriage of MRSA in multivariate analysis.

Patel et al [14] detected MRSA carriage in 12% of 103 patients who underwent hemodialysis. Unsuccessful renal

transplantation, hospital admission in the last six months, use of first generation cephalosporins, cefepime, and vancomycin were identified as risk factors associated with MRSA nasal carriage. In their study, Çelik et al [15] found higher rate of nasal carriage for MRSA in patients undergoing hemodialysis and aged above 61 years. They identified chronic lung disease, history of infectious disease, and deterioration in the general condition as the risk factors in nasal carriers of MRSA.

In the present study, the rate of nasal carriage for MRSA was significantly higher in females and in patients who had sustained catheter infection in the last one year. In multivariate logistic regression analysis, gender and the history of catheter infection in the last one year appeared as independent risk factors for nasal carriage of MRSA.

Saxena AK et al [19] reported that MSSA and MRSA nasal carriage rates among hemodialysis patients >75 years of age were significantly higher. The authors concluded that the elderly hemodialysis patients who were nasal *S. aureus* carriers had an elevated risk of potentially serious complications.

Diaware et al [20] reported that no significant correlation was found regarding the nasal carriage of *S. aureus* and hemodialysis duration, diabetes, sex and recent hospitalization in patients on hemodialysis. Our present study differs from the literature, as MRSA nasal carriage rate was higher in female sex and in the patients who had catheter infection in the last one year.

In the study by Lederer et al [4], the rate of nasal carriage for *S. aureus* was 53% (41% MSSA, 12% MRSA) in 138 patients who underwent hemodialysis. Nasal carriers of MRSA had more advanced age and mostly comprised of those who were hospitalized and had infectious diseases when compared to MSSA carriers. The study found that mupirocin was an effective agent in the eradication of nasal carriage. The infections occurring in outpatient hemodialysis patients and in patients undergoing peritoneal dialysis are often associated with the treatment.

Nasal carriage of *S. aureus* is the most important source for blood infections (bacteremia, endocarditis, and catheter infection) related to *S. aureus*. Thus, infection control measures involving the eradication of nasal colonization are required to prevent blood infections related to *S. aureus* [10-13].

In conclusion, since the history of catheter infection was determined as an independent risk factor for the nasal carriage of MRSA, we consider that the eradication of MRSA carriage might prevent catheter infections that can be caused by this agent.

Declaration of conflicting interests

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